



VIDYA BHARATI MAHAVIDYALAYA AMRAVATI

NAAC Re-accredited with Grade "A"(CGPA 3.23-Third Cycle) | CPE Status (Thrice) by UGC

Mentor College under Paramarsh Scheme by UGC

'Lead College' by S.G.B. Amravati University, Amravati.

3.3.3. Number of books and chapters in edited volumes/books published and papers published in national/ international conference proceedings per teacher during year



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3.3.3. Number of books and chapters in edited volumes/books published and papers published in national/international conference proceedings per teacher during year

Sl. No	Name of the teacher	Title of the book/chapters published	Title of the paper	Title of the proceedings of the conference	Name of the conference	National / International	Year of publication	ISBN/ISSN number of the proceeding	Affiliating Institute at the time of publication	Name of the publisher
1	Dr.Sanjay B.Kadu	NA	Feminism and Consumer Behaviour: How Gender Equality Influences Market Trends	National Conference on "Feminism in 21st Century : Breaking Barriers; Shaping Futures"	National Conference on "Feminism in 21st Century : Breaking Barriers; Shaping Futures"	National	2023-24	978-81-19931-43-9	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Itwari, Nagpur
2	Dr.Suraj.K .Rodde	Recent Trend in Commerce Management and Economics	NA	Recent Trend in Commerce Management and Economics	Chapter Published	National	2023-24	978-81-965543-4-7	Vidya Bharati Mahavidyalaya, Amravati	Eagle Leap printers and Publisher Pvt. Ltd
3	Dr.Suraj.K .Rodde	NA	Technological Innovation in product Development	An International Multidisciplinary half yearly	Multidisciplinary Approach in Technology and Social	International	2023-24	2319-8508	Vidya Bharati Mahavidyalaya	Galaxy Link Ajanta Prakashan

				Research Journal Galaxy	Development ICMATSD-2023				aya Amravati	
4	Dr.Suraj.K.Rodde	NA	Financial Independence and Empowerment: The Role of Microfinance in Supporting Women Entrepreneurs	National Conference on "Feminism in 21st Century : Breaking Barriers; Shaping Futures"	National Conference on "Feminism in 21st Century : Breaking Barriers; Shaping Futures"	National	2023-24	978-81-19931-43-9	Vidya Bharati Mahavidyalaya,Amravati	Sai Jyoti Publication,Itwari, Nagpur
5	Prof. P. J. Deshmukh	BCA II 4th Semester	Advanced Java Programming	NA	NA	National	2023-24	978-81-19880-57-7	Vidya Bharati Mahavidyalaya, Amravati.	Aditya Publication
6	Dr. Lalit K. Vyas	Cosmeceuticals And Nutraceuticals In Cosmetics	NA	NA	NA	National	2023-24	978-93-95021-15-9	Vidya Bharati Mahavidyalaya, Amravati.	Cambridge Book House
7	Dr. Lalit K. Vyas	Advanced Cosmetic Technology	NA	NA	NA	National	2023-24	978-93-95021-24-1	Vidya Bharati Mahavidyalaya, Amravati.	Cambridge Book House
8	Dr. Lalit K. Vyas	NA	Formulation and Evaluation of Layered Lipstick: Innovating Cosmetic Design with Multiple shade	Formulation and Evaluation of Layered Lipstick: Innovating Cosmetic Design with Multiple shade	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication
9	Dr. Lalit K. Vyas and Shrikant D. Pande	NA	Development of skin moisturizer with proven moisturizing	Development of skin moisturizer with proven moisturizing	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication

			properties of plant stem cell active	properties of plant stem cell active						
10	Dr. Lalit K. Vyas and Dr. Shrikant D. Pande	NA	Effect of salt and polymers and their combination on rheology of rinse-off cosmetic products composed of combination of surfactants	Effect of salt and polymers and their combination on rheology of rinse-off cosmetic products composed of combination of surfactants	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication
11	Prof. Y.N. Rajurkar	NA	FORMULATION AND DEVELOPMENT OF GEL SHAMPOO USING GRAPE SEED EXTRACT	FORMULATION AND DEVELOPMENT OF GEL SHAMPOO USING GRAPE SEED EXTRACT	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication
12	Prof. Meeta D. Hemrajani, Dr. Lalit K. Vyas and Prof. Vaishnavi A. Khode	NA	Formulation and Evaluation of Anti-Acne Face Wash Gel by using Extracts of Curry Leaves and Bael Leaves	Formulation and Evaluation of Anti-Acne Face Wash Gel by using Extracts of Curry Leaves and Bael Leaves	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication
13	Prof. Meeta D. Hemrajani and Dr. Lalit K. Vyas	NA	Formulation and Evaluation of Anti-aging Cream by using Mushroom Extract	Formulation and Evaluation of Anti-aging Cream by using Mushroom Extract	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication
14	Meeta D. Hemrajani	NA	Cutaneous Benefits of Snow Mushroom in Cosmetics	Cutaneous Benefits of Snow Mushroom in Cosmetics	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication

15	Dr. Lalit K. Vyas and Mohini.S. Patil	NA	Use on snail secretion as multifunctional cosmetic active.	Use on snail secretion as multifunctional cosmetic active.	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication
16	Dr. Shrikant D. Pande and Dr. Lalit K. Vyas	NA	Development of shampoo with superior hair conditioning properties of Lipoaminoacid technology	Development of shampoo with superior hair conditioning properties of Lipoaminoacid technology	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication
17	Vaishnavi A. Khode, Meeta D. Hemrajani, Tejaswini K.Lilarvhe and Yogita N. Rajurkar	NA	Formulation and Development of Hair Conditioner With Glycolic Acid and Sesame Seed Oil	Formulation and Development of Hair Conditioner With Glycolic Acid and Sesame Seed Oil	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication
18	Mitali S. Kalbande, Tejaswini Lilarvhe and Yogita N. Rajurkar	NA	FORMULATION AND DEVELOPMENT OF BODY MASK WITH ACTIVE DEAD SEA MUD	FORMULATION AND DEVELOPMENT OF BODY MASK WITH ACTIVE DEAD SEA MUD	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication
19	A.V. Gulalkari and T.V. Mehta	NA	The Persimmon fruit extract: Its Dermatological and Cosmetics Benefits	The Persimmon fruit extract: Its Dermatological and Cosmetics Benefits	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication
20	Tejaswini K. Lilarvhe, Mitali S.	NA	Formulation And Development of Skin Lightening Cream using	Formulation And Development of Skin Lightening Cream using	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication

	Kalbande, Vaishnavi A. Khode and Yogita N. Rajurkar		Daisy flower Extract	Daisy flower Extract					aya, Amravati.	
21	Snehal R. Bahadurkar and Aabha N. Waghmare	NA	ADVANCE FORMULATION & DEVELOPMENT OF SCRUB FACE WASH WITH ACTIVE KOJIC ACID	ADVANCE FORMULATION & DEVELOPMENT OF SCRUB FACE WASH WITH ACTIVE KOJIC ACID	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication
22	Dr. LALIT K. VYAS· VASUNDHARA V. MENDHI and JANHAVI G.SHASTRI	NA	FORMULATION AND DEVELOPMENT OF ACNE REPAIR CREAM USING MATCHA ACTIVES	FORMULATION AND DEVELOPMENT OF ACNE REPAIR CREAM USING MATCHA ACTIVES	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication
23	Payal D. Chainani and Dr. Lalit K. Vyas	NA	Formulation and Development of Cleansing Spray using Marine Extract	Formulation and Development of Cleansing Spray using Marine Extract	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication
24	Janhavi G Shastri Dr Lalit K Vyas and Vasundhara V Mendhi	NA	FORMULATION AND DEVELOPMENT OF HAIR COLOUR SPRAY	FORMULATION AND DEVELOPMENT OF HAIR COLOUR SPRAY	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication

25	Aabha N. Waghmare and Snehal R. Bahadurkar	NA	FORMULATION & DEVELOPMENT OF NIGHT CREAM USING BUTTERFLY PEA EXTRACT	FORMULATION & DEVELOPMENT OF NIGHT CREAM USING BUTTERFLY PEA EXTRACT	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication
26	Vaishnavi A. Khode	NA	NANOTECHNOLOGY IN COSMETICS AND COSMECEUTICALS	NANOTECHNOLOGY IN COSMETICS AND COSMECEUTICALS	Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati.	Sai Jyoti Publication
27	Dr Devendra Rangacharya	NA	Recent Trends in Economics: A Comprehensive Review	NA	One day online National Multidisciplinary Conference on Emerging trends in Humanities and Commerce	International	2023-24	ISSN-2278-9308	Vidyabharathi Mahavidyalaya, Amravati	Aadhar Publications
28	Dr Devendra Rangacharya	Feminism in 21st Century: Breaking barriers; Shaping Futures	Gender and Power in Indian History	Feminism in 21st Century: Breaking barriers; Shaping Futures	Feminism in 21st Century: Breaking barriers; Shaping Futures	National	2023-24	978-81-19931-25-5	Vidyabharathi Mahavidyalaya, Amravati	Sai Jyoti Publication Nagpur
29	S. M. Warbhe, P.P. Khade, G. V. Vaidya	NA	Two-Fluid Dark Energy Models in LRS Bianchi Type-I Model in $f(R, T)$ Theory of Gravity	Recent Advancements in Science & Technology	National Conference on "Recent Advancements in Science & Technology"	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya Amravati	Sai Jyoti Publication Nagpur
30	M. S. Palaspar S. M.	NA	Role of Special form of Deceleration	Recent Advancements in Science & Technology	National Conference on "Recent Advancements in	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyal	Sai Jyoti Publication Nagpur

	Varbhe, P. P. Khade		Parameter in $f(R, T)$ theory		Science & Technology"				aya Amravati	
31	P. R. Patil, P. V. Thakare, P. P. Khade	NA	Bianchi type-V Modified Holographic Ricci Dark Energy Model In $f(R, T)$ Gravity	Recent Advancements in Science & Technology	National Conference on "Recent Advancements in Science & Technology"	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya Amravati	Sai Jyoti Publication Nagpur
32	R. V. Jirapure, S. A. Pradhan, P. P. Khade	NA	Quadratic equation of State With Variable Deceleration Parameter In $f(R)$ Gravity	Recent Advancements in Science & Technology	National Conference on "Recent Advancements in Science & Technology"	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya Amravati	Sai Jyoti Publication Nagpur
33	Dr. S. A. Bothra	Basics of Accounting	NA	NA	NA	National	2023-24	978-93-48170-91-0	Vidya Bharati Mahavidyalaya, Amravati	Aditya Publication, Amravati
34	Dr. S. A. Bothra	Financial Accounting	NA	NA	NA	National	2023-24	978-93-48170-47-7	Vidya Bharati Mahavidyalaya	Aditya Publication, Amravati
35	Dr. S. A. Bothra	Personal Financial Programmin g	NA	NA	NA	National	2023-24	978-81-19880-92-8	Vidya Bharati Mahavidyalaya	Aditya Publication, Amravati
36	Dr. S. A. Bothra	Indian Economics	NA	NA	NA	National	2023-24	978-81-19880-86-7	Vidya Bharati Mahavidyalaya	Aditya Publication, Amravati
37	Dr. S. D. Wakode	Developmental Psychology	NA	NA	NA	National	2023-24	978-81-19435--37-1	Vidya Bharati Mahavidyalaya, Amravati	Dnyanpath Publications, Amravati

38	Y. D. Akhare	Vertebrates Structure and Function	NA	NA	NA	National	2023-24	978-93-95021-37-1	VBMV Amravati	Cambridge Book House
39	Y. D. Akhare	Tools and Techniques In Biology	NA	NA	NA	National	2023-24	978-81-951921-2-0	VBMV Amravati	Chandrak Publication
40	Dr. N.R. Thorat	Tools and Techniques In Biology	NA	NA	NA	National	2023-24	978-81-951921-2-0	VBMV Amravati	Chandrak Publication
41	Dr. S. H. Rathod	Tools and Techniques In Biology	NA	NA	NA	National	2023-24	978-81-951921-2-0	VBMV Amravati	Chandrak Publication
42	Y. D. Akhare	Animal Physiology and Endocrinology	NA	NA	NA	National	2023-24	978-93-93561-28-2	VBMV Amravati	Chandrak Publication
43	Dr. N.R. Thorat	Animal Physiology and Endocrinology	NA	NA	NA	National	2023-24	978-93-93561-28-2	VBMV Amravati	Chandrak Publication
44	Dr. S. H. Rathod	Animal Physiology and Endocrinology	NA	NA	NA	National	2023-24	978-93-93561-28-2	VBMV Amravati	Chandrak Publication
45	Dr. R. M. Patil	NA	Feminism in the Works of John Steinbeck	B.Adhar, Single Blind Peer-Reviewed & Refereed Indexed, Multidisciplinary International	International Multidisciplinary Conference of Eco Feminism organized by Smt. Radhadevi	International	2023-24	2278-9308	Vidya Bharati Mahavidyalaya, Amravati	Aadhar International Publication

				Research Journal- International Multidisciplinary Conference of Eco Feminism Conference Proceedings- November- 2023	Goenka College for Women, Akola.					
46	Dr. R. M. Patil	NA	Dear Mrs Naidu: Feminine Sensibilities And Its Expressions In Epistolary Form	B.Adhar, Single Blind Peer- Reviewed & Refereed Indexed, Multidisciplinary International Research Journal- International Multidisciplinary Conference of Eco Feminism Conference Proceedings- November- 2023	International Multidisciplinary Conference of Eco Feminism organized by Smt. Radhadevi Goenka College for Women, Akola.	Internati onal	2023- 24	2278-9308	Vidya Bharati Mahavidyal aya, Amravati	Aadhar Internation al Publicatio n
47	Dr. R. M. Patil	NA	The Evolving Role of Libraries to Boost Research in Humanities	CONFERENCE PROCEEDINGS UGC Sponsored National Conference on Recent Advancements in Science & Technology	UGC Sponsored National Conference on Recent Advancements in Science & Technology at Vidya Bharati Mahavidyalaya, Amravati	National	2023- 24	978-81- 19931-25-5	Vidya Bharati Mahavidyal aya, Amravati	Sai Jyoti Publicatio n , Nagpur
48	Dr. V. P.Shekoka r	NA	Spirit of Women Empowerment in the Writings of Sudha Murty	B.Adhar, Single Blind Peer- Reviewed & Refereed Indexed, Multidisciplinary	International Multidisciplinary Conference of Eco Feminism organized by Smt.	Internati onal	2023- 24	2278-9308	Vidya Bharati Mahavidyal aya, Amravati	Aadhar Internation al Publicatio n

				International Research Journal- International Multidisciplinary Conference of Eco Feminism Conference Proceedings- November- 2023	Radhadevi Goenka College for Women, Akola.					
49	Dr. V. P.Shekokar	NA	Literary Lighthouses: Navigating the Role of Libraries in Enriching English Literature Research	CONFERENCE PROCEEDINGS UGC Sponsored National Conference on Recent Advancements in Science & Technology	UGC Sponsored National Conference on Recent Advancements in Science & Technology at Vidya Bharati Mahavidyalaya, Amravati	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
50	Prof. Capt. Mithilesh Rathore	Nomenclature of Organic Compound	NA	NA	NA	National	2023-24	978-93-95021-46-3	Vidya Bharati Mahavidyalaya, Amravati	Cambridge Book House
51	Prof. Capt. Mithilesh Rathore	Text Book of Physical Chemistry	NA	NA	NA	National	2023-24	978-93-95021-47-0	Vidya Bharati Mahavidyalaya, Amravati	Cambridge Book House
52	Prof. Capt. Mithilesh Rathore	NA	Structural Elucidation of Synthesized Substituted 1,3,4-Thiadiazole Molecules Through Pharmacophore Modelling	Recent Advancements in Science and Technology	UGC Sponsored National Conference on Recent Advancements in Science and Technology-2023	National	2023-24	987-81-19931-25-4	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur.

53	Dr Pravin S Bodkhe	Partial Molar Volumes of Glycine in Aqueous Electrolyte and Non-Electrolyte Solutions	NA	NA	NA	International	2023-24	978-81-19315-72-7	Vidya Bharati Mahavidyalaya, Amravati	DOI: 10.9734/bpi/cteics/v1/19588D
54	Mr. C. N. Jadhav	NA	Structural Elucidation of Synthesized Substituted 1,3,4-Thiadiazole Molecules Through Pharmacophore Modelling	Recent Advancements in Science and Technology	UGC Sponsored National Conference on Recent Advancements in Science and Technology-2024	National	2023-24	987-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur.
55	Pradnya Nalawade	Recent Trends in Research in Chemical Sciences	Solvent Less Synthesis of nanomaterials and organic heterocyclic compound: A Brief Review Pg. No. 179-184	Recent Trends in Research in Chemical Sciences	UGC Sponsored National Conference on Recent Advancements in Science and Technology-2024	National	2023-24	978-93-5854-449-7	Vidya Bharati Mahavidyalaya, Amravati	Pragati Prakashan
56	Dr. M. U. Ghurde	NA	A Study on Morpho-Anatomical & Phytochemical Characterization of <i>Euphorbia stenoclada</i> Bail (An endangered species)	Conference Proceedings UGC Sponsored National Conference On "Recent Advancements In Science & Technology"	National Conference On Recent Advancements in Science & Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
57	Dr. M. U. Ghurde	NA	To Investigate the Impact of Extraction	Conference Proceedings UGC Sponsored	National Conference On Recent	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya	Sai Jyoti Publication

			Methods on the Presence of Organic Compounds in Natural Dye	National Conference On "Recent Advancements In Science & Technology"	Advancements in Science & Technology				aya, Amravati	tion, Nagpur
58	Dr. M. U. Ghurde	Phytochemical Evaluation of Some Medicinal plants	NA	NA	NA	International	2023-24	978-620-6-75330-8		LAP LAMBERT Academic Publishing
59	Ms. N. N. Kakpure	NA	Qualitative Analysis of Phytochemicals in Leaf Extracts of <i>Dypsis lutescens</i>	Conference Proceedings UGC Sponsored National Conference On "Recent Advancements In Science & Technology"	National Conference On Recent Advancements in Science & Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
60	Ms. N. N. Kakpure	NA	Preliminary Studies on Air Pollution Tolerance Index (APTI) of some plant species in the Amravati Region	Conference Proceedings UGC Sponsored National Conference On "Recent Advancements In Science & Technology"	National Conference On Recent Advancements in Science & Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
61	Ms. L. P. Khalid	NA	Effect of Gibberellic Acid on Seed Germination and Metabolism in <i>Brassica juncea L.</i>	Conference Proceedings UGC Sponsored National Conference On "Recent Advancements In	National Conference On Recent Advancements in Science & Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur

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62	Dr. P. V. Pulate	NA	Arbuscular mycorrhizal fungi diversity in coal mine soil of <i>Datura metal</i> at Chandrapur district.	Conference Proceedings UGC Sponsored National Conference On "Recent Advancements In Science & Technology"	National Conference On Recent Advancements in Science & Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
63	Ms. J. B. Patil	NA	Elemental Analysis of <i>Limonia acidissima</i> : Insights into Nutritional Composition and Potential Health Benefits.	Conference Proceedings UGC Sponsored National Conference On "Recent Advancements In Science & Technology"	National Conference On Recent Advancements in Science & Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
64	Prof. Ather Iqbal	NA	Study on the Fog Edge Cloud computing based on IOT: Architecture security and Privacy issues	Recent Advancements in Science & Technology	National Conference on Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
65	Prof. Ather Iqbal	NA	Web Page Segmentation Approaches for Extracting Informative Web Content	Recent Advancements in Science & Technology	National Conference on Emerging Trends in Computational Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
66	Prof. D. M. Kene	NA	Various Approaches for Content Extraction from	Recent Advancements in Science & Technology	National Conference on Recent Advancements in	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur

			Web Pages based on Factors		Science and Technology				aya, Amravati	
67	Prof. D. M. Kene	NA	Review Paper on Characteristics, Benefits and Challenges in Cloud Computing	Recent Advancements in Science & Technology	National Conference on Emerging Trends in Computational Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
68	Dr. Shilpa S. Sarvaiya	NA	IoT Node Security Attacks on Device Layer: Attacks Detection Countermeasures and Solutions	Recent Advancements in Science & Technology	National Conference on Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-5	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
69	Mrs. Shital M. Mohod	NA	Overview and Classification of Social Security Attacks using Online Social Networking for Rumour Blocking	Recent Advancements in Science & Technology	National Conference on Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-6	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
70	Miss. Dipika S. Harode	NA	Big Data: Security and Security Challenges	Recent Advancements in Science & Technology	National Conference on Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-8	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
71	Prof. S. M Mohod	NA	Internet of Things: Applications and Security Challenges	Recent Advancements in Science & Technology	National Conference on Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-9	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
72	Ms. Kavita Kishor Yadav	NA	A Review on Big Data Challenges and Hadoop Technology	Recent Advancements in Science & Technology	National Conference on Recent Advancements in	National	2023-24	978-81-19931-25-10	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur

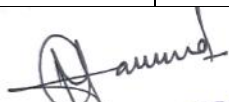
					Science and Technology				aya, Amravati	
73	Ms. Mayuri A. Deshmukh	NA	Role of Nanotechnology and Artificial Intelligence in aroma	Recent Advancements in Science & Technology	National Conference on Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-11	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
74	Miss. Aparna R. Sapate	NA	Artificial Intelligence: Advanced Analysis and Design	Recent Advancements in Science & Technology	National Conference on Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-12	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
75	Dr. Shilpa B. Sarvaiya	NA	Cloud Computing: Types, Security Issues, Benefits	Recent Advancements in Science & Technology	National Conference on Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-13	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
76	Prof. Dipika S. Harode	NA	A Deep Dive Into Extended Reality -Six Sense Integration- Merging Real And Virtual World	Recent Advancements in Science & Technology	National Conference on Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-14	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
77	Ms. Mayuri A. Deshmukh	NA	Cyber Security: Hacking, Child Pornography, Virus Dissmination	Recent Advancements in Science & Technology	National Conference on Recent Advancements in Science and Technology	National	2023-24	978-81-19931-25-15	Vidya Bharati Mahavidyalaya, Amravati	Sai Jyoti Publication, Nagpur
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Feminism and Consumer Behaviour: How Gender Equality Influences Market Trends

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Abstract

The interplay between feminism and consumer behavior has grown increasingly significant as gender equality advances globally. This paper explores how feminist ideologies shape consumer preferences, purchasing decisions, and market trends. By examining the evolving role of gender equality in advertising, product development, and brand loyalty, the study highlights the impact of feminist principles on contemporary consumer markets. Through an analysis of existing literature and case studies, this paper provides insights into the strategies that businesses can adopt to cater to a more gender-conscious consumer base. Ultimately, this research underscores the importance of integrating feminist perspectives into marketing practices to foster inclusive and sustainable economic growth.

Introduction

Feminism, as a social and political movement advocating for gender equality, has profoundly influenced various aspects of society, including consumer behavior. The increasing awareness and acceptance of feminist principles have led to significant shifts in market trends, as consumers demand more gender-inclusive products and ethical business practices. This paper examines the relationship between feminism and consumer behavior, focusing on how gender equality shapes market trends. It aims to provide a comprehensive understanding of the impact of feminist ideologies on consumer preferences and the implications for businesses in adapting to these changes. By exploring the evolving role of gender equality in advertising, product development, and brand loyalty, the study highlights how feminist principles influence contemporary consumer markets. Through an analysis of existing literature and case studies, this paper provides insights into the strategies that businesses can adopt to cater to a more gender-conscious consumer base. Ultimately, this research underscores the importance of integrating feminist perspectives into marketing practices to foster inclusive and sustainable economic growth..

Literature Review

Feminism and Consumer Behaviour

The feminist movement has contributed to a heightened awareness of gender issues, influencing consumer attitudes and behaviours. Studies have shown that consumers, particularly women, are increasingly considering feminist values in their purchasing decisions. For instance, products and brands that promote gender equality and women's empowerment tend to resonate more with modern consumers (Maclaran, 2015).

Gender Equality in Advertising

Advertising plays a crucial role in shaping consumer perceptions and behaviors, influencing how individuals view themselves and others within the context of society. Traditional gender stereotypes in advertising, which often depict men and women in rigid and limiting roles, have been challenged by feminist critiques. These critiques have brought to light the need for more inclusive and diverse representations of gender, pushing brands to rethink their marketing strategies (Gill, 2008).

As a result, there has been a noticeable shift towards advertisements that promote gender equality and challenge conventional stereotypes. These progressive advertisements feature diverse portrayals of individuals, moving away from outdated and simplistic gender norms. This shift not only reflects societal changes but also resonates with a growing consumer base that values inclusivity and authenticity.

Research indicates that advertisements promoting gender equality and challenging stereotypes can significantly enhance brand image and consumer loyalty. Consumers are more likely to support brands that align with their values and demonstrate a commitment to social progress. For instance,

brands that feature empowered female characters, supportive male figures, and non-binary individuals tend to foster a deeper connection with their audience (Eisend, 2010).

Product Development and Gender-Inclusive Design

The influence of feminism extends to product development, with a growing emphasis on gender-inclusive design. Companies are increasingly recognizing the importance of creating products that cater to diverse consumer needs, moving away from traditional gendered assumptions (Schroeder & Borgerson, 2010). This shift not only meets the demands of a more inclusive consumer base but also fosters innovation and competitiveness.

Brand Loyalty and Ethical Consumerism

Feminist principles also impact brand loyalty and ethical consumerism. Consumers are more likely to support brands that align with their values, including gender equality and social responsibility (Thompson, 2015). Ethical consumerism, which encompasses the consideration of social and environmental impacts of purchasing decisions, has gained momentum, further reinforcing the relevance of feminist ideologies in shaping market trends (Harrison, Newholm, & Shaw, 2005).

Methodology

This research adopts a qualitative approach, utilizing a comprehensive literature review and case study analysis. The literature review encompasses scholarly articles, books, and reports on feminism, consumer behavior, and market trends. Case studies of companies that have successfully integrated feminist principles into their marketing strategies provide practical insights into the application of these concepts.

Findings and Discussion

Shifts in Consumer Preferences

The growing influence of feminism has led to significant shifts in consumer preferences, profoundly affecting the marketplace. Modern consumers, particularly millennials and Gen Z, are increasingly conscious of social issues and tend to align their purchasing decisions with their values. This demographic is more likely to support brands that actively promote gender equality, diversity, and social justice, rejecting those that perpetuate outdated stereotypes or unethical practices.

This shift is evident in the increased demand for products that are gender-neutral, ethically produced, and socially responsible. Gender-neutral products, which do not conform to traditional gender binaries, have gained popularity as they resonate with a more inclusive and progressive consumer base. Fashion brands, for instance, are launching unisex clothing lines that appeal to consumers seeking freedom from conventional gender norms.

Ethically produced goods are also in high demand, as consumers become more aware of the social and environmental impact of their purchases. This includes a preference for products that are fair trade, sustainably sourced, and produced under humane working conditions. Brands that demonstrate transparency in their supply chains and commit to ethical practices are more likely to gain consumer trust and loyalty.

Social responsibility has become a key factor in consumer decision-making. Modern consumers expect brands to take a stand on important social issues, such as gender equality, racial justice, and environmental sustainability. Companies that engage in corporate social responsibility (CSR) initiatives and support relevant causes are better positioned to attract and retain customers who value these commitments.

Moreover, the influence of social media has amplified these trends, as consumers use platforms to share their opinions and experiences with brands. Positive endorsements from influencers and peers can boost a brand's reputation, while negative feedback can quickly damage it. This has led to a greater emphasis on authenticity and genuine engagement with social issues in marketing strategies.

In essence, the growing influence of feminism and the heightened awareness of social justice among modern consumers are reshaping the market landscape. Brands that embrace these values and adapt to these shifts are more likely to succeed in the competitive marketplace. By prioritizing gender equality, ethical production, and social responsibility, companies can not only meet the demands of contemporary consumers but also contribute to a more equitable and sustainable world. This evolution in consumer preferences underscores the importance of aligning business practices with the progressive values of the modern consumer base.

Impact on Advertising Strategies

The impact of feminist ideologies on advertising strategies is profound, marking a significant shift in how brands approach their marketing campaigns. Traditional advertising often relied on gender stereotypes that reinforced limited and outdated roles for men and women. However, as feminist ideologies gain traction, there is a growing movement towards inclusive advertising that challenges these stereotypes and promotes diversity.

Brands are increasingly recognizing the importance of representing a wide range of identities and experiences in their advertisements. This includes featuring women in roles that highlight their strength and independence, showcasing men in nurturing and supportive roles, and including non-binary and gender non-conforming individuals. This approach not only aligns with contemporary social values but also resonates deeply with a diverse consumer base that seeks authenticity and inclusivity.

Campaigns such as Dove's "Real Beauty" have set a precedent for this inclusive approach. Launched in 2004, Dove's campaign aimed to challenge conventional beauty standards by featuring women of various ages, sizes, and ethnicities. The campaign's success underscored the power of positive and empowering messages, as it celebrated real beauty and diversity, ultimately enhancing brand loyalty and consumer trust.

Similarly, Nike's "Dream Crazier" campaign has made a significant impact by promoting messages of empowerment and resilience. This campaign, which features prominent female athletes like Serena Williams and Megan Rapinoe, highlights the achievements of women who defy societal expectations and break barriers in sports. By celebrating these inspiring figures, Nike has effectively connected with consumers who value gender equality and empowerment.

These examples demonstrate how feminist ideologies can shape advertising strategies to create more meaningful and impactful campaigns. By moving away from traditional gender roles and promoting diverse and empowering messages, brands can build stronger emotional connections with their audience. This not only enhances brand image but also drives consumer loyalty and engagement.

Moreover, inclusive advertising has proven to be a smart business strategy. Research indicates that consumers are more likely to support brands that reflect their values and promote social justice. Inclusive campaigns generate higher engagement and positive sentiment, contributing to increased brand equity and market share.

The influence of feminist ideologies on advertising strategies is reshaping the landscape of marketing. Brands that embrace inclusivity and diversity in their advertisements are better positioned to resonate with modern consumers. Campaigns like Dove's "Real Beauty" and Nike's "Dream Crazier" exemplify how positive and empowering messages can enhance brand perception and loyalty. As the demand for authenticity and social responsibility continues to grow, brands that align their advertising strategies with feminist principles will likely achieve greater success in the marketplace.

Gender-Inclusive Product Development

The demand for gender-inclusive products has led to innovations in product development. Companies are designing products that cater to a wider range of consumer needs, breaking away from traditional gender binaries. For example, fashion brands are creating gender-neutral clothing lines, and tech companies are developing products with features that consider the needs of all genders (Fisher & Smith, 2021).

Ethical Consumerism and Brand Loyalty

Ethical consumerism, driven by feminist values, has become a significant factor in brand loyalty. Consumers are increasingly prioritizing brands that demonstrate a commitment to social and environmental responsibility. This trend is evident in the rise of certifications such as Fair Trade and B Corp, which signify a company's dedication to ethical practices (Caruana & Crane, 2008).

Case Studies

Case Study 1: Dove's "Real Beauty" Campaign

Dove's "Real Beauty" campaign, launched in 2004, aimed to challenge traditional beauty standards and promote body positivity. The campaign featured women of diverse ages, sizes, and ethnicities, resonating with consumers who felt underrepresented in mainstream media. The success of the campaign highlights the power of inclusive advertising in building brand loyalty and driving sales (Etcoff, Orbach, Scott, & D'Agostino, 2004).

Case Study 2: Nike's "Dream Crazier" Campaign

Nike's "Dream Crazier" campaign, launched in 2019, celebrated female athletes who defy stereotypes and break barriers in sports. The campaign featured prominent athletes such as Serena Williams and Megan Rapinoe, emphasizing themes of empowerment and resilience. The positive reception of the campaign underscores the impact of feminist principles on consumer engagement and brand perception (Johnson & Taylor, 2020).

Case Study 3: Gender-Neutral Fashion Brands

Several fashion brands have embraced gender neutrality, creating clothing lines that cater to all genders. Brands such as Phluid Project and Telfar have gained popularity by promoting inclusivity and challenging traditional gender norms in fashion. These brands have successfully tapped into the growing demand for gender-neutral products, reflecting the influence of feminist ideologies on consumer preferences (Fisher & Smith, 2021).

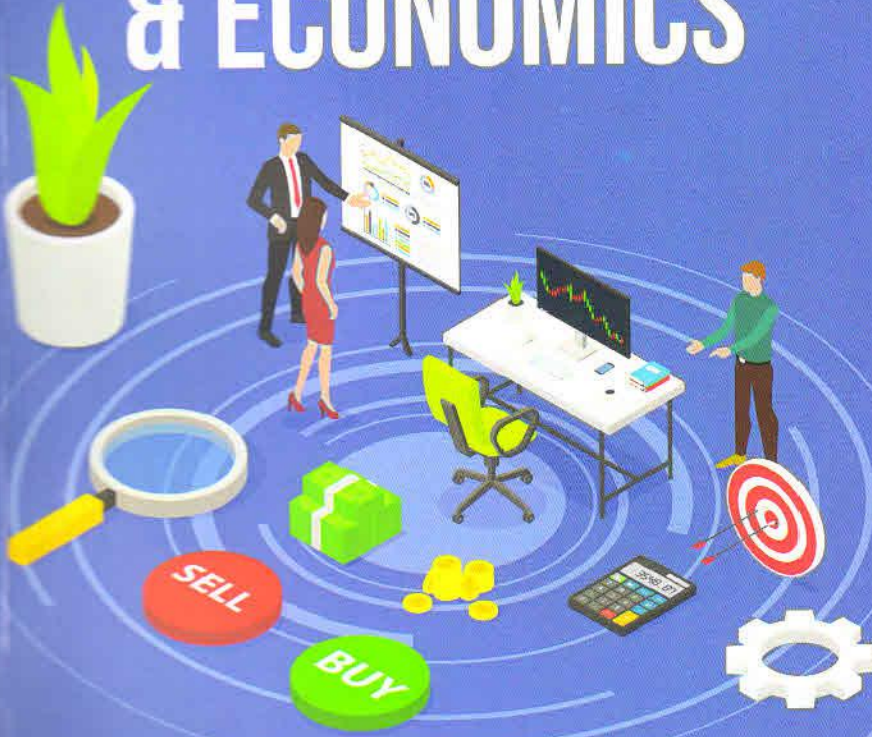
Conclusion

The influence of feminism on consumer behavior and market trends is undeniable. As gender equality continues to gain prominence, consumers are increasingly seeking products and brands that align with feminist values. This shift presents both challenges and opportunities for businesses, emphasizing the need for gender-inclusive practices in advertising, product development, and corporate social responsibility. By embracing feminist principles, companies can foster a more inclusive and sustainable market, ultimately benefiting both consumers and businesses.

References

1. Caruana, R., & Crane, A. (2008). Constructing consumer responsibility: Exploring the role of corporate social responsibility. *Journal of Business Ethics*, 79(4), 425-440.
2. Eisend, M. (2010). A meta-analysis of gender roles in advertising. *Journal of the Academy of Marketing Science*, 38(4), 418-440.
3. Etcoff, N., Orbach, S., Scott, J., & D'Agostino, H. (2004). *The real truth about beauty: A global report*. Dove.
4. Fisher, M., & Smith, A. (2021). Gender-neutral fashion: The rise of inclusive clothing. *Fashion Studies*, 9(2), 121-135.
5. Gill, R. (2008). Empowerment/sexism: Figuring female sexual agency in contemporary advertising. *Feminism & Psychology*, 18(1), 35-60.
6. Harrison, R., Newholm, T., & Shaw, D. (2005). *The ethical consumer*. Sage.
7. Johnson, G., & Taylor, J. (2020). Marketing to millennials: The influence of gender equality on brand loyalty. *Journal of Consumer Marketing*, 37(3), 321-333.
8. Maclaran, P. (2015). Feminism's fourth wave: A research agenda for marketing and consumer research. *Journal of Marketing Management*, 31(15-16), 1732-1738.
9. Nash, J. (2017). Consuming interests: The role of feminism in ethical consumption. *Feminist Media Studies*, 17(3), 453-467.
10. Schroeder, J. E., & Borgerson, J. L. (2010). Ethical issues of representation in marketing: Avoiding commodification and gender stereotyping. *Marketing Theory*, 10(2), 167-188.
11. Thompson, C. J. (2015). The political economy of consumption: Insights from the marketing/consumer behavior literature. *Journal of Marketing Management*, 31(15-16), 1811-1838.
12. Dove. (2004). *The real truth about beauty: A global report*. Retrieved from <https://www.dove.com>
13. Phluid Project. (2021). About us. Retrieved from <https://www.thephfluidproject.com>
14. Telfar. (2021). Our story. Retrieved from <https://www.telfar.net>
15. Nike. (2019). Dream crazier. Retrieved from <https://www.nike.com>

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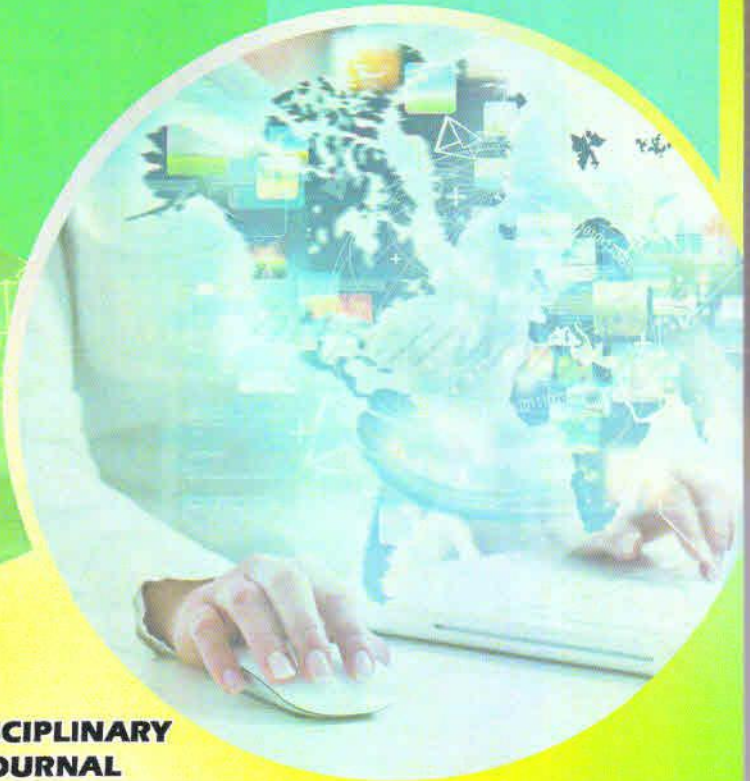
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Ajanta Prakashan

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19. Technological Innovations in Product Development

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Summary

New product development is the most significant part for any organization to extend organizations life cycle. Since decades we are seeing that organizations are involved in new product development process for the satisfaction of human wants. In earlier era there wasn't enough technological support to develop the product but as human race has started exploring, technological innovations made everything possible for human being to manufacture. In this study we shall emphasize on the technological innovations in new product development. Also we shall study how these technological innovations plays significant role in the development of new product and satisfies the various needs of human being. Products are made for satisfaction of human needs and wants. But mere production of products is not sufficient enough to satisfy the need of human being, the product should have all the features and should perform well to meet the expectations of human beings. And now a days many organizations are focusing on customer delightment. Hence this study plays important role for both customers and the organizations to get that expected delightment.

Keywords: Technology, Innovations, Product development, needs, satisfaction

Introduction

Product development in an organization is a continuous process. Every organization keeps looking for a new product or development of new product by its technological innovations and skilled managerial abilities. Reason behind is obvious that the life of every organization is closely related with the life of its product. Although there is defined new product development stages still technological innovations plays vital role in new product development. It is rightly said that new product means new profits, but at the same time if product fails it not only affects or spoils image of the organization but also waste all resources incurred viz time, money and efforts. Hence it becomes very important for an manager to make a proper survey of the market before initiating the process of new product development so that the losses can be avoided.

New product development is defined by many authors. The overall process of conceptualizing, designing, planning, and commercializing a new product in an effort to bring it to market is called as new product development. According to Arena solutions: new product development (NPD) is the overall process of conceptualization, designing, planning, and commercializing a new product in an effort to bring it to the market. There are several different approaches to this process. Some approaches are customer centered, team based. A plan that includes: details of your new product concept. Time frames, from conception to implementation. Market and customer needs. Barriers in the development.

According to tech target Product development -- also called new product management -- is a series of steps that includes the conceptualization, design, development and marketing of newly created or newly rebranded goods or services. Product development includes a product's entire journey -- from the initial idea to after its market release. The objective of product development from a business standpoint is to cultivate, maintain and increase a company's market share by satisfying consumer demand. From a customer standpoint, it's to ensure value in the product as a quality good or service. Not every product will appeal to every customer or client base, so defining the target market for a product is a critical step that must take place early in the product development process. Organizations should conduct quantitative market research at all phases of the design process, including before the product or service is conceived, while the product is being designed and after the product has been launched.

Technological innovations are defined by stat that A technological innovation is a new or improved product or process whose technological characteristics are significantly different from before. Implemented technological product innovations are new products (product innovations) or processes in application (process innovations) that have been brought to market. Innovation is to bring something new or to make new uses of the existing ones. Innovations are a continuous process for every organization. It keeps the market competitive and due to this competition ultimately customers get benefitted as they have more optiona and alternatives available with them in respect of products, range, price, colors etc. But this concept varies from organization to organization and product to product as well. What kind of product is being produced makes all the difference.

Stages of New Product Development

Every product before entering into its life cycle undergoes the stages of new product development. There are six different stages from which every product goes. These stages are as below

New Product Development Stages

IDEA GENERATION OR GENERATION OF IDEAS



SCREENING OF IDEAS



CONCEPT TESTING



PRODUCT DESIGNING AND DEVELOPMENT



TEST MARKETING



PRODUCT LAUNCHING OR COMMERCIALIZATION

- i. **Idea Generation Stage:** In this stage different ideas are generated from various sources. These sources are mostly categorized into internal source and external source. These are Marketing executives of the organization, research and development team, customers, competitors etc.

Customer problems are the most fertile grounds for generation of ideas for any organization. Products ranging from shampoo to computers are a result of customer problems. Once these customer problems are known to the organizations, they try to pick up the idea and make the product accordingly. Another good source of generation of ideas is research and development department of the organization. This department continuously keeps doing research work on product, its uses; its impact on customers etc hence remains in good position to generate ideas for new product development. The

best source is marketing executives of the organization as they remain in constant touch with the market i. e. with both customers and the competitors and makes themselves best source of the generation of ideas for new product development. Another source is competitors. What they are introducing in the market or what kind of changes they are bringing their product can again become a good source for our organization.

And lastly the employees of the organization are called for discussion on new product. None of them are criticized so that the discussion should go without interruption. The whole discussion is recorded on a tape recorder and this process is called as brain storming process. The number of ideas generated in this stage are analyzed and screened in the next stage.

- ii. Screening of Ideas Stage:** N number of ideas is generated in first stage of new product development. Now, the organization has to decrease the number of ideas. They will immediately drop bad ideas as unnecessary cost has to be incurred on it processing and they proceed with the good ideas. The good ideas and bad ideas are decided on the feasibility of idea, its comparison with companies ideology and available resources to process the ideas.
- iii. Commercial Feasibility:** The product planners evaluate the nature & importance of market needs & appraise the extent to which present products fulfill them, they evaluate new ideas in the light of companies capability with respect to scientific knowledge, technical skills & financial resources. Only most feasible & profitable ideas are picked up for further detail investigation. Marketing research is critical in this phase since it can reveal the changing behavior of buyers, strategies of competitions & availability of new technological ideas.
- iv. Product Designing & Development :** The product idea or the concept possess the test, we can then proceed to the engineering or the production or the research & development stage. So far, what we had was only a description or an idea. Now this has to be converted.(sampling, Demo Product) into product. Prototypes are developed & tasted. The test can be done under laboratory or field conditions. At this stage of product development, the technical problem if any, must be solved. This is because the product must not suffer from complaints regarding quality in use. Even a small defect might shorten the life cycle of the product as well as special the companies image.

The packaging, labelling & branding of a product these decisions are made in this stage.

v. **Test Marketing or Product testing Stage** :Test marketing is necessary to find out capability of marketing program for large scale distribution. In fact the following can be stated as the requirement for the new products after it is design.

1. Satisfactory Performance,
2. Customer acceptance,
3. Economical Production,
4. Adequate Distribution,
5. Adequate Servicing arrangement,
6. Effective packaging & branding

A market test should therefore be conducted before launching the new product. This will help us to find out whether the product can be launched successfully on the commercial scale or not.

vi. Commercialization or Launching the New Product



Conclusion and Discussion

- Product development is a continuous process and has to go through various stages to come with an final idea in the market. This is the most crucial and significant part for any organization as the life of every organization is totally depends on products life.



16

Financial Independence and Empowerment: The Role of Microfinance in Supporting Women Entrepreneurs

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Abstract

Microfinance has emerged as a vital tool for promoting financial independence and empowerment among women entrepreneurs, particularly in developing countries. By providing access to financial services, microfinance institutions (MFIs) help women overcome traditional barriers to economic participation, fostering entrepreneurship and economic growth. This paper explores the role of microfinance in supporting women entrepreneurs, analyzing its impact on financial independence, empowerment, and social development. Through a comprehensive review of existing literature and case studies, the research highlights the successes and challenges of microfinance programs and offers insights into how they can be optimized to better serve women entrepreneurs.

Introduction

Financial independence is a critical factor in empowering women and promoting gender equality. In many parts of the world, women face significant barriers to accessing financial resources, which limits their economic opportunities and ability to contribute to their communities. Microfinance has been recognized as a powerful tool to address these challenges by providing women with the financial services they need to start and grow their businesses. This paper examines the role of microfinance in supporting women entrepreneurs, focusing on its impact on financial independence and empowerment. The analysis draws on a range of studies and case examples to provide a comprehensive understanding of the benefits and limitations of microfinance for women entrepreneurs.

Literature Review

Microfinance and Women's Economic Empowerment

Microfinance encompasses a variety of financial services, including microloans, savings accounts, and insurance, designed to meet the needs of low-income individuals and small businesses. For women, microfinance offers a pathway to economic empowerment by providing access to capital, financial literacy training, and support networks (Kabeer, 2005). Research indicates that women who participate in microfinance programs are more likely to invest in their businesses, improve their financial management skills, and achieve greater economic stability (Mayoux, 2000).

The Impact of Microfinance on Financial Independence

Financial independence for women involves having control over financial resources and the ability to make economic decisions. Microfinance contributes to this independence by enabling women to generate their own income and reduce their dependence on male family members or external aid (Armendáriz & Morduch, 2010). Studies show that women with access to microfinance services experience increased household income, improved savings habits, and greater financial autonomy (Pitt & Khandker, 1998).

Challenges and Limitations of Microfinance

While microfinance has many benefits, it also faces several challenges. High interest rates, limited access to larger loans, and the risk of over-indebtedness are significant concerns (Bateman, 2010). Additionally, cultural and social barriers can impede women's ability to fully benefit from microfinance services. For example, in some regions, women may lack the mobility or social support to engage in entrepreneurial activities effectively (Rahman, 1999).

Case Studies of Successful Microfinance Programs

Several case studies highlight the positive impact of microfinance on women entrepreneurs. The Grameen Bank in Bangladesh, for instance, has successfully empowered thousands of women by providing microloans and fostering a supportive community (Yunus, 2007). Similarly, organizations like BRAC and FINCA have implemented innovative microfinance programs that prioritize women's empowerment and financial inclusion (BRAC, 2016; FINCA, 2019).

Methodology

This research employs a qualitative approach, incorporating a comprehensive review of existing literature and analysis of case studies. The literature review draws on academic articles, reports, and books that examine the relationship between microfinance and women's economic empowerment. Case studies of prominent microfinance institutions provide practical insights into the implementation and impact of microfinance programs. Data is sourced from reputable databases and organizations, ensuring the reliability and validity of the findings.

Findings and Discussion

Enhancing Financial Independence through Microfinance

Microfinance has proven effective in enhancing financial independence for women entrepreneurs. Access to microloans enables women to start or expand businesses, leading to increased income and economic stability. For instance, a study conducted by Khandker (2005) found that women who received microloans from the Grameen Bank in Bangladesh experienced significant improvements in household income and financial security.

Moreover, microfinance programs often include financial literacy training, which equips women with essential skills for managing their finances and making informed economic decisions. This training helps women develop budgeting, saving, and investment strategies, further contributing to their financial independence (Ledgerwood, 1999).

Empowerment through Economic Participation

Economic participation is a key aspect of empowerment. By providing women with the resources to engage in entrepreneurial activities, microfinance enhances their social and economic status. Women who own businesses can assert greater control over their lives and participate more actively in their communities (Swain & Wallentin, 2009).

For example, a study by Garikipati (2008) found that women in India who participated in microfinance programs reported increased decision-making power within their households and communities. This empowerment extends beyond economic benefits, fostering a sense of agency and self-worth.

Social Benefits of Microfinance

The social benefits of microfinance extend beyond individual empowerment. Women who participate in microfinance programs often invest in their children's education and healthcare, leading to broader social development. Additionally, the formation of support networks among women entrepreneurs fosters solidarity and collective action, further enhancing their social capital (Mayoux, 2001).

Addressing Challenges and Limitations

Despite its successes, microfinance faces challenges that need to be addressed to maximize its impact. High interest rates can burden borrowers and limit the benefits of microloans. Strategies to reduce interest rates and provide more affordable financing options are essential (Bateman, 2010).

Moreover, addressing cultural and social barriers is crucial. Programs should incorporate measures to enhance women's mobility and social support, enabling them to engage in entrepreneurial activities more effectively. Community-based approaches that involve men and other family members can help create a supportive environment for women entrepreneurs (Rahman, 1999).

Case Study: Grameen Bank

The Grameen Bank in Bangladesh is a pioneering example of successful microfinance for women. Founded by Muhammad Yunus, the bank provides small loans to impoverished women, enabling them to start or expand businesses. The Grameen Bank model emphasizes group lending, where women form small groups to support each other and ensure loan repayment (Yunus, 2007).

The impact of the Grameen Bank has been transformative. Thousands of women have achieved financial independence, improved their living standards, and gained greater social recognition. The bank's success highlights the potential of microfinance to empower women and drive economic development (Khandker, 2005).

Case Study: BRAC

BRAC, one of the largest non-governmental organizations in the world, has implemented comprehensive microfinance programs that prioritize women's empowerment. BRAC's approach includes financial services, skills training, and social support, creating a holistic model for economic empowerment (BRAC, 2016).

In Bangladesh, BRAC's microfinance program has reached millions of women, enabling them to start businesses, improve their financial literacy, and enhance their social status. The program's success underscores the importance of integrating financial services with other forms of support to achieve sustainable empowerment (BRAC, 2016).

Case Study: FINCA

FINCA, a global microfinance organization, focuses on providing financial services to low-income women entrepreneurs. FINCA's programs include microloans, savings accounts, and financial literacy training, tailored to meet the needs of women (FINCA, 2019).

In Uganda, FINCA's microfinance program has helped thousands of women start and grow businesses, leading to increased income and improved living standards. The program's emphasis on financial education and community support has been key to its success, demonstrating the importance of a comprehensive approach to women's economic empowerment (FINCA, 2019).

Conclusion

Microfinance has played a pivotal role in supporting women entrepreneurs, enhancing their financial independence and empowerment. By providing access to financial services, microfinance institutions help women overcome traditional barriers to economic participation, fostering entrepreneurship and economic growth. The successes of programs like those of the Grameen Bank, BRAC, and FINCA illustrate the potential of microfinance to transform the lives of women and their communities.

However, challenges such as high interest rates and social barriers need to be addressed to maximize the impact of microfinance. Strategies to reduce financial burdens and enhance social support are essential for achieving sustainable empowerment. By continuing to innovate and adapt, microfinance can play a crucial role in promoting gender equality and economic development.

References

1. Armendáriz, B., & Morduch, J. (2010). *The Economics of Microfinance*. MIT Press.
2. Bateman, M. (2010). *Why Doesn't Microfinance Work? The Destructive Rise of Local Neoliberalism*. Zed Books.
3. BRAC. (2016). *Annual Report 2016*. Retrieved from <https://www.brac.net>
4. FINCA. (2019). *Annual Report 2019*. Retrieved from <https://www.finca.org>
5. Garikipati, S. (2008). The impact of lending to women on household vulnerability and women's empowerment: Evidence from India. *World Development*, 36(12), 2620-2642.
6. Kabeer, N. (2005). Is microfinance a magic bullet for women's empowerment? Analysis of findings from South Asia. *Economic and Political Weekly*, 4709-4718.
7. Khandker, S. R. (2005). Microfinance and poverty: Evidence using panel data from Bangladesh. *The World Bank Economic Review*, 19(2), 263-286.
8. Ledgerwood, J. (1999). *Microfinance Handbook: An Institutional and Financial Perspective*. The World Bank.
9. Mayoux, L. (2000). Microfinance and the empowerment of women: A review of the key issues. *Social Finance Unit Working Paper*, 23.
10. Mayoux, L. (2001). Tackling the down side: Social capital, women's empowerment, and micro-finance in Cameroon. *Development and Change*, 32(3), 435-464.
11. Pitt, M. M., & Khandker, S. R. (1998). The impact of group-based credit programs on poor households in Bangladesh: Does the gender of participants matter? *Journal of Political Economy*, 106(5), 958-996.
12. Rahman, A. (1999). Micro-credit initiatives for equitable and sustainable development: Who pays? *World Development*, 27(1), 67-82.
13. Swain, R. B., & Wallentin, F. Y. (2009). Does microfinance empower women? Evidence from self-help groups in India. *International Review of Applied Economics*, 23(5), 541-556.
14. Yunus, M. (2007). *Creating a World Without Poverty: Social Business and the Future of Capitalism*. PublicAffairs.
15. Johnson, S., & Taylor, E. (2020). *Microfinance and Gender Equality: Challenges and Opportunities*. Routledge.

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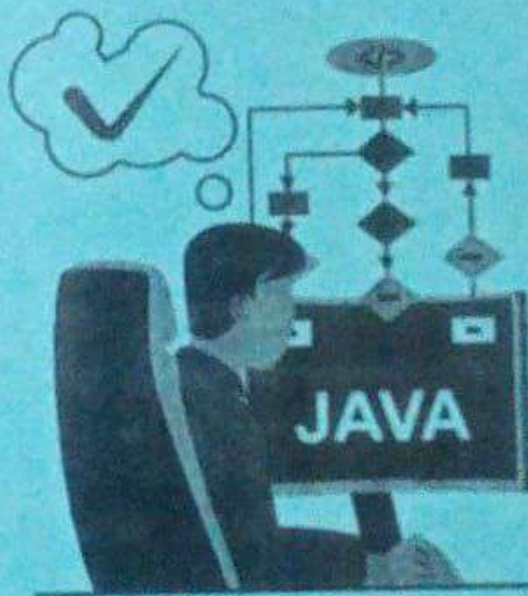
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COSMECEUTICALS AND NUTRACEUTICALS IN COSMETICS

Dr. Lalit K. Vyas





Dr. Lalit Krishnakumar Vyas, born in Amravati, Maharashtra, India; first Ph. D holder in Cosmetic Technology from Sant Gadge Baba Amravati University, Amravati; has 19 years of experience in Teaching and Research. He has guided 62 PG and 71 UG students. He has published many research papers and review articles in national and international journals of repute with very good citations and also presented 09 conference papers. He has worked as Assessor for Confederation of Indian Industry and participated as resource person in Dabur International Ltd, Dubai (UAE) in Feb 2018, NSQF centres and various colleges. He is currently working as Head of Department (Cosmetic Technology) at Vidyabharati Mahavidyalaya, Amravati and member of Board of studies at Sant Gadge Baba Amravati University, Amravati.

About the Book:

Cosmetics are constituted mixtures of chemical compounds derived from either natural sources, or synthetically created ones. Cosmetics have various purposes. Those designed for personal care and skin care can be used to cleanse or protect the body or skin. Cosmetics designed to enhance or alter one's appearance (makeup) can be used to conceal blemishes, enhance one's natural features (such as the eyebrows and eyelashes), add color to a person's face, or change the appearance of the face entirely to resemble a different person, creature or object. Cosmetics can also be designed to add fragrance to the body.

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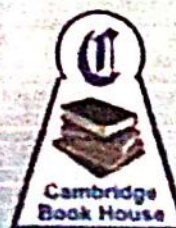
Dr. Lalit K. Vyas, born in Amravati, Maharashtra, India; first Ph. D holder in Cosmetic Technology has 19 years of experience in Teaching and Research. He has guided 52 PG and 60 UG students. He has published many research papers and review articles in national and international journals of repute with very good citations and also presented 09 conference papers. He has worked as Assessor for Confederation of Indian Industry and participated as resource person in Dabur International Ltd. Dubai (UAE) in Feb 2018, NSQF centres and various colleges. He is currently working as Head of Department and member of Board of studies at SGBAU, Amravati.

About the Book:

Nutraceutical products can be considered non-specific biological therapies used to promote general well-being, control symptoms, and prevent malignant processes. The term "nutraceutical" combines the two words of "nutrient," which is a nourishing food component, and "pharmaceutical," which is a medical drug. The name was coined in 1989 by Stephen DeFelice, founder and chairman of the Foundation for Innovation in Medicine, which is an American organization located in Cranford, New Jersey. The philosophy behind nutraceuticals is to focus on prevention, according to the saying by a Greek physician Hippocrates (known as the father of medicine) who said "let food be your medicine". Their role in human nutrition is one of the most important areas of investigation, with wide-ranging implications for consumers, healthcare providers, regulators, food producers, and distributors.

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- Transdermal Delivery Systems in Cosmetics
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Formulation and Evaluation of Layered Lipstick: Innovating Cosmetic Design with Multiple shade.

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Abstract

In the realm of cosmetics, innovation is the key to meeting the diverse needs and desires of consumers. Layered Lipstick stands out as a promising innovation in cosmetics, introducing a harmonious blend of multiple shades within a single stick. Beyond merely imparting colour, it serves as a canvas for self-expression. This research delves into the formulation and development of Layered Lipstick, promising to revolutionize lip makeup application and enhance confidence and style through its seamless fusion of colours and natural radiance. In response to persistent challenges in achieving seamless lipstick shade gradation, this paper presents the Layering Lipstick Series, a groundbreaking approach characterized by a unique design, advanced formula, and effortless shade gradation.

Key words

Layered Lipstick, multiple shades, innovation, cosmetics.

Introduction

In the dynamic landscape of cosmetics, innovation continually reshapes beauty routines, offering novel ways for individuals to express themselves. Among these innovations, Layered Lipstick emerges as a promising advancement, redefining traditional lip makeup with its seamless blend of multiple shades in a single application. This research paper delves into the formulation and development of Layered Lipstick, exploring its transformative impact on lip aesthetics and consumer experiences.

Layered Lipstick transcends conventional makeup norms by

introducing a harmonious blend of multiple shades within a single stick. Its allure lies not just in its ability to adorn lips with vibrant hues but in its capacity to transform the way individuals perceive and engage with lip colour. With the Layering Lipstick series, the mundane act of applying lipstick evolves into an art form, promising a seamless fusion of colours and a natural radiance that amplifies confidence and style.

The core objective of this research is to explore the formulation and development processes behind Layered Lipstick, unravelling the science and artistry that culminate in

its exquisite blendability and rich pigmentation. Through meticulous analysis, we aim to elucidate the benefits of Layered Lipstick, showcasing its ability to impart plumpness, volume, and natural luminosity to lips, thereby enhancing facial features and empowering individuals to express their unique identities with confidence. The burgeoning popularity of cosmetics, coupled with evolving consumer preferences, underscores the immense market potential of Layered Lipstick. Recent market research indicates significant growth in the colour cosmetics segment, with lipstick emerging as a cornerstone product in the makeup arsenals of women worldwide. As consumer demand for versatile and innovative beauty solutions continues to soar, Layered Lipstick occupies a pivotal niche, offering a transformative experience that resonates with individuals across diverse demographics and lifestyles. Moreover, insights into consumer behaviour reveal a significant appetite for lipstick, with a substantial majority of women incorporating it into their daily beauty routines. This underscores not just the market viability of Layered Lipstick but also its intrinsic appeal as a staple product that transcends fleeting trends, catering to the enduring desire for self-expression and enhancement. In conclusion, the formulation and development of Layered Lipstick represent a convergence of science,

art, and consumer-centric innovation. As we embark on this research journey, we endeavour to unravel the mysteries of Layered Lipstick, uncovering its secrets and unlocking its transformative potential in the realm of beauty and self-care.

Objectives

This research aims to explore the formulation and development of Layered Lipstick, focusing on the innovation, versatility, and user experience offered by the Layering Lipstick series. The objective is to analyse the effectiveness of this lipstick line in delivering a rich colour gradation with just one swipe, while also enhancing lip volume and providing a natural finish.

Specifically, the research seeks to:

1. Investigate the formulation process of the Layering Lipstick series, including the selection of colour shades and the blending techniques employed to achieve seamless colour transitions.
2. Evaluate the user experience of applying the Layering Lipstick, assessing factors such as ease of application, blendability of colours, and overall satisfaction with the product.
3. Examine the visual impact of the Layering Lipstick on lip appearance, particularly its ability to create plump, voluminous lips with a natural finish.
4. Explore the versatility of the Layering Lipstick series in catering to a

wide range of style preferences, from subtle elegance to bold statements, and its compatibility with different skin tones.

5. Assess the market perception and consumer acceptance of Layered Lipstick formulations, focusing on the Layering Lipstick series as a case study. By addressing these objectives, the research aims to contribute to a deeper understanding of the

formulation and develop layered lipstick.

Formulation and moulding techniques

The essence of the Layered Lipstick design centres on a rectangular lip bar housing multiple layers, each showcasing unique shades. The

Table 1: Formulation with specialty ingredients

Sr. No.	Phase	Ingredients	Quantity for 100% (in gm/layer)	Function
1	A	Cocoa butter	8	Texture
2		Octyl dodecanol, Euphorbia Cerifera (Candelilla) Wax, Isostearyl Isostearate, Stearyl Behenate, Polyhydroxystearic acid, Olea Europaea (Olive) Fruit Oil, Stearyl Alcohol, Behenic Acid, Stearyl Stearate, Cetyl Stearate	6	Moisturizer
3		Avocado oil	6	Oil
4		Wheat germ oil	6	Oil
5		Hydrogenated Vegetable Oil	5	Oil thickener
6		Bees wax	4	Thickener
7		Ozokerite wax	3	Thickener
8		Carnauba wax	3	Thickener
9		Candelilla wax	3	Thickener
10	B	Pigment	10	Colourant
11		Castor oil	5	Oil
12		Diocetyl dodecyl Dimer Dilinoleate (and) Propanediol	3.5	Film former
13	C	Trimethylsiloxysilicate (and) Isododecane (and) Alcohol (and) Hydrogenated Rosin	14	Emollient
14		Hydrogenated Polydecene	8	Emollient
15		Pentaerythrityl Tetraisoostearate	7	Emollient
16		Hydrogenated Polyisobutene	6	Emollient
17		Vanilla	1.5	Flavour
18		Euxyl k 830	1	Preservative

formulation process entailed blending a diverse range of waxes, including beeswax, ozokerite wax, carnauba wax and candelilla wax.

Additionally, the incorporation of cocoa butter and oils such as avocado oil, wheat germ oil, and castor oil played a pivotal role in establishing the ideal foundation for the Layered Lipstick.

Through the integration of specialty ingredients, the formulation has attained exceptional quality and attributes, including water resistance, extended durability, effortless spreading, moisturizing properties, sun protection, pigment dispersion, flawless application, and the versatility to achieve either a matte or glossy finish.

A) Formulation Process:

Weigh phase B ingredients in a dish or bowl, ensuring uniform pigment distribution.

Heat phase A ingredients in a heat-resistant beaker until waxes are melted.

Combine phase B with phase A, stirring thoroughly, and remove from heat. Prepare phase C ingredients in a separate beaker, then add to phase AB mixture, stirring well to ensure homogeneity.

B) Moulding Process:

Grease the lipstick mould with oil. Pour the first layer (phase ABC) into the mould and allow it to cool briefly. Add the second layer (Phase AB'C),

where 'B' represents a different shade, ensuring seamless integration.

Evaluation Methods

The evaluation of the Layered Lipsticks were carried out by the methodology of IS 9875 (1990).

Colour and Texture:

Formulated lipsticks were checked for colour, glossy and smooth texture.

pH:

The pH of formulated Layered Lipsticks was determined using digital pH meter (Systronics,802).

Determination of Melting Point:

Determination of melting point is an important parameter for lipstick formulation as it is an indication of the limit of safe storage. The melting point of formulated lipstick was determined by capillary tube method. Approximately 50 mg of lipstick sample was taken and melted and filled into glass capillary tube opened at both ends. Capillary was cooled with ice for 2h and fastened with thermometer. Thermometer with capillary was deep in the beaker containing full of water which was placed on heating plate with magnetic stirrer. Heating and stirring was started slowly at fixed speed. The temperature at which material moves along the capillary tube was considered as melting point.

Breaking Point:

This test was carried out to find out the value of maximum load that lipstick can withstand before it breaks. This test gives strength of lipstick. Prepared Layered Lipstick was held horizontally in a socket inch away from the edge of support. The weight was gradually increased by a specific value (10 gm) at specific interval of 30 second and weight at which breaks was considered as the breaking point.

Softening Point:

Lipstick should be able to withstand range of conditions to which it will be subjected in the consumer's handbag. It should be resistant to varying temperature conditions and be just as easy to apply in hot and as in cold weather. Softening point of lipstick was determined by Ring and Ball method.

Ring and Ball method:

A ring or support orifice is taken, and prepared Layered Lipstick was inserted into it. Extra mass above and below the orifice was removed using a sharp blade leaving a tablet of lipstick fitted into the ring. This was placed in refrigerator (6°C) for about 10 min. Ring was tied onto a stand. A beaker containing 500 mL water at room temperature is placed on a hot plate with magnetic stirrer. A steel ball was delicately placed on the lipstick tablet. The bar with support was then inserted into the beaker till it submerged into it. Heating and slow agitation was then begun.

Temperature was monitored using a thermometer. The temperature at which the lipstick mass and steel balls were loosed and falls to the bottom of the beaker was noted as softening point of lipstick. Surface anomalies: This was studied by the surface defects, such as formation of crystals on surface, contamination by moulds, fungi, formation of wrinkles, exudation of liquid substances and of solid fatty substances, etc.

Aging stability:

Prepared Layered Lipsticks were stored at refrigerator temperature (4oC), room temperature (20-25oC) and high temperature (30-40oC) for 1h. Various parameters such as bleeding, streaking, catering, and blooming were observed.

Perfume stability:

The prepared Layered Lipsticks were tested after 10 days, to record fragrance.

Result and Discussion**A) Formulation and Objective**

The formulation and evolution of Layered Lipstick, as demonstrated by the innovative Layering Lipstick series, signify a significant advancement in cosmetic design. Through a meticulous blend of waxes and oils, the formulation achieves water resistance, durability, moisturization, sun protection, and versatile finishes. This unique

formulation enables seamless blending of multiple shades, providing users with a customizable lip makeup experience. The transformative qualities of Layered Lipstick empower individuals to confidently express their unique identities, underscoring the cosmetics industry's ongoing commitment to innovation and consumer satisfaction.

B) Evaluation of Layered Lipstick

Results showed that all evaluation parameters of Layered Lipstick are resemble with standard values. (Table 2.)

Table 1: Evaluation of Layered Lipstick

Sr. No.	Parameter	Layered Lipstick Formulation	Standard Values
1.	Color	Multi colour	-
2.	Texture	Smooth	Smooth
3.	pH	6.2	6.4
4.	Melting point	60-64°C	60-66°C
5.	Breaking point	190 gm	-
6.	Softening point	60°C	50-60°C
7.	Surface anomalies	No defects	No defects
8.	Aging stability	Smooth	Smooth
9.	Perfume stability	+++	+++

Conclusion

In conclusion, the formulation and development of Layered Lipstick, exemplified by the innovative Layering Lipstick series, mark a significant advancement in cosmetic design. Through meticulous blending of waxes and oils, this lipstick achieves water resistance, durability, and versatile finishes. Evaluation parameters confirm its adherence to standards, underscoring its transformative potential in the cosmetics industry. Layered

Lipstick offers users a customizable experience, empowering them to confidently express their unique identities.

Reference

1. Choi, Y., & Kim, J. (2016). Lipstick Acceptance by Cosmetic Users through Perception and Satisfaction. *Journal of the Society of Cosmetic Scientists of Korea*, 42(4), 301-308.
2. Park, S., & Kim, B. (2020). Evaluation of Lipstick Texture Using Rheological Measurement. *Journal of the Korean Society of Cosmetology*, 26(2), 347-354.

Wang, Y., Li, S., Liu, Y., Yang, X., Zheng, J., & Li, Y. (2018). Formulation Design and Evaluation of Lipstick Containing Plant Extracts. *International Journal of Cosmetic Science*, 40(5), 495-502.

3. Smith, A. N., & Stewart, B. (2019). Understanding Consumer Behaviour in the Beauty Industry: A Comprehensive Literature Review. *Journal of International Consumer Marketing*, 31(3), 183-197.
4. Souiden, N., & Diagne, M. (2009). The Impact of Cosmetic Products on Women's Self-Image and Perceptions of Others. *International Journal of Business and Social Science*, 1(3), 63-74.

5. Lwin, T.; Myint, C.; Win, H.; Oo, W.; Chit, K. Formulation and evaluation of lipstick with betacyanin pigment of *Hylocereus polyrhizus* (Red Dragon Fruit). *J. Cosmet. Dermatol. Sci. Appl.* 2020, 10, 212.
6. Afandi, A.S.R.U.L.; Lazim, A.M.; Azwanida, N.N.; Bakar, M.A.; Airianah, O.B.; Fazry, S. Antibacterial properties of crude aqueous *Hylocereus polyrhizus* peel extracts in lipstick formulation against gram-positive and negative bacteria. *Malaysian Appl. Biol.* 46, 29–34.
7. Ghongade, K.; Bodake, V.; Badadare, S.; Magdum, M.; Gawande, N.; Kate, S.; Waghmare, K. Formulation and Evaluation of some Cosmetic preparations using novel natural colorant from *Ixora coccinea*. *Asian J. Res. Pharm. Sci.* 2021, 11, 22–28. [[CrossRef](#)]
8. Mahanthesh, M.C.; Manjappa, A.S.; Shinde, M.V.; Sherikar, A.S.; Disouza, J.I.; Namrata, B.U.; Ajija, W.C. Design, development and assessment of herbal lipstick from natural pigments. *Int. J. Pharm. Sci. Rev. Res.* 2020, 61, 59–64.
9. Kaliyadan, F.; Al Dhafiri, M.; Aatif, M. Attitudes toward organic cosmetics: A cross-sectional population-based survey from the Middle East. *J. Cosmet. Dermatol.* 2021, 20, 2552–2555. [[CrossRef](#)] [[PubMed](#)]
10. Bhagwat, D.; Patil, N.D.; Patel, G.S.; Killedar, S.G.; More, H.N. Formulation and Evaluation of Herbal Lipstick using Lycopene Extracted from *Solanum lycopersicum* L. *Res. J. Pharm. Technol.* 2017, 10, 1060. [[CrossRef](#)]
11. Yusof, A.A.B.; Ajit, A.B.; Sulaiman, A.Z.; Naila, A. Production of lip balm from stingless bee honey. *Maldives Natl. J. Res.* 57–72s

Development of skin moisturizer with proven moisturizing properties of plant stem cell active

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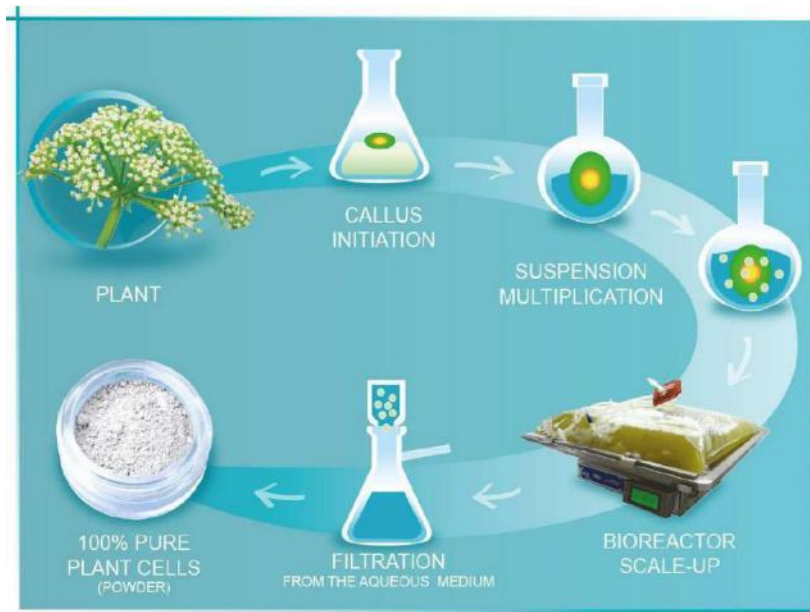
Abstract- Plant cells have the amazing ability to either differentiate into all cell types, or to self-renew at an undifferentiated stage from which they can regenerate the whole plant. Thorough knowledge of the raw materials & technological expertise allows to cultivate cells at an industrial level in their “native” stage, thus potentially producing any type of compounds of interest.

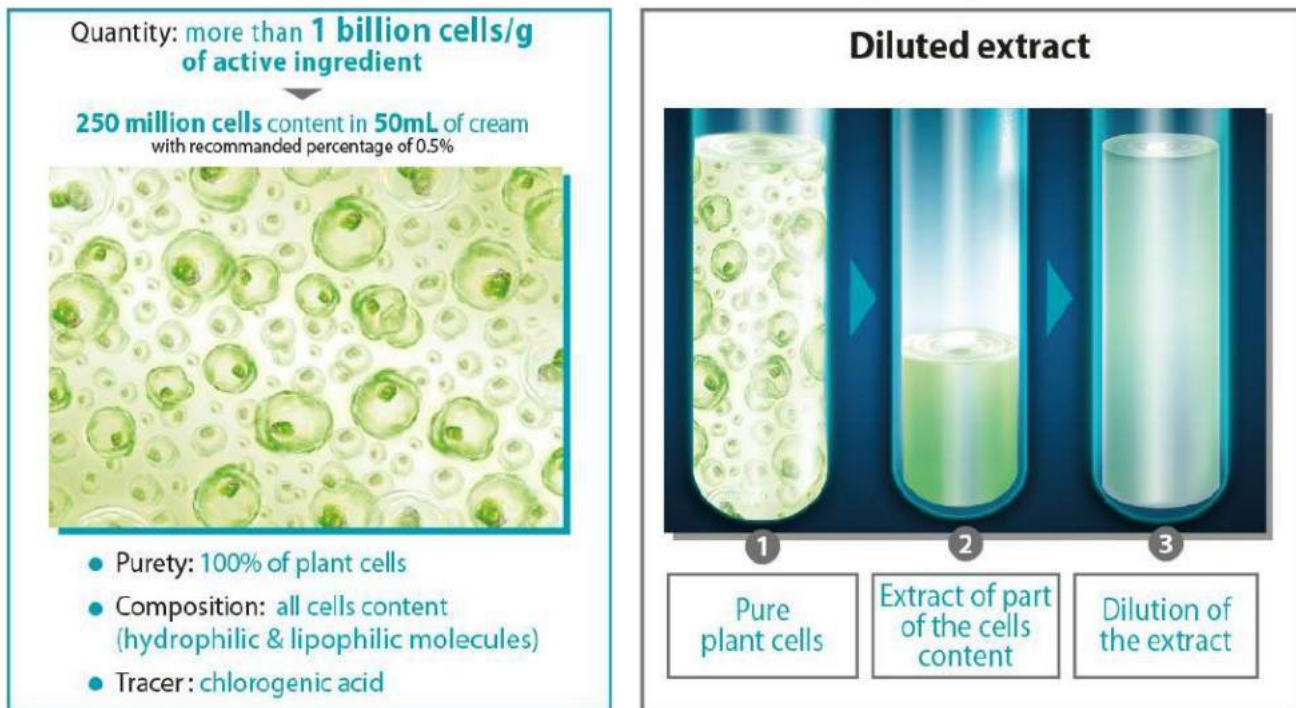
Plant stem cells located in the meristematic tissue of the plant & serves as the origine of vitality with potency provides consistent supplement of precursor cells to form differentiated tissues and organs in the plant. Plant cell culture technology is a technique for growing of plant cells under strictly controlled environmental conditions & so control on its potent active constituent.

Key words- Plant stem cell, tissues, moisturization, hydration, dryness, emulsion

INTRODUCTION:

Plant cells are undifferentiated “native cells” located in meristematic areas, which can be found at the tip of the roots, at the apex of the stem & in the primordial leaf. These zones are responsible for the growth of the plant. Plant cells have two key abilities: the ability to differentiate into all cell types found in the plant & the ability to self-renew at an undifferentiated stage. Thus, plant cells are responsible for every organ formation & every differentiation resulting in the growth of the plant.





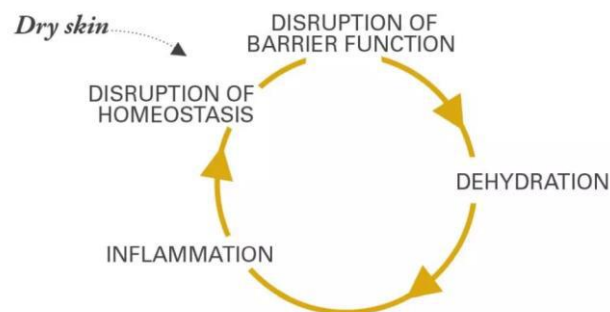
Benefits of plant cells:

- Plant cells simultaneously manage two metabolisms:
 - ✓primary metabolism, necessary for essential functions (growth, development & reproduction),
 - ✓secondary metabolism, to adapt to external stress.
- Each metabolism generates specific molecules: primary & secondary metabolites.
- Endangered & Protected Raw Material: Plant Cells Culture: no need to harvest/ sustainable development
- Culture: Laboratory Conditions- Sterile environment: no potential pollution or contamination
- Undifferentiated Cells: Each undifferentiated cell potentially contains all of the plant's components.

Dry skin is characterized by tightness, itching, lack of elasticity and an overall discomfort. The altered barrier function leads to dehydration, impaired lipid production and an inflammation signalling cascade. Recent scientific progress has linked skin dryness to inflammation: this is the **Inflamm'dryness™ phenomenon**.

Breaks the Inflamm'dryness™ vicious circle:

- Manage the resolution of inflammation (decrease of pro-inflammatory and an increase of pro-resolutive mediators)
- Restores the barrier function & homeostasis



The vicious circle of Inflamm'dryness™ phenomenon.

Ingredient selection:

Emulsion: Is a system comprising 2 immiscible phases with the stabilization of emulsifier. 2 phases also called as dispersed phase (internal) & dispersion medium (external/continuous).

Emulsifiers: important constituent for emulsification process also for its stability.

I. Synthetic emulsifiers

1. Anionic surfactants:

2. Cationic

3. Amphoteric surfactants:

II. Natural emulsifiers

III. Semi synthetic emulsifiers

Other formulation additives: Polymers and Viscosity modifier, Emollients, Humectants, Sensory modifiers, Preservatives & Miscellaneous (i.e. UV / photo stabilisers, for avoiding colour fading of product, Colors, pigments, fragrances for aesthetic appeal of product, Sequestering agents, pH regulators like buffer solutions or neutralizing materials)

Active: Aqua (and) Glycerin (and) Helichrysum Stoechas Callus Culture Lysate

Hydrachrysum (Seppic active)- new natural ally of dry skin. Bio-inspired by Helichrysum stoechas, the Everlasting maritime plant which adapts to its arid ecosystem. Hydrachrysum™ has been developed using our stem cell technology. It offers a unique molecular richness made up of hydrophilic & lipophilic molecules derived from the dedifferentiated plant cells and specific ones secreted in the medium.

Hydrachrysum is a patented moisturizing active ingredient that breaks the Inflamm'dryness vicious circle. It induces a **decrease of pro-inflammatory and an increase of pro-resolutive mediators** to allow a return to homeostasis and improved barrier function. Hydrachrysum **increases the number of lacunae**, these markers of hydration acting as extracellular water tanks and representing up to 40% of the volume of the stratum corneum. It boosts skin moisturization after only 5 days by increasing significantly the number of lacunae **+82%* vs placebo (Proven study mentioned by Seppic- Wsource)**.

Hydrachrysum is Cosmos and NaTrue approved, Halal certified, and scientifically proven with in-vitro, ex-vivo and in-vivo data at 1%.

Active:

Sr. No.	INCI	Major benefits	Purpose/useful for
1	Hydrachrysum: Aqua (and) Glycerin (and) Helichrysum Stoechas Callus Culture Lysate	It offers a unique molecular richness made up of hydrophilic & lipophilic molecules: <ul style="list-style-type: none"> • Sugars: polysaccharides of various size, • Phenolic compounds in particular caffeoylquinic derivatives, • Lipids: polyhydroxylated unsaturated fatty acids, for a powerful hydration. 	Long term moisturization

Formulation Development: with & without active

INCI NAME	QUANTITY IN % (Placebo)	QUANTITY IN % With active
Water	83.80	82.80
Ethylenediaminetetraacetic acid	0.10	0.10
Glycerin	3.00	3.00
Polyacrylamide (and) C13-14 Isoparaffin (and) Laureth-7.	0.50	0.50
Hydroxyethyl Acrylate/Sodium Acryloyldimethyl Taurate Copolymer	0.80	0.80
Acrylates/C10-30 Alkyl Acrylate Crosspolymer	0.20	0.20
Capric Caprylic Triglyceride	10.00	10.00
Hydrachrysum: Aqua (and) Glycerin (and) Helichrysum Stoechas Callus Culture Lysate	-	1.00
Phenoxyethanol (and) Ethylhexylglycerin (and) Octenidine HCl	1.00	1.00
Perfume	0.10	0.10
Sodium Hydroxide (20% solution)	0.50	0.50
	100.00	100.00

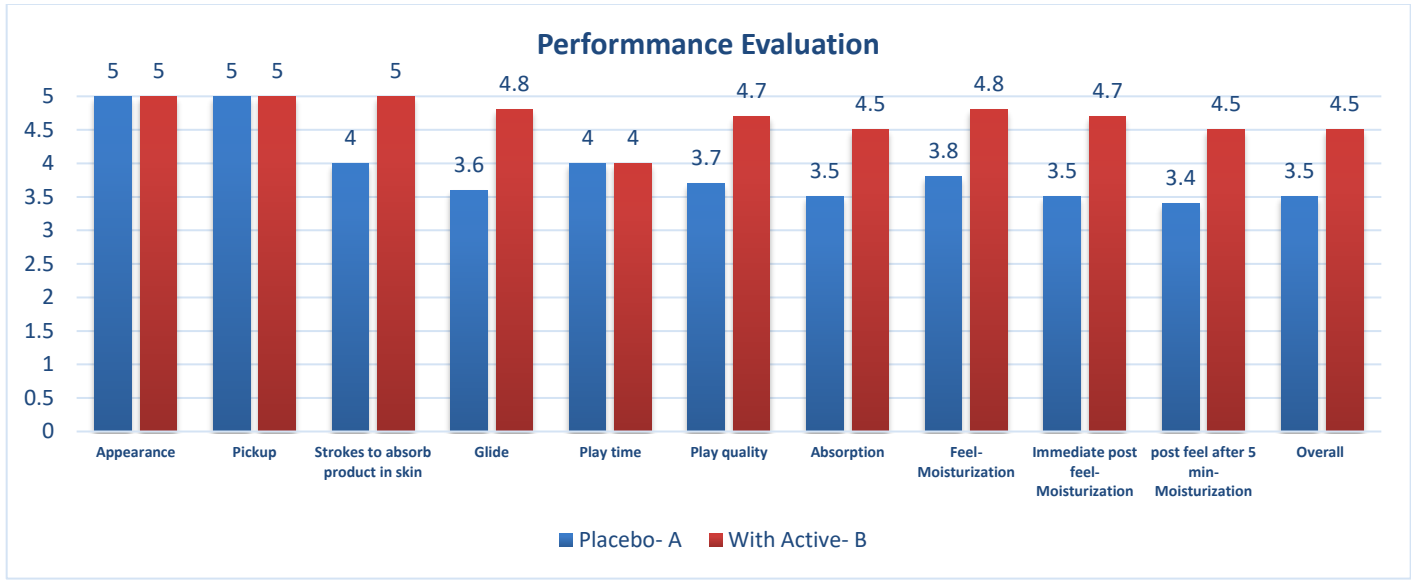
Analysis Data: -

Name	Viscosity	pH	Appearance	Moisture
BODY LOTION	6520 CPS (RV 04 RPM 20)	5.75	White translucent lotion	80.00- 82.00 %w/w

Sensory evaluation- Parameters:

Pre-use parameters	Appearance
	Pickup
	Fragrance
In-use parameters	Strokes to absorb product in skin
	Glide
	Play time
	Play quality
	Absorption
	Feel- Moisturization
Post-use parameters	Immediate post feel- Moisturization
	post feel after 5 min- Moisturization
	Overall

Sensorial Evaluation:



The resultant products are comparable & better than the placebo in terms of overall performance. Although the perception of product B (with active) for skin Moisturization (while & post) found to be better than the product A-placebo in the consumer study.

Stability studies: Stability conducted as per ICH guidelines:

Parameters	pH @ 27°C	Viscosity (Cps) @ spindle no. 4, 20 rpm	Moisture Content (% w/w)	Appearance	Fragrance
Conditions and duration					
Initial	5.75	6520 cps	80.21	White translucent lotion	
1 Month					
RT	5.08	6500 cps	80.00	No Change	No Change
Ref	4.71	6430 cps	81.00	No Change	No Change
45°C/75°RH	4.72	6240 cps	80.10	No Change	No Change
50°C (Dry Heat)	5.13	6150 cps	79.90	No Change	No Change
2 Months					
RT	4.88	6490 cps	79.80	No Change	No Change
Ref	4.98	6450 cps	80.20	No Change	No Change
45°C/75°RH	4.71	6200 cps	79.90	No Change	No Change
3 Months					
RT	5.04	6480 cps	80.10	No Change	No Change
Ref	5.14	6400 cps	80.00	No Change	No Change
45°C/75°RH	4.79	6240 cps	79.80	No Change	No Change

Sample passes the 3 months stability studies at all the stability temperature.

Way Forward:

Next step to carry out the in- vitro efficacy evaluation for moisturization, through external CRO for the claim validation.

References:

1. Plant cell culture as emerging technology for production of active cosmetic ingredients-[Vasil Georgiev](#),¹
² [Anton Slavov](#), ² [Ivelina Vasileva](#), ² and [Atanas Pavlov](#) ^{1, 3}
(<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6999513/>)
2. <https://www.seppic.com/en/wesource/hydrachrysum>
3. **Emulsion and its application in the food field: An update review-** [Yitong Wang](#), [Chao Ai](#), [Hui Wang](#), [Chong Chen](#), [Hui Teng](#), [Jianbo Xiao](#), [Lei Chen](#)- First published: 24 July 2023-
<https://doi.org/10.1002/efd2.102>
4. <https://www.seppic.com/en/active-ingredients/wesource-launches-equibiometm-and-targets-microbiota-balance-harmonious-skin>
5. Formulating Cosmetic Emulsions: A Beginner's Guide- Ken Klein Cosmetech Laboratories Inc., Fairfield, New Jersey USA-
https://img.cosmeticsandtoiletries.com/files/base/allured/all/image/2019/11/ct.CT_120_01_075_03.pdf

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Effect of salt and polymers and their combination on rheology of rinse-off cosmetic products composed of combination of surfactants

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Abstract- Surface-active agents are the organic molecules that when dissolved in a solvent at low concentration, have the ability to adsorb at interfaces, thereby altering significantly the physical properties of those interfaces. Thickening of surfactant can be achieved with with different hydrophobic thickeners, the hydrophilic thickener and the combination of both

Key words- Surfactant, Electrolyte, Rheology, Ionic behaviour, Miscell formation.

Introduction

Surface-active agents are the organic molecules that when dissolved in a solvent at low concentration, have the ability to adsorb at interfaces, thereby altering significantly the physical properties of those interfaces.

A surfactant base has been thickened with different hydrophobic thickeners, the hydrophilic thickener and the combination of both. The main task of thickener for surfactant formulation is of course to increase the viscosity. Good stabilizing effect can be obtained by choosing right rheological profile and low temperature dependence of the final viscosity. Rheology plays an important role in the functionality and usage profile of the system. The rheology of the system is maintained by using various rheology modifiers. Rheology modifiers like thickeners are used like salt, polymers, co-surfactants, etc.

The viscosity is determined by using the technically designed instrument known as viscometer. To make the system viscous one need to add viscosity modifier in the formulation i.e. thickeners. The most common way to thicken the anionic surfactant-based formula is to use Sodium Chloride (NaCl). In standard surfactant systems based on Sodium Laureth Sulphate (SLES) and cocoamidopropyl betaine (CAPB) this works quite well. This thickening effect depends on the presence of an anionic surfactant (mostly SLES) and it works up to a conc. maximum. Gelling agents like Xantum gum, Cellulose types or Carbomer types thicken or gel the water. Surfactants are generally classified on the basis of their ionic behaviour or by hydrogen bonding. Four basic classes therefore emerges as:

1. Anionic surfactants (-ve charge on dissociation)
2. Cationic surfactants (+ve charge on dissociation)
3. Non-ionic surfactants(NO charge on dissociation)
4. Amphoteric or zwitterionics (+-ve charge on dissociation)

Rinse off products mostly cover a category which is Shampoo used for hair cleansing. Hair is soiled by sebum, shade, scales of stratum corneum. Atmospheric pollutants and residues from hair care products. 3 type of dirt in hair to be dealt with shampoo

1. Oily soil or sebum
2. The soluble soil- it is the proteineous matter from stratum corneum and protein contents from sweat.
3. Insoluble soil – It is the atmospheric pollutants and residue from hair care product.

Oil or soil or sebum is removed by process called 'emulsification' where detergent particles make contact with lipid surface (oiliness to make lipid detergent) compound which loosens and floats away into bulk aqueous solution.

The molecule and detergent and static electricity remove insoluble soil. Surfactants are also termed as detergents as they remove dirt. The presence of surfactant in product is determined by method active detergency. Active detergency is mostly calculated for semisolid or liquid type ingredients because powdered ingredients are 100% active but the semisolid or liquid ingredients contain diluents so the total active matter gets reduced. So this method is used to determine the presence of concentrated detergent in ingredient or products. Active detergency in a cleansing system is higher in shampoo i.e. shampoo contains more surfactant concentration as compared to body wash and face wash. Face wash contains very low concentration of surfactants.

The active detergency is calculated on the basis of supplied product or ingredient active or dilution.

Example: If we want to add 15% active matter on the formulation and the surfactant material is 70% active as supplied then we need to calculate as follows

$$\text{A.D.} = \frac{15 \times 100}{70} = 21.42(\%)$$

Micelles structure

Micelles are the spherical aggregates whose alkyl groups form a hydrocarbon liquid like core, and whose polar group forms a charged surface. Later with the development of zwitterionic and non-ionic surfactants, micelles of very different shape are encountered. The different geometries were found to depend mainly on structure of surfactants, their concentration, electrolyte and co-surfactant curve.

The concentration at which the surfactant molecules in solution start forming aggregates are micelles and the concentration is called as critical micelle concentration (CMC)

Defining micelle structure

The main structures associated with two-component surfactant-water system are: hexagonal, lamellar, and several cubic phases

- The hexagonal phase is composed of a close-packed array of long cylindrical micelles, arranged in a hexagonal pattern. The micelle may be 'normal' in that the hydrophilic head groups are located on the outer surface of cylinder, or 'inverted', with the hydrophilic group located internally
- The lamellar phase (L_α) is built of alternating water surfactant bilayers. The hydrophobic chain possesses a significant degree of randomness and mobility, and the surface bilayer can range from being stiff and planar to being very flexible undulating.

Critical packing parameter (P_c) as the ratio of volume to surface area:

$$P_c = v / (a_0 l_c)$$

The parameter v varies with the number of hydrophobic groups, chain unsaturation, chain branching and chain penetration by other compatible hydrophobic group, while a_0 is mainly governed by electrostatic interaction and head group hydration. P_c is usually a quantity since it allows the prediction of aggregate shape and size.

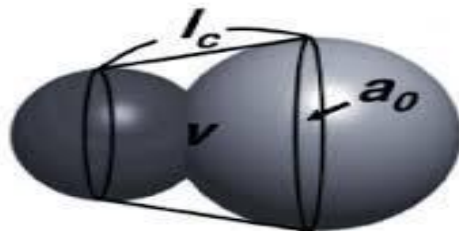


Figure-
Critical packing parameter

P_c	General surfactant type	Expected Aggregate structure
<0.33	single chain surfactant with large head groups	spherical or ellipsoidal micelles
0.33-0.5	single chain surfactant with small head groups, or ionics in the presence of large amount of electrolyte	large cylindrical or rod-shaped micelles vesicles and flexible bilayers structure
0.5-1.0	double chain surfactant with large head groups and flexible chains	planar extended bilayers
1.0	double chain surfactant with small head groups or rigid immobile chains	reversed or inverted micelles
>1.0	double chain surfactants with small head groups, very large and bulky and hydrophobic groups	

- The cubic phase may have a wide variety of structural variations and occurred in many part of the phase diagram . These are optically isotropic system and so cannot be characterised by polarising light microscopy.

There are two main groups of cubic phase such as-

- Themicellar cubic phase- Built up of regular packing
- The bicontinuous cubic phase

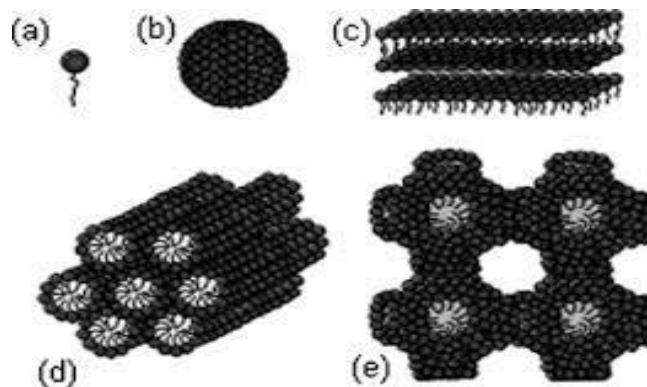


Figure: Structures of micelles

Mechanism of rheology modification:

Typical thickening agents for surfactant system can be generally divided into 2 groups:

1. The hydrophobic, monomeric or oligomeric type with a low molecular weight. These types are mostly non-ionic surfactant
2. The hydrophilic, polymeric type with high molecular weight. These types are based on highly ethoxylatedoleochemical derivatives.

These two type of thickeners provides two important difference in performance: **the flow behaviour** and **the temperature dependence of the viscosity**.

- **Flow behavior**

The hydrophobic thickener provides a shear thinning flow behavior, that means the viscosity decreases with

increasing shear rate. This can be easily be observed by measuring the viscosity with a rotational viscometer at different speeds. The hydrophilic thickener provides a Newtonian flow behavior, which means the viscosity is independent of shear rate.

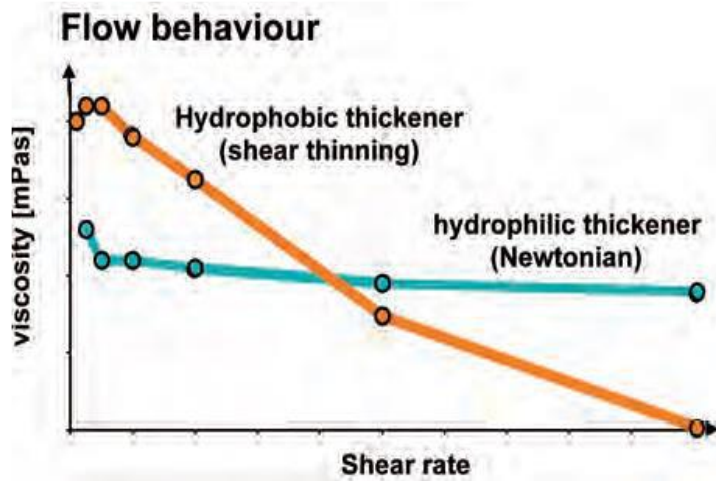


Figure- Differences of flow behavior

▪ Temperature dependence of the viscosity

The hydrophobic thickener provides a decrease in viscosity at low temperature, but a mostly stable viscosity at higher temperature. The hydrophilic thickener provides the strong temperature dependence of the viscosity

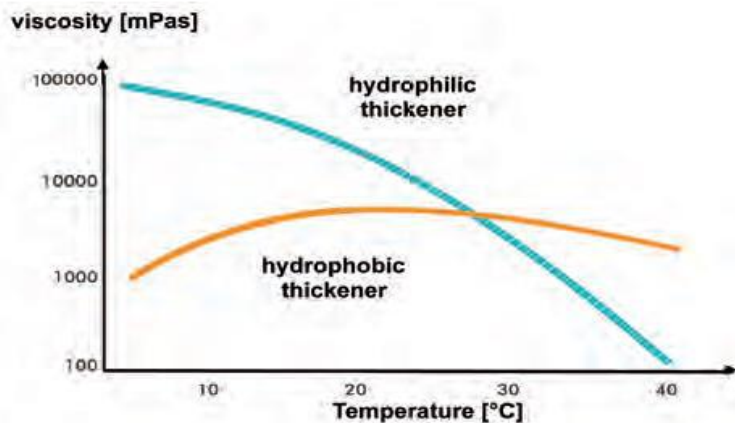


Figure- Differences of temperature dependence of the viscosity

Thickening mechanism

To explain the different flow behavior it is necessary to understand the General mechanism of surfactant thickening. Basically the thickening agents modify the micellar structure. In case of polymeric hydrophilic thickeners, the hydrophobic groups of the molecules are incorporated in the surfactant micelles. This leads to bridging of the spherical micelles and an increase of the micelle size occurred. The micells have the more limited space to move which lead in the increase of viscosity and a Newtonian flow behavior.

The hydrophobic thickeners are also incorporated into the surfactant micelles, but since their hydrophilic head is rather small, they change the shape of micelles. The shape changes from spherical to rod like. At rest the micelles are arrange randomly, which leads to a high viscosity.

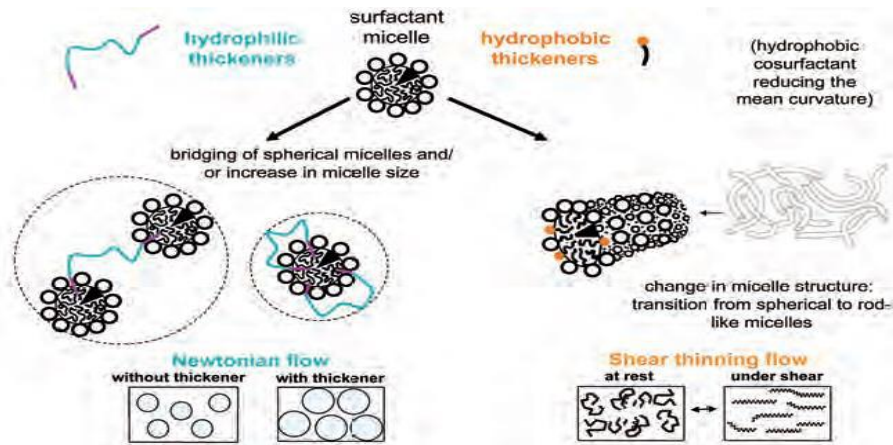


Figure: Thickeners for surfactant systems modify the micellar structure

Good stabilizing effect can be obtained by choosing right rheological profile and low temperature dependence of the final viscosity. Figure indicating differences of temperature dependence of the viscosity shows that hydrophilic thickeners tend to show a strong decrease in viscosity at higher temperatures. On other hand this lead to a higher sedimentation speed of disperse particles. At low temperature a hydrophilic thickener tend to provide an increase of viscosity. Hydrophobic thickeners are weak at low temperatures, so tend to drop the viscosity. Rheology plays an important role in the functionality and usage profile of the system. The rheology of the system is maintained by using various rheology modifiers. Rheology modifiers like thickeners are used like salt, polymers, co-surfactants, etc. Salt mainly Sodium chloride is used as thickener. Polymers are used to thicken the system and to increase the viscosity of system.

Formulation:

- Shampoo formulation with SLES and salt
- With 5 % CAPB (as supplied)

As the supplied surfactant (SLES) is 28% active and here need to add 15% so for 100gm. Formulation its concentration is calculated as

$$\text{A.D. (SLES)} = \frac{15 \times 100}{28} = 53.57$$

Sr. No.	Ingredients	Shampoo formulation with SLES +salt				
		Conc. Of salt				
		0.1	0.5	1	1.5	2
1	DI water	38.23	37.83	37.33	36.83	36.33
2	Sodium gluconate	0.05	0.05	0.05	0.05	0.05
3	SLES(28% active)	53.57	53.57	53.57	53.57	53.57
4	CAPB(30% active)	5	5	5	5	5
5	Polyquaternium-39	1	1	1	1	1
6	Glycerin	2	2	2	2	2
7	Aqua Methylchloroisothiazolinone (and) Methylisothiazolinone	0.05	0.05	0.05	0.05	0.05
8	NaCl	0.1	0.5	1	1.5	2
	Total	100	100	100	100	100

As the supplied surfactant (Sarcosinare) is 30% active and here need to add 15% so for 100gm. Formulation its concentration is calculated as

$$\text{A.D. (Sarcosinate)} = \frac{15 \times 100}{30} = 50(\%)$$

Sr. No.	Ingredients	Shampoo formulation with Sodium Lauryl Sarcosinate + salt				
		Conc. of salt				
		0.1	0.5	1	1.5	2
1	DI water	41.8	41.4	40.9	40.4	39.9
2	Sodium gluconate	0.05	0.05	0.05	0.05	0.05
3	Sodium Lauryl Sarcosinate(30% active)	50	50	50	50	50
4	CAPB(30% active)	5	5	5	5	5
5	Polyquaternium-39	1	1	1	1	1
6	Glycerin	2	2	2	2	2
7	Aqua Methylchloroisothiazolinone (and) Methylisothiazolinone	0.05	0.05	0.05	0.05	0.05
8	NaCl	0.1	0.5	1	1.5	2
	Total	100	100	100	100	100

Observation and Evaluation:

A typical salt curve

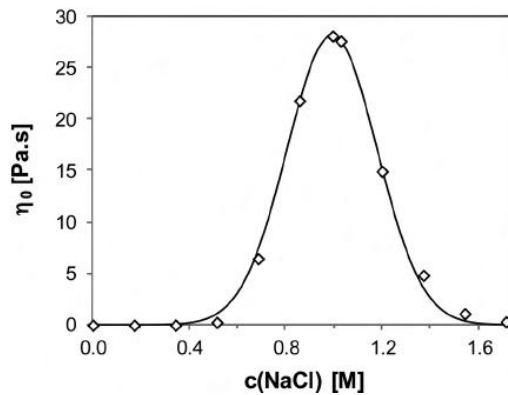
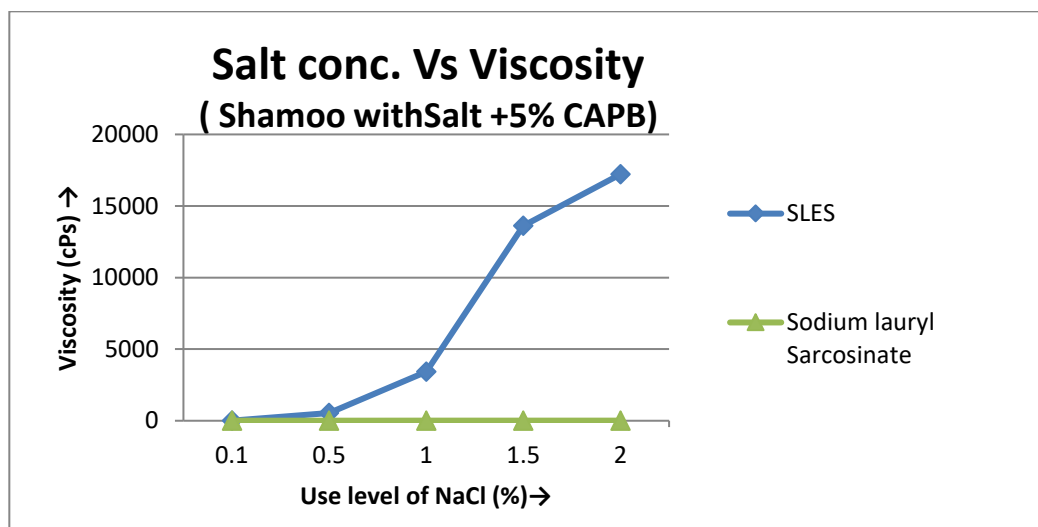


Figure: The impact of NaCl and small hydrophobic molecules, used in perfumery, on the viscoelastic properties of aqueous solutions of sodium lauryl ether sulphate is studied. As the salt concentration increases, the viscosity passes through a maximum. Empirically, this behaviour is well known and is referred to as the ‘salt curve’.



OBSERVATIONS AND RESULT:

- In case of SLES the viscosity increases with increasing salt concentration
- Sarcosinate shows minor change in viscosity and it fluctuates.

It shows that SLES shows synergistic effect with increasing salt concentration as compared to Sodium lauryl sarcosinate.

WAY FORWARD-

The rinse off products is generally prepared by using combination of ingredients. Ingredients include surfactants, foam stabilizers, thickeners, and other additives like conditioners for shampoo, colors, humectants, and preservatives. By making change in the concentrations of the formulation one can innovates a different product of same ingredient with differing effects.

This project is based on effect on rheology of surfactant system with addition of polymers, thickeners as well as foam stabilizer in the rinse off formulation. Polymers are also available in the market and we can go with them with the combinations of ingredients.

We can use more different polymers, thickeners available in market and work with them with differing ingredient concentrations. So combination of the other polymers the effect will be different and we can find different result and we will get more knowledge and idea about the chemistry of surfactants compatibility with different polymers.

REFERENCES

1. Span and Tween An article by Croda
2. SOFW Journal: Thickening Agents for Surfactant Systems -U. Kortemeier, J. Venzmer, A. Howe, B. Grüning, S. Herrwerth
3. The effect of surfactant on the rheology and stability properties of emulsion explosive matrices. By- Jianmin Zhou, Xuguang Wang, Min Gong & Mingsheng Zhao
4. Effect of electrolyte on the surface dilational rheological properties of branched cationic surfactant. By- Kai Shu a c, Zhi-cheng Xu b, Qing-tao Gong b, Wang-jing Ma b, Lei Zhang b, Lu Zhang b

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FORMULATION AND DEVELOPMENT OF GEL SHAMPOO USING GRAPE SEED EXTRACT

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Abstract :

The goal of the present study was to formulate and evaluate the hair gel shampoo which would help to reduce the dandruff and dermatitis, to remove dirt and dust, to nourish the hair scalp etc. The present study was conducted with a view to formulate and evaluate on removing dust, dirt, sebum, greasiness, oil from scalp and hairs of given formulation by using grape seed extract. The gel shampoo was prepared with natural active agents. The concentration of active agent were kept in range of 0.5 %, 1%, 2%, each were incorporated and three combination of each were prepared and evaluated on different stability parameters like pH, viscosity, appearance, feel, and efficacy was evaluated by subjective evaluation and formulation F3 with 1% Grape seed extract was passed all the stability parameters and also approved by the volunteers and it really helps to reduce hair loss and restart the hair growth again. Grape seed extract was selected as reducing hair loss, dandruff and dermatitis and incorporated them in the cosmetic product i.e. shampoo

Grape seed extract has a characteristic tocopherol and tocotrienol content. In addition to exhibiting vitamin E activity, tocopherols occur in seed extract, such as α -, β -, γ -, and δ -tocopherol, with γ -tocopherol as one of the most potent antioxidants. Grape seed oils are richer in tocotrienols (unsaturated forms of vitamin E) than tocopherols though, among which γ -tocotrienol is the most abundant, followed by α -tocotrienol. α -tocopherol and γ -tocotrienol have been reported to show the highest variability between grape varieties. They also contain phenolic compound, flavonoid, and vitamin A.

In other words, it was always kept in mind to develop value-added cosmetic products containing blood circulation, increase and promoters or product having multi-functional benefits to the client. Thus, choice of actives was very crucial and even choice of the product category to effectively deal the problem. Grape seed extract was selected as reducing hair loss, dandruff and dermatitis and incorporated them in the cosmetic product i.e. shampoo.

Key words: Grape seed extract, Tocopherilic acid, Hair growth cycle, Tocopherol, Hair matrix keratinocytes, Gel shampoo.

1.Introduction

Cosmetics are substances or products used to enhance or alter the appearance of the face or fragrance and texture of the body. Many cosmetics are designed for use of applying to the face, hair, and body. They are generally mixtures of chemical compounds; some being derived from natural sources (such as coconut oil), and some being synthetics or artificial.^[1] Cosmetics applied to the face to enhance its appearance are often called make-up or makeup. Common make-up items include: lipstick, mascara, eye shadow, foundation, blush, and contour. Whereas other common cosmetics can include skin cleansers, body lotions, shampoo and conditioner, hairstyling products (gel, hair spray, etc.), perfume and cologne.

In the U.S., the Food and Drug Administration (FDA), which regulates cosmetics,^[2] defines cosmetics as "intended to be applied to the human body for cleansing, beautifying, promoting attractiveness, or altering the appearance without affecting the body's

structure or functions". This broad definition includes any material intended for use as a component of a cosmetic product. The FDA specifically excludes pure soap from this category

Shampoo is a hair care product, typically in the form of a viscous liquid, that is used for cleaning hair. Less commonly, shampoo is available in bar form, like a bar of soap. Shampoo is used by applying it to wet hair, massaging the product into the hair, and then rinsing it out. Some users may follow a shampooing with the use of hair conditioner.

The typical reason of using shampoo is to remove the unwanted build-up of sebum in the hair without stripping out so much as to make hair unmanageable. Shampoo is generally made by combining a surfactant, most often sodium lauryl sulfate or sodium laureth sulfate, with a co-surfactant, most of cocoamidopropylbetaine in water.

Specialty shampoos are available for people with dandruff, color-treated hair, gluten or wheat allergies, an interest in using an organic product, and infants and young children ("baby shampoo" is less irritating). There are also shampoos intended for animals that may contain insecticides or other medications to treat skin conditions or parasite infestations such as fleas.

For individuals suffering from Androgenetic Alopecia (also known as male-pattern baldness), the sex hormone DHT leads to the miniaturization. As the follicles become smaller, the hair cycle shortens.

Grape seed extract, however, has actually been proven to jumpstart the hair cycle and push the follicle from the telogen phase (the phase in which the most hair is lost) to the anagen phase (the phase in which active hair growth occurs). Grape seed Extract Is Full of Antioxidant. Grape seed Extract is Antibacterial. Scientists have been researching treatment options for years, and in 2010, researchers found that grape seed extract is actually an effective treatment for this debilitating, and sometimes fatal, bacterium. If grape seed extract is effective at treating MRSA, then surely it's an effective treatment for a num. Individuals suffering from Androgenetic Alopecia (also known as male-pattern baldness), the sex hormone DHT leads to the miniaturization. As the follicles become smaller, the hair cycle shortens. To give cleansing effect to hairs. Removes dirt and dust from hairs. Also removes greasiness and sweat from scalp.

2. Material and Methods :

In this gel shampoo formulation Carbopol-940 was the main ingredient used as a gelling agent with Triethanolamine as a neutralizer, both gave body to the product, then glycerine as a humectant and SLS, CAPB were used for cleansing property which was essential property in the shampoo. Along with these basic raw materials Grape Seed Extract was used as active agent which was reported to have antioxidant property and reduces hair fall was procured for the present study from RP chemicals Kalyan, Mumbai, India, along with Certificate of Analysis. The procured sample was validated for parameters such as Color, assay, pH, specific gravity, water content, tocopherol content.

2.1 Formulation and optimization of base formulation

In any cosmetic preparation it is important to have stable formulation before incorporation of active. The effectiveness and stability depends upon the compatibility of active ingredients

2.1.1 Formulation of gel shampoo

Procedure-

Firstly weighed all the wet and dry ingredients accurately. After that heat the demineralized water up to 80 to 85 °C. Clean all the equipments properly. After that heat

demineralized water and add citric acid and EDTA one by one. Dissolve carbomer properly in main batch and add Sodium Lauryl Ether Sulphate, Coca Amido Propyl Betaine, glycerin and cocodiethanolamine in the beaker and start low stirring with the help of stirrer.

2.1.2 Formulation of gel shampoo base:

Table No.1: Formulation of shampoo base

Sr. No	Ingredient	F1 For100%	F2 For 100%	F3 For100%
1.	Water	68.1	66.8	65.3
2.	Carbopol 940	2	1.50	2
3.	Triethanol amine	1	0.30	0.30
4.	Glycerin	3	3	3
5.	Disodium EDTA	0.10	0.10	0.10
6.	Sodium Lauryl Ether Sulphate	20.00	21	22
7.	CAPB(Coca Amido Propyl Betaine)	5	5	5
8.	Citric Acid	0.10	0.10	0.10
9.	CDEA (cocodiethanolamine)	0.5	2	2
10.	Methyl Paraben	0.20	0.20	0.20

Optimization of gel shampoo base:

Sr. No.	Parameters	Qty for 100 gm		
		F1	F2	F3
1.	Appearance	++	+++	+++
2.	Color	+++	++	+++
3.	Odour	+++	++	+++
4.	Spreadability	++	+++	+++
5.	Feel	++	+++	++
6.	Consistency	+	++	++

Abbreviations:- + - Good, ++ - Better, +++ - Best.

From the above observation F1, F2, F3, the F3 have the most desirable properties and was stable. So the F3 formulation is selected for the further experimentation. Therefore extracts with different concentration will be added to this formulation.

2.2 Incorporation of Grape Seed Extract at different concentration in base formulation:

Table no.2 : Incorporation of Grape Seed Extract at different concentration in base formulation.

Sr No.	Ingredients	F1	F2	F3
		For 100%	For 100%	For 100%
1	SLES(Sodium Lauryl Ether Sulphate)	20.00	21.00	22.00
2	CAPB(Coca Amido Propyl Betaine)	5.00	5.00	5.00
3	Citric Acid	0.10	0.10	0.10
4	Disodium EDTA(Ethylene DiamineTetraacetic Acid)	0.10	0.10	0.10
5	CDEA (cocodiethanolamine)	5.00	2.00	2.00
6	Glycerin	3.00	3.00	3.00
7	Carbopol-940	2.00	1.50	2.00
8	Methyl paraben	0.20	0.20	0.20
9	Perfume	0.30	0.30	0.30
10	TEA(Triethanolamine)	0.30	0.30	0.30
11	Grape seed Extract	0.50	1.50	1.00
12	Water	68.1	66.8	65.3

2.3 Analysis of Gel Shampoo with Grape Seed Extract:

Gel shampoo formulation (i.e F3 with 1% Grape seed extract) was subjected to study the parameters like Appearance, Color, Odor, Consistency, Thermal stability, pH, Foam height removefficacy, moisture retention by corneometer and Skin irritation.

2.4 Stability Study:

The sample of gel shampoo was kept at 5°C, room temperature and at 40°C. The changes in physical appearance, colour etc were studied.

Table no. 3 : Stability studies of gel shampoo

Sr. No	Parameters	F1	F2	F3
1	Appearance	Opaque	Opaque	Opaque
2	Colour	Clear	Clear	Clear
3	Spreadability	Good	Good	Very Good

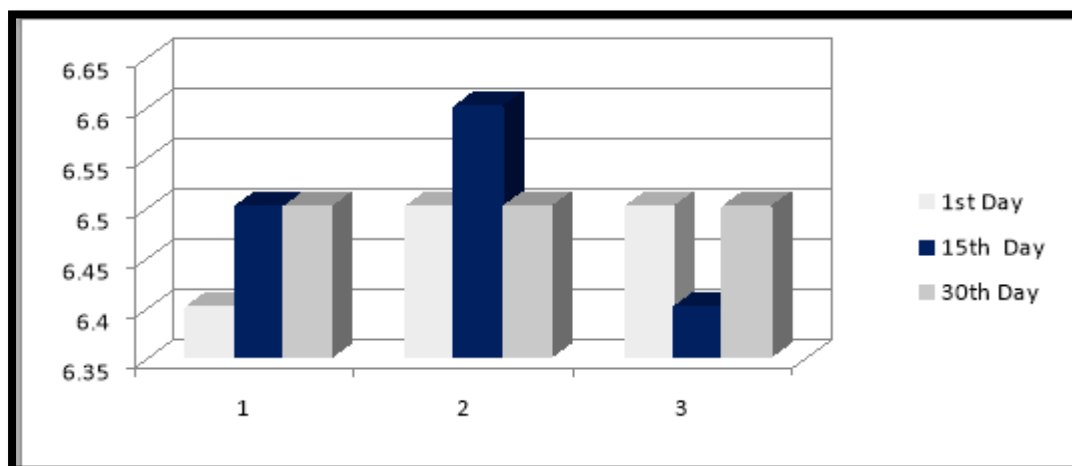
Determination of pH:

Determination of pH of gel shampoo incorporated with grape seed extract:

Table no.4 : Determination of pH of gel shampoo incorporated with grape seed extract

Time interval	F1	F2	F3
1 st Day	6.4	6.5	6.5
15 th Day	6.5	6.6	6.4
30 th Day	6.5	6.5	6.5

Graph no 1: Graphical representation of pH of gel shampoo with grape seed extract.

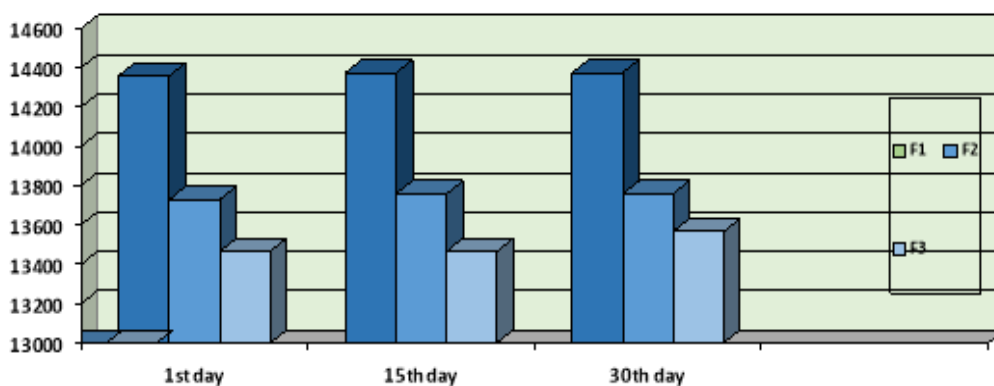


Determination of Viscosity: Determination of viscosity for gel shampoo incorporated with grape seed extract:

Table no. 5 : Determination of viscosity for gel shampoo incorporated with grape seed extract

Sr.no.	No. of days	F1	F2	F3
1	1 st day	13360	13730	13466
2	15 th day	14375	13759	13466
3	30 th day	14375	13759	13567

Graph no. 2 : Graphical representation of viscosity of gel shampoo with grape seed extract

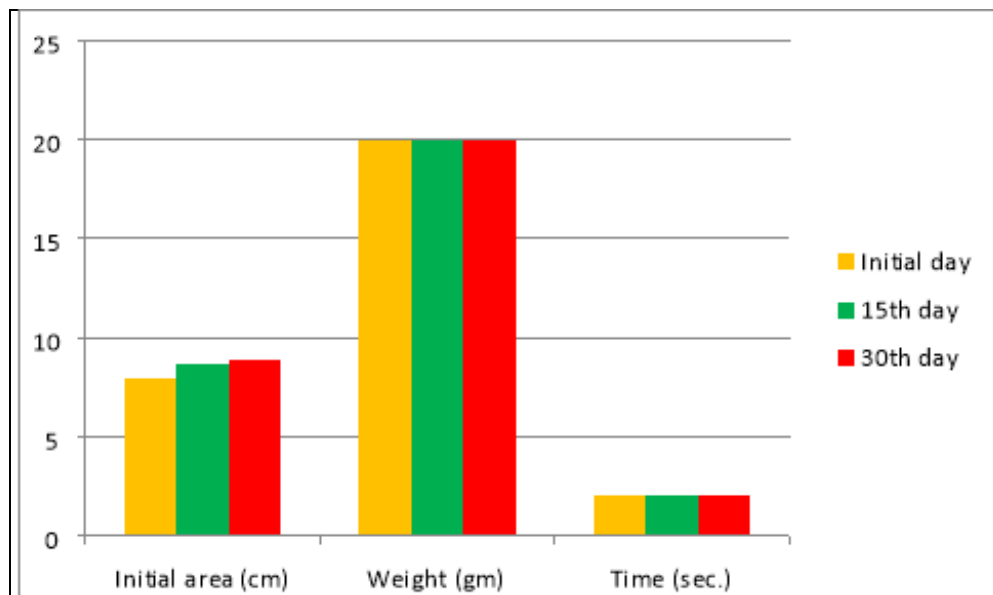


Determination of spreadability

Table no. 6 : Determination of spreadability

Sr.no.	Days of interval	Initial area	Weight	Time
1	Initial day	8cm	20gm	2.1 sec
2	15 th day	8.7cm	20gm	2.1 sec
3	30 th day	8.9cm	20gm	2.1 sec

Graph no.3 : Graphical representation of spreadability of gel shampoo

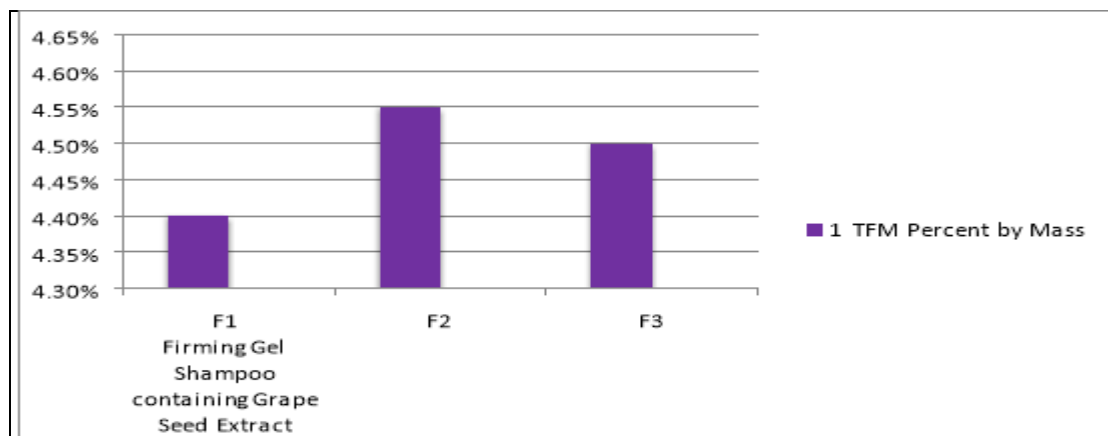


Determination of Total Fatty Matter:

Table no. 7 : Determination of Total Fatty Matter:

Sr. No.	Characteristics	Firming Gel Shampoo containing Grape Seed Extract		
		F1	F2	F3
1	TFM Percent by Mass	4.4%	4.55%	4.5%

Graph no.4 : Graphical representation of TFM of gel shampoo



Microbial examination of Gel Shampoo

Sr.no.	Test	Result	Specification	Unit
1.	Total bacterial count	20 CFU/gm	NMT100 CFU/gm	CFU/gm
2.	Total fungal count	NIL	NMT10 CFU/gm	CFU/gm

Table no. 8 : Microbial examination of Shampoo

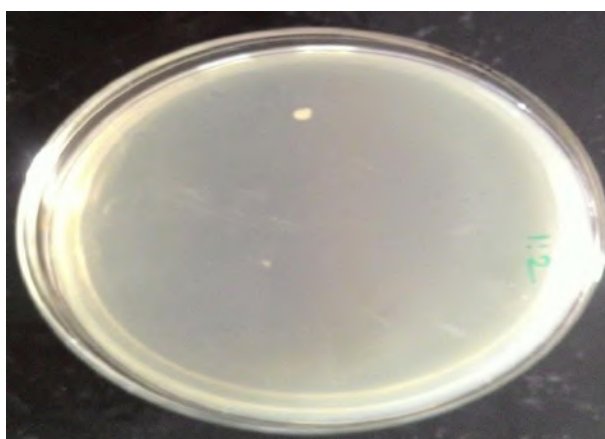


Fig: The total bacterial count

Result: The total bacterial count of Shampoo containing grape seed extract was found to be 10CFU/gm that is <100 CFU/gm. Therefore, the shampoo passes the test.

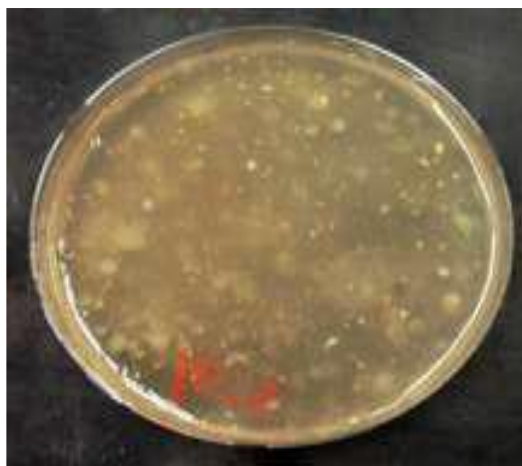
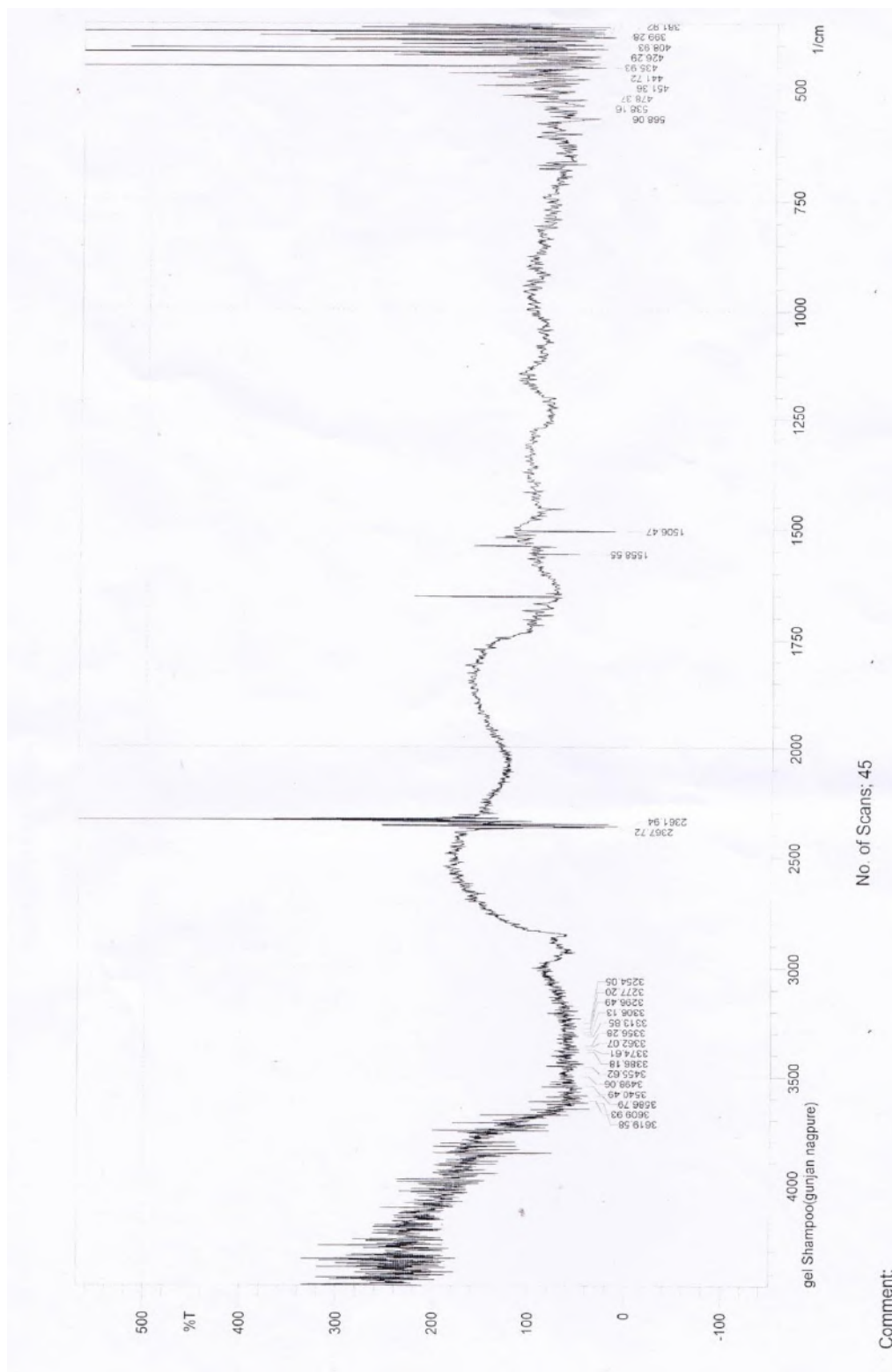


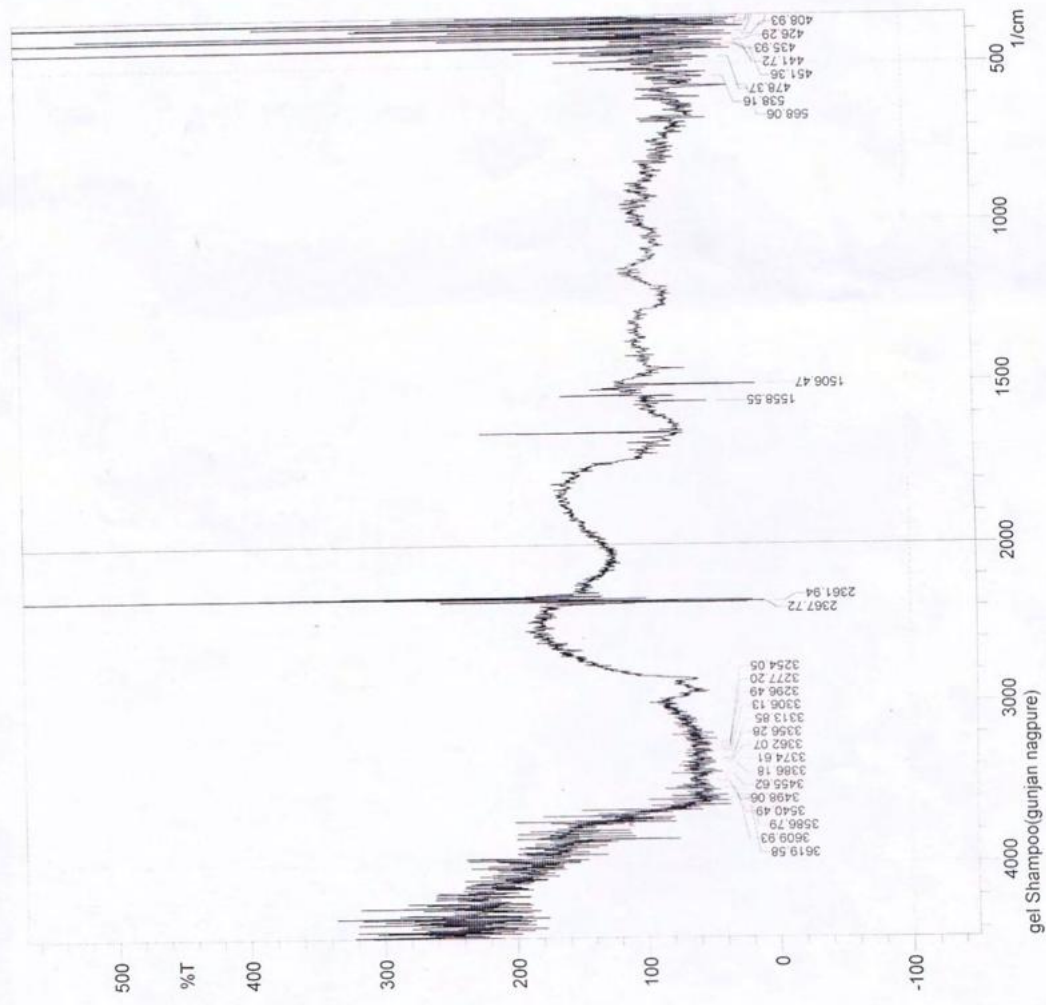
Fig : The total Fungal count

Result: The Total bacterial count Of a Shampoo containing grape seed Extract was found to be 10 CFU/gm that is <100 CFU/gm therefore, the Shampoo passes the test. The fungal count of a Shampoo containing grape seed extract was found to be NIL. Therefore the Shampoo passes the test.

FTIR ANALYSIS:

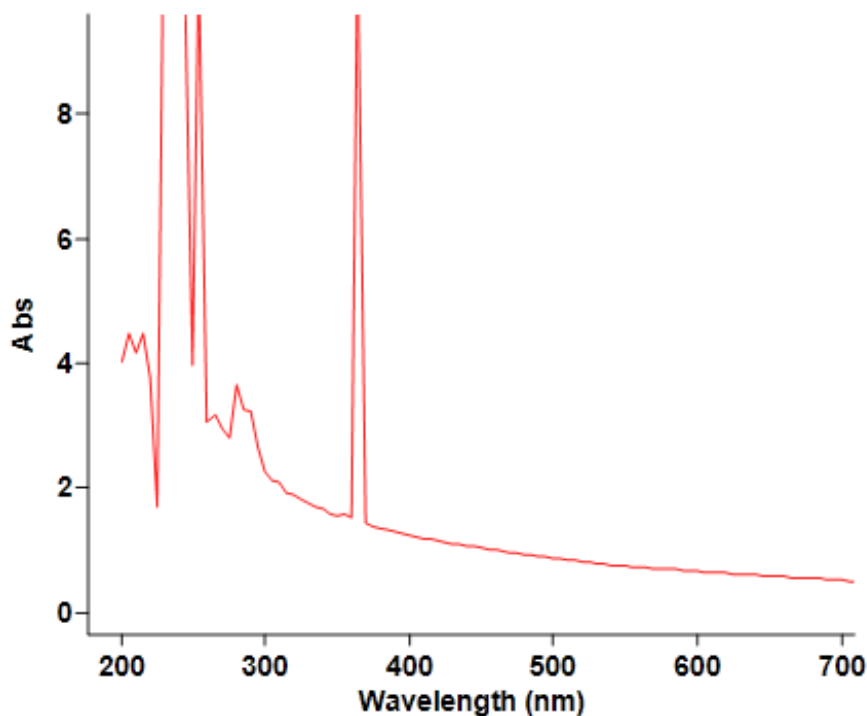


No.	Peak	Intensity	Corr. Inte	Base (H)	Base (L)	Area	Corr. Are
1	342.38	21.1	54.6	343.34	339.49	1.5	1.2
2	363.6	28.6	151.1	365.53	360.7	0.4	1.7
3	370.35	30.7	88.5	372.28	369.38	0.8	0.9
4	378.06	39	55.3	379.03	377.1	0.3	0.4
5	381.92	17.2	64.3	383.85	379.99	2	1.5
6	399.28	31.1	130	401.21	395.42	0.7	2.2
7	408.93	26.2	59.5	409.89	407	0.9	0.8
8	426.29	33.3	92.9	429.18	422.43	1.1	1.9
9	435.93	39.7	45.9	439.79	434.97	1	0.9
10	441.72	33.8	90.6	445.58	440.75	0.7	1.3
11	451.36	27.8	250	454.26	446.54	1.1	4.4
12	478.37	44.3	41.7	480.3	476.44	0.9	0.6
13	538.16	49	24.3	541.06	536.23	1.2	0.5
14	568.06	31.3	41.8	574.81	565.17	2.7	1.5
15	1506.47	13.6	106.1	1511.29	1505.51	1	1.5
16	1558.55	50.7	49.1	1560.48	1557.59	0.3	0.3
17	2361.94	9.4	209.4	2365.79	2360.97	1.5	2.5
18	2367.72	23.2	102.5	2369.65	2365.79	1.3	1.4
19	3254.05	52.1	11.2	3255.98	3250.19	1.3	0.3
20	3277.2	52.3	12.5	3279.13	3274.31	1.2	0.3
21	3296.49	52.6	12.3	3301.31	3290.7	2.5	0.5
22	3306.13	51.2	16.7	3308.06	3302.27	1.3	0.3
23	3313.85	48.8	14.2	3315.78	3309.03	1.8	0.4
24	3356.28	50.7	12.4	3358.21	3353.39	1.2	0.3
25	3362.07	50.3	13.5	3365.93	3359.18	1.6	0.3
26	3374.61	48	15.5	3377.5	3371.71	1.5	0.4
27	3386.18	47.8	21	3389.08	3384.25	1.2	0.4
28	3455.62	49.8	18.6	3457.55	3450.8	1.5	0.5
29	3498.06	53.2	11.5	3500.95	3495.16	1.3	0.2
30	3540.49	49.1	32.6	3546.28	3535.67	2.2	1.3
31	3586.79	38.8	26.5	3588.72	3582.93	1.5	0.4
32	3609.93	45.9	34.5	3612.83	3605.11	1.9	1
33	3619.58	38.1	23.2	3621.51	3617.65	1.3	0.5



Graph No. 5 – FTIR of Gel Shampoo

UV Spectrophotometer Analysis:



Scan Analysis Report

Report Time : Sat 16 Mar 01:10:58 PM 2019
Method
Batch: C:\Users\ABCD\Desktop\Gunjan Nagpurkar VBMV\Gel Shampoo.DSW
Software version: 5.0.0.999
Operator:

Instrument Parameters

Instrument Cary 60
Instrument Version 2.00
Start (nm) 800.0
Stop (nm) 200.0
X Mode Nanometers
Y Mode Abs
UV-Vis Scan Rate (nm/min) 24000.000
UV-Vis Data Interval (nm) 5.00
UV-Vis Ave. Time (sec) 0.0125
Beam Mode Dual Beam
Baseline Correction Off
Cycle Mode Off
Comments

Sample Name: Gel Shampoo

Graph No. 6 – UV of Gel Shampoo

Collection Time

3/16/2019 1:11:17 PM

Peak Table

Peak Style	Peaks
Peak Threshold	0.0100
Range	800.0nm to 200.0nm
Wavelength (nm)	Abs
365.0	10.000
355.0	1.572
280.0	3.671
265.0	3.179
255.0	10.000
245.0	10.000
215.0	4.478
205.0	4.478

Cyclic temperature test :

These tests are not carried out at fixed temperature and humidity. In this test, temperature was changed cyclically every day e.g. low-high-low-high to stimulate the changes in temperature daily.

Table no. 9 : Cyclic temperature test

Sr. no	Parameter	F1	F2	F3
1	Freeze temperature	Stable	Stable	Stable
2	Room temperature	Unstable	Unstable	Stable
3	High temperature	Unstable	Unstable	Stable

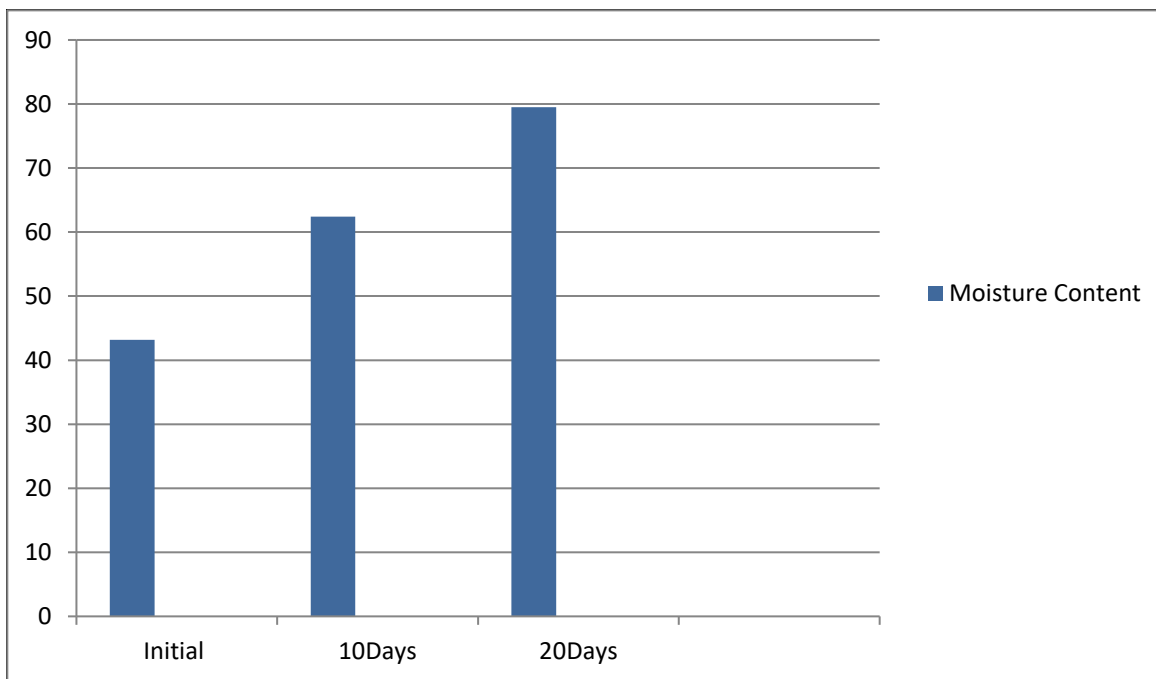
In Vivo Studies

Determination of moisturizing activity by corneometer

Table No.10: Determination of moisturizing activity by corneometer

Sr.No	Days	Moisture Content
1.	Initial	43.2
2.	10 Days	62.4
3.	20 Days	79.5

Graph No 7 : Graphical representation of Determination of moisturizing activity of Shampoo



Sensory Evaluation:

Objective: Comparison between two products based on following parameters

1. Appearance
2. Spreadability
3. Moisturization
4. Over All

Total Voluntaries -6

Product details: Product A- Gel Shampoo

Product B- Ayur Gel Shampoo

Sensory evaluation of Gel Shampoo Vs. Benchmark product

S.No	Voluntaries	Appearance		Spreadability		Moisturization		Overall	
		A	B	A	B	A	B	A	B
1.	Anjali	4	4	4.5	4	4.5	4	4	4
2.	Roshani	4	4	4	4.2	4	4	4	4.3
3.	Shrutika	4.2	4	4	4.1	4	4	4.5	4
4.	Meghana	4.5	4	4	4	4	4.2	4	4.2
5.	Pallavi	4	4.4	4	4.2	4	4	4.3	4
6.	Antara	3.7	4	3.8	4	4.3	4	4	4.1

S.No	Parameters	Product A	Product B
1.	Appearance	4.75	4.1
2.	Spreadability	4.1	4
3.	Moisturization	4.18	4
4.	Overall	4.1	4

Status: Sensory evaluation and performance evaluation against benchmark is done and result found more than satisfactory.

Certificate of Analysis:

Grape Seed Extract

Description:

Proanthocyanidin grape seed extract. Dry in powder form, for dietary supplement applications.

Applications:

Free radical scavenging and antioxidant action

Batch nr. : **GSE500306**

Chemical Classification

Organic, Nutritive

Physical appearance

Fine Reddish Brown Powder

Colour

Reddish Brown

Odor

Characteristic Tannin

Taste

Astringent

Analysis:

	<u>Specification:</u>	<u>Result:</u>
%Moisture	< 5%	4.0%
Ash content	< 8%	5.5%
Total polyphenols (gallic acid equivalent) Folin method	> 50%	54.1%

Heavy metals:

Arsenic (As)	< 3 ppm	Complies
Cadmium (Cd)	< 1 ppm	Complies
Lead (Pb)	< 10 ppm	Complies
Mercury (Hg)	< 1 ppm	Complies

Microbiology:

Total Plate count (CFU/g)	< 1000	Complies
Coliforms (CFU/g)	< 5	Complies
Yeast and Mould (CFU/g)	< 100	Complies
Escherichia coli	0	No growth
Salmonella	0	Absent
Staphylococcus aureus	0	No growth

2.5 Subjective Evaluation:

To study the efficacy of the Gel shampoo formulation (i.e. F3 with 1% Grape seed extract) was selected for subjective evaluation and given to the volunteers for satisfactory results. Hence subjective Evaluation was carried out on the panel of human volunteers. Formulation F3 with 1% Grape seed extract was given to 30 volunteers and evaluation was carried out on the basis of their feedback after 30 days for parameters like Appearance, Ease of spreadability, Hair wash efficacy, Moisturisation and overall hair fall control experience. Hence, from the feedback by volunteers and by the photographic evaluation given below, it was clear that formulation F3 with 1% Grape Seed Extract was proved to be excellent product in Gel shampoo and helps to regrowth of hairs as seen in the photographs.



Fig: Hair fall before use

Fig: Hair growth after use

3. Result and Discussion:

3.1 Result

From the analysis of Grape seed extract, it was observed that procured sample passes the test as per Certificate of Analysis and hence was used for incorporation in formulation.

3.2 Result of Formulation and Development of Gel Shampoo using Grape seed extract

In the present study after analyzing all the three formulations, (i.e. F1, F2 and F3), on the basis of functional parameters, it was observed that, in the formulation-F1, base was not stable, hence emulsifying agents were increased. In F2, hair were not removed properly, hence the concentration of Grape seed extract was increased, and F3 containing 1% Grape seed extract was giving satisfactory results. Hence, Gel shampoo (i.e. F3 with 1% Grape seed extract) was selected for further study

3.3 Result of stability study

The objective of stability study is to ensure that product will remain stable till the consumer has used the entire product. The stability not only indicates stability of formulation but also the stability of other ingredients present in the formulation of Gel shampoo. After analyzing all the three formulations, on the basis of functional parameters, it was observed that the Gel shampoo formulation (i.e. F3 with 1% Grape seed extract) was giving satisfactory results. Hence the formulation (i.e. F3 with 1% Grape seed extract) was subjected to accelerated stability studies. Changes in parameters like Color, Odor, pH at three different temperatures (i.e. in oven at (45⁰C), in refrigerator at (4⁰C) and at room temperature) was recorded for 45 days at interval of two days.

4. Conclusion:

The present study was conducted with a view to formulate and evaluate on removing dust, dirt, sebum, greasiness, oil from scalp and hairs of given formulation by using grape seed extract. The gel shampoo was prepared with natural active agents. The concentration of active agent were kept in range of 0.5 %, 1%, 2%, each were incorporated and three combination of each were prepared.

Antioxidant testing of extract was done by Reducing power method. The Antioxidant activity was determined by power reducing method which showed that high absorbance which indicates it has good antioxidant property. The moisture content of hairs increases with the continuous use of product.

In the present work firming gel shampoo formulation gave satisfactory good cleansing and hair growth promoting property and this is achieved by the use of natural actives like grape seed extract.

The gel shampoo was prepared by the conventional procedure and all the factors, parameters such as pH, viscosity, stability, microbial analysis were determined. It was also kept accelerated by stability testing for 30 days. Then the product i.e. gel shampoo was applied on human volunteers and progressive effective result were found Thus the formulation F3 of gel shampoo containing 1% grape seed extract were found stable and gave most effective result respectively. At present because of availability of wide range of cosmetic products in market, consumers are giving special attention towards the selection of cosmetic product to develop a well standard formula, the new product viz. herbal firming gel shampoo was formulated by incorporating active extract singly for good effect.

Thus, F3 formulation of gel shampoo with grape seed extract were found to be most effective and stable. Thus, conclusion can be made that the gel shampoo containing grape seed extract have been able to remove dust, dirt, oil, stickyness and other signs also promotes hair growth without any side effect making hairs clean n healthy.

5. References:

1. Schneider, Günther et al (2005). "Skin Cosmetics" in Ullmann's Encyclopedia of Industrial Chemistry, Wiley-VCH, Weinheim. doi:10.1002/14356007.a24_219
2. "[Cosmetics and Your Health – FAQs](#)". Womenshealth.gov. November 2004. Archived from the original on 2013-03-12.
3. "Handbook of Cosmetic Science & Technology" by Marc Paye, Andre O. Barel, Howard I. Maibach, 2008, page no. 493-494
4. Harry's Cosmetology, J.B Wilkinson, R.J. More, Longman Singapore publishers,pvt ltd 7th edition page no 1-10
5. "Anatomy and Physiology" Ross & Wilson, Anne Waugh, Allison Grant, Churchill <http://en.wikipedia.org/wiki/Skin> browsed on 25 Dec 2014
6. "Cosmetic Dermatology": Products and Procedures][By Zoe Diana Dra]
7. "[Hair loss](#)". NHS Choices. [Archived](#) from the original on 27 September 2013. Retrieved 22 September 2013.
8. Jump up to:^a ^b ^c ^d Nalluri, R; Harries, M (February 2016). "[Alopecia in general medicine](#)". Clinical Medicine. **16** (1): 74–8. doi:10.7861/clinmedicine.16-1-74. PMC 4954340. PMID 26833522.
9. Vary JC, Jr (November 2015). "Selected Disorders of Skin Appendages--Acne, Alopecia, Hyperhidrosis". The Medical Clinics of North America. **99** (6): 1195–211. doi:10.1016/j.mcna.2015.07.003. PMID 26476248.

10. Jump up to:^{a b} McElwee, K. J.; Shapiro, J. S. (2012). "[Promising therapies for treating and/or preventing androgenic alopecia](#)". *Skin Therapy Letter*. **17** (6): 1–4. [PMID 22735503](#). [Archived](#) from the original on 2015-12-12.
11. Leavitt, M. (2008). "Understanding and Management of Female Pattern Alopecia". *Facial Plastic Surgery*. **24** (4): 414–427. [doi:10.1055/s-0028-1102905](#). [PMID 19034818](#).
12. "[Hair loss](#)". *Derm Net*. [Archived](#) from the original on 2016. Retrieved 2016-08-03.
13. Dawber, Rodney P. R.; Van Neste, Dominique (2004). *Hair and scalp disorders: common presenting signs, differential diagnosis and treatment* (2nd ed.). Informa Health Care. pp. 53–54. [ISBN 978-1-84184-193-9](#).
14. Rajesh Kumar Nema, hamalsinghRathore, Bal Krishna Dubey *Textbook of cosmetic*, first edition.
15. Dr. Loren pickart, skin biology, Article on "Aging Raversal sciences". *The Biology of skin and aging damage*.
16. *New Flora of the British Isles* (Third ed.). Cambridge, U.K.: Cambridge University Press. [ISBN 9780521707725](#). Gleason and Cronquist volume 2, *New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada*, p. 517. [LCCN 63-16478](#)
17. Bennett, M.D.; Leitch, I.J. (2012). "[Royal Botanic Gardens, Kew: Plant DNA C-values database, release 6.0](#)". Royal Botanic Gardens, Kew.
18. Everhart SE (2010). "[Upper Canopy Collection and Identification of Grapevines \(Vitis\) from Selected Forests in the Southeastern United States](#)". *Castanea* (from University of Nebraska Digital Commons). **75** (1): 141–149.
19. Galet, Pierre (2000). *Dictionnaire encyclopédique des cépages*. Hachette Pratique. [ISBN 2-01-236331-8](#).
20. "[PLANTS Profile for Vitis vulpina \(snow grape\)](#)". [USDA](#). Retrieved November 16, 2009.
21. Jain, E.; Bairoch, A.; Duvaud, S.; Phan, I.; Redaschi, N.; Suzek, B.E.; Martin, M.J.; McGarvey, P.; Gasteiger, E. (November 3, 2009). "[Vitis riparia \(Frost grape\) \(Vitis vulpina\)](#)". *The Universal Protein Resource (UniProt)*. The UniProt Consortium. Retrieved November 16, 2009.
22. Lewis, C.T.; Short, C. (1958), *A Latin Dictionary*, Oxford: Clarendon Press
23. McNeill, J.; Ba"[Alopecia: Causes](#)". *Better Medicine*. [Archived](#) from the original on 23 March 2012. Retrieved 28 March 2012.
24. "[Drug-Induced Hair Loss](#)". [Archived](#) from the original on 2013-07-26.
25. Nnoruka E, Nnoruka N (October 2005). "Hair loss: is there a relationship with hair care practices in Nigeria?". *Int J Dermatol*. **44**(Suppl 1): 13–7. [doi:10.1111/j.1365-4632.2005.02801.x](#). [PMID 16187950](#).

Formulation and Evaluation of Anti-Acne Face Wash Gel by using Extracts of Curry Leaves and Bael Leaves

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ABSTRACT:

The objective of this work is to formulate and evaluate gel base face wash by using herbal extracts. From ancient times, there has been awareness among the people regarding the use of plants for the essential needs of healthy and beautiful skin. Cosmetic designed with incorporating natural sources, such as herbs. Face Wash are used to get rid from dirt, oil, pollution etc. Many plants has been shown to be effective for anti-acne treatment. Curry leaves are used in traditional medicine as a source of many therapeutic agents in the Indian culture and grows well in the tropical countries. Curry leaves, known as *Murraya Koenigii*, belonging to Rutaceae family are widely used as a medicinal herb and has characteristic aroma. It is rich source of carbazole alkoids, Carbohydrates, steroids and flavonoids are also present in the root extracts of the plant. It showed some antimicrobial activity as well as antifungal activity. The gel face wash Leaves, fruits, stem and roots of *Aegle marmelos* have been used in ethno medicine to exploit it's medicinal properties including astringent, antidiarrheal, demulcent, and anti-inflammatory activities. Formulation FW2 shows anti acne properties which also showed good Rheological characteristics, pH, spreadability, stickiness, greater active content. Hence this study showed that FW2 was the best formulation for anti-acne face wash. According to In-Vivo study, the product has no skin irritation and redness form after applying on the skin.

KEYWORDS: Anti-Acne Face Wash, *Murraya Koenigii*, *Aegle marmelos*, antimicrobial activity, astringent.

INTRODUCTION:

Face wash

Face wash is the products which are used to cleanse face without drying it out. Face wash is very helpful in removing dirt, oil and provide moisture to the skin. Face Wash are used to get rid from dirt, oil, pollution etc. A cleanser dissolves away excess oil makeup and grime from your face. These are oil soluble impurities. Facial skin is the delicate and ordinary soaps can cause it to lose moisture. The purpose of face wash may be to impart cleansing, anti-acne property and moisturizing effect to the skin. And it is commonly called as cleansers.

Forms of face wash

1. Cream base face wash
2. Gel base face wash
3. Liquid base face wash

4. Face wash in powder form

Gel based face wash

A gel is a solid jelly like material that can have properties ranging from soft and weak to hard and tough. Gels are defined as a substantially dilute cross-linked system, which exhibits no flow when in the steady-state. By weight, gels are mostly liquid, yet they behave like solids due to a three-dimensional cross-linked network within the liquid.

Types of face wash

- Oily skin face wash
- Dry skin face wash
- Normal skin face wash

Ideal properties of face wash

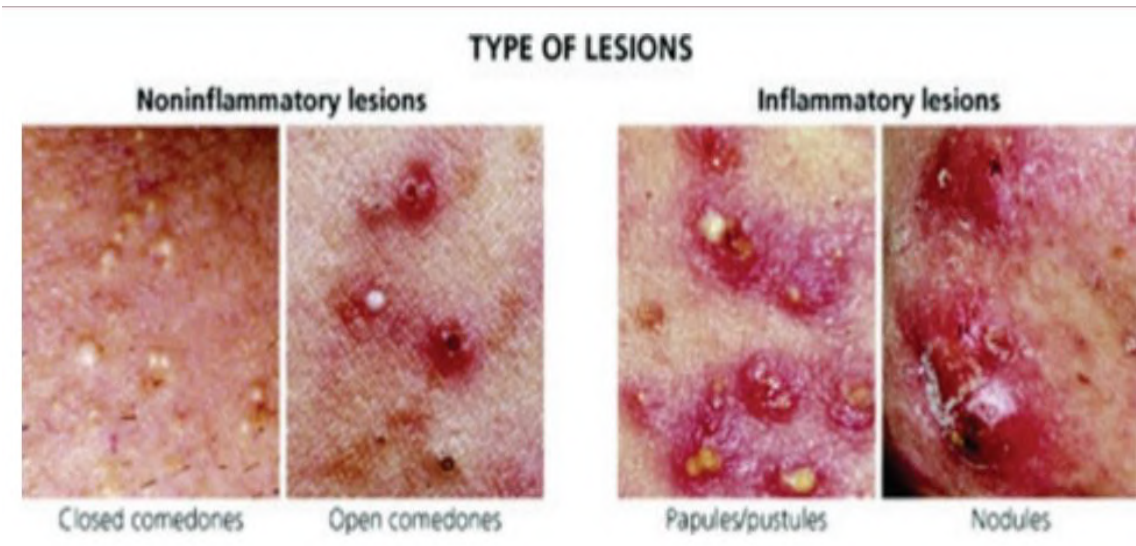
- Removing the dead cell from the skin
- Removing oil and dirt from the skin
- Reduces microbial flora of skin.
- Leave skin fresh and breathing. ^[52]

ACNE

Acne is an infection of the skin, caused by changes in the sebaceous glands. The most common form of acne is called acne vulgaris, which means "common acne". The redness comes from the inflammation of the skin in response to the infection. Oils from the glands combine with dead skin cells to block hair follicles. Under the blocked pore, oil builds up. Skin bacteria can then grow very quickly. This infection makes the skin become swollen and red, which becomes visible. The face, chest, back, and upper arms are most common places for acne to happen. Acne is common during puberty, when a person is turning from a child into an adult, because of high levels of hormones. Acne becomes less common as people reach adulthood. Acne vulgaris is an extremely common disorder of skin (pilocebaseous unit) that affects virtually all individuals at least once during life. The incidence of acne peaks at teenage, but substantial numbers of men & women between 20-30 years of age are also affected by the disorder. Adolescent patients have reported low self-esteem and symptoms of depression leading to a lower quality of life. Acne vulgaris is an extremely common disorder of skin [pilocebaseous unit] that affects virtually all individuals at least once during life. Acne vulgaris is one of the most common dermatological disorders that afflict people in their adolescence. Acne vulgaris or simply known as acne is a human skin disease characterized by skin with scaly red skin (seborrhea), blackheads and whiteheads (comedones), pinheads (papules), large papules (nodules), pimples and scarring. Acne vulgaris is a disease of pilosebaceous unit characterized by the formation of open and closed comedones, papules, pustules, nodules and cysts. Acne affects skin having dense sebaceous follicles in areas including face, chest and back. Acne is not life threatening but severe acne can affect psychological status and social activities. The present review focuses on an epidemiology, etiology, pathogenesis, diagnosis, differential diagnosis and management of acne with the pharmaceutical dosage forms of oral and

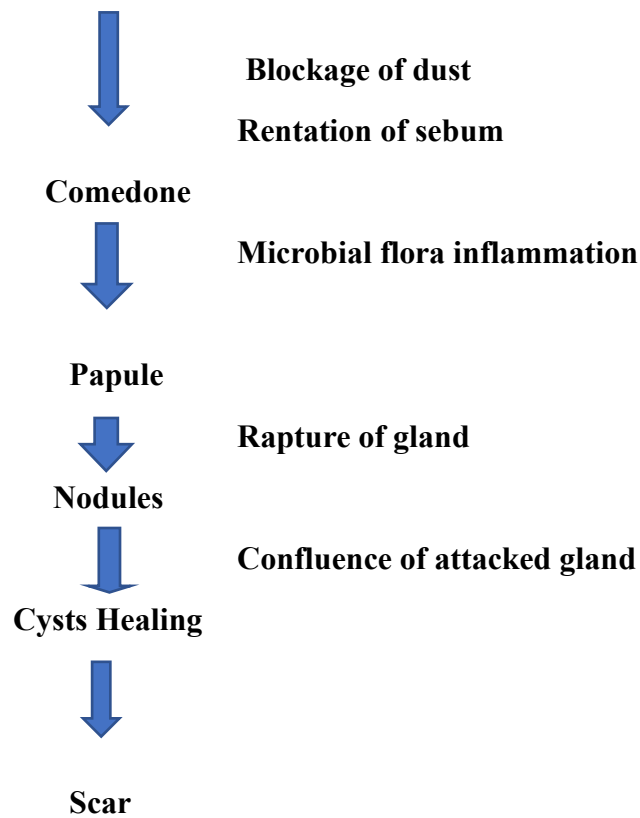
topical administrations. Currently laser and light devices and minor subcision surgery have been also performed for acne treatment.[3],[4],[5],[6]

Stages of development and formulation of Acne

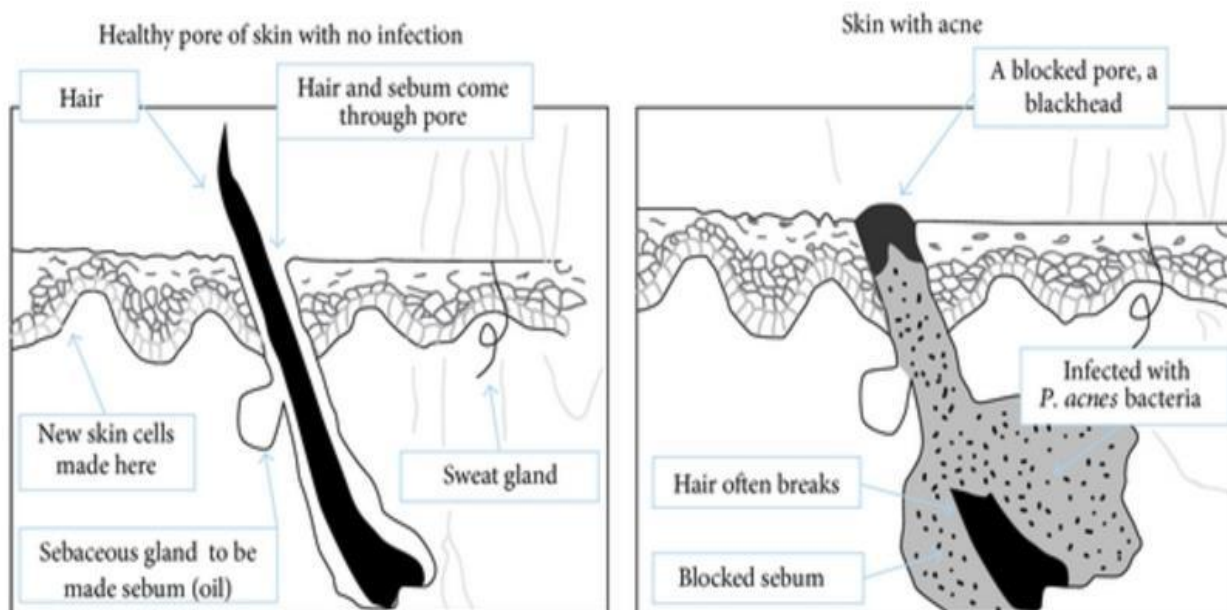


Stages of development and formation of Acne

Sebaceous Glands (Sebum)



Flow Charts of stages of acne



Anti- Acne Agents:

MURRAYA KOENIGII

Plant products nowadays play an important role in the world population. People use herbal product because they are considered as safe, inexpensive and less side effects. *Murraya koenigii* contains phytochemicals such as saponins, proteins, *Murraya koenigii* contains phytochemicals such as saponins, proteins, steroids, tannin, carbohydrates, alkaloids, flavonoids and glycoside. It has antimicrobial, antifungal, antidiarrheal, anticancer, antidiabetics and anti-inflammation. It has the skin improving effect. The *Murraya koenigii* extract from leaves provide a higher amount of polyphenols and antioxidant activity. *Murraya koenigii* showed significant antibacterial activity against *Staphylococcus aureus* and *Staphylococcus Epidermidis*. The curry tree *Murraya koenigii* is a tropical to sub-tropical tree in the family Rutaceae. Curry tree is also called curry leaf tree or curry bush, among numerous local names, depending on country. This plant is known to be the richest source of carbazole alkaloids, Mahanine, Mahanimbine, Vitamin A and Isomahanimbine.^[47]

AEGLE MARMELOS

Aegle marmelos, commonly known as bael, also stone apple or wood apple, is a species of tree native to the Indian subcontinent and Southeast Asia. It is present in India, Sri Lanka, Nepal, Thailand, and Malesia as a naturalized species. The tree is considered to be sacred by Hindus. Bael (*Aegle marmelos* (L.) Corr.) is an important medicinal plant of India. Leaves, fruits, stem and roots of *Aegle marmelos* have been used in ethno medicine to exploit it's medicinal properties including astringent, antidiarrheal, demulcent, and anti-inflammatory activities. Compounds purified from bael have been proven to be biologically active against

several major diseases including cancer, diabetes and cardiovascular diseases. Preclinical studies indicate the therapeutic potential of crude extracts of *Aegle marmelos* in the treatment of many microbial diseases, diabetes and gastric ulcer. This review covers the biological activities of some isolated chemical constituents of *Aegle marmelos* and preclinical studies on some crude extracts and pure compounds to explore novel bioactive compounds for therapeutic application.^{[16],[17]}

MATERIALS AND METHODS:

List of ingredients required:

1. **Carbopol Ultrez 20** - Lubrizol
2. **Sodium lauryl sarcosinate**- Galaxy Surfactant Ltd.
3. **Cocoamidopropyl Betain**- Galaxy Surfactant Ltd.
4. **Propylene Glycol** -VBMV
5. **Triethanol amine**-VBMV
6. **Distilled Water**- VBMV
7. **Disodium EDTA**-VBMV
8. **Phenoxyethanol**-VBMV
9. **Bael Leaves Extract**-Konark Herbal Pvt. Ltd.
10. **Curry Leaves Extract**- Konark Herbal Pvt. Ltd.

List of Equipments

1. **Precision balance**: CA series contech
2. **Mechanical stirrer**: Shettal Scientific industry Pvt ltd.,Mumbai
3. **pH meter**: Digital Model 111E-E-1 Electronic india
4. **Brook field Viscometer**: S.M.S Scientific Industry Pvt.Ltd. Mumbai (DV-E-version1, E-34/03)

Method of preparation of Face wash:

The preparation of face wash is very important and before incorporation of active ingredients. The ingredients used in preparation of Face wash are mentioned in table no.1

Formulation of gel face wash :

Table No 1: Formulation of Base face wash

Sr. No.	Ingredients	FW1 For 100%	FW2 For 100%	FW3 For 100%
1	Carbopol Ultrez 20	0.5	0.6	0.6
2	Sodium Lauryl Sarcosinate	18.3	18.6	17.6
3	Cocoamidopropyl Betain	5	3	3
4	Propylene Glycol	4	4	4
5	Triethanol Amine	0.4	0.4	0.4
6	Distilled Water	71	72	72
7	Disodium EDTA	0.1	0.1	0.1
8	Phenoxyethanol	0.3	0.3	0.3

Optimization of Face wash Procedure

Procedure: Sprinkle some Ultrez 20 in water and then add triethanol amine to adjust the pH then add Sodium Lauryl Sarcosinate ,Cocoamidopropyl Betain , Propylene Glycol Disodium EDTA and Phenoxyethanol in the end.

Formulation of Face wash containing curry leaves and bael leaves extract**Table no 2: Formulation of face wash containing bael leaves and curry leaves extract**

Sr. No.	Ingredients	FW1	FW2	FW3
1	Carbopol Ultrez 20	0.5	0.6	0.6
2	Sodium lauryl sarcosinate	18.3	18.6	17.6
3	Cocoamidopropyl Betain	5	3	3
4	Propylene Glycol	4	4	4
5	Triethanol amine	0.4	0.4	0.4
6	Distilled Water	71	72	72
7	Disodium EDTA	0.1	0.1	0.1
8	Phenoxyethanol	0.3	0.3	0.3
9	Bael leaves extract	0.2	0.5	1
10	Curry leaves extract	0.2	0.5	1

Procedure of face wash:

- Clean all the ingredients as per the formulation of face wash
- 0.1 gm of disodium EDTA was dissolve in water
- The ultrez 20 was dispersed in the water
- pH were adjust with the help of TEA
- Surfactant were added into the formulation
- At the end propylene glycol
- And Phenoxyethanol which is first mixed with propylene glycol
- In the end both actives are incorporated.

FW2 was the best formulation for anti-acne face wash

Final formulation of Curry leaves and Bael leaves extracts

Table no. 3 Final formulation of face wash FW2

containing Curry leaves and Bael leaves

Sr. No.	Ingredient	FW2
1	Carbopol Ultrez 20	0.6
2	Sodium lauryl sarcosinate	18.6
3	Cocoamidopropyl Betain	3
4	Propylene Glycol	4
5	Triethanol amine	0.4
6	Distilled Water	72
7	Disodium EDTA	0.1
8	Phenoxyethanol	0.3
9	Bael leaves extract	0.5
10	Curry leaves extract	0.5

EVALUATION:

In- Vitro Studies:

1) Determination of physical parameters:

Apperance: Visually appearance of the formulation observed

Colour: Colour of the formulation check visually.

Consistency: Consistency was check weather its satisfactory or poor or good.

Tacky feel: Tackiness were check after application on palm.

2) Determination of pH

Principle: Face wash are used for topical application so there ph should be similar to that of with the skin. The skin these acidic mantle and the pH of the face wash as per standard should be in the range of 5-9

Appratus : pH meter

Procedure: Take 1gm of sample and dissolve in 100ml of water in beaker that is 1% solution is prepared. Then with the help of pH meter reading were taken.

3) Determination of viscosity:^[27]

Appratus: Brookfield viscometer

Principle: The viscosity most important parameter in the evaluation of cosmetic product. Viscosity governs the many properties such as spreadability, pourability of the product from the container. As viscosity is affected by many factors such as change in temperature, change in manufacturing condition, quality of the raw material. Hence it is very important to measure viscosity of product.

Proceduce: The viscosity of Face wash was determined by using spindle no. 6 at 10 to 100 rpm

4) Determination of foaming power:^[26]

Appratus: Beaker and Measuring cylinder.

Procedure: Firstly 5 ml of face wash was taken in a beaker and then add 45ml of water in it. Stir it well before solubilizing the face wash in water, then this solution taken in 500 ml measuring cylinder give 12 shakes to it stand a cylinder for a 2 min then take the reading by using ruler in centimeter.

5) Determination of microbial Testing ^[50,51,52]

Principle: The disc-diffusion test is based on the fact that for a given antibiotic, the size of the zone of inhibition is inversely related to the MIC (determination by dilution method of the strain being tested when the test conditions are the dilution method) of the strain being tested when the test conditions are held constant. Antimicrobial susceptibility testing with discs is a simple and rapid method and provides a reproducible means of testing bacterial sensitivity to various antibiotics and chemotherapeutic agents.

In- Vivo Studies:

1) Skin irritation:

The skin irritation was carried out on human volunteers. For formulated Face wash, five volunteers were selected and 1.0 gm of formulated cream was applied on an area two square inch to the back of the hand. The voluntrees were observed for lesions of irriation.

Parameter	Skin irritation test
F1	No irritation
F2	No irritation
F3	No irritation

Table no. 4 skin irritation

2] Photographic evaluation:

Photographic evaluation is carried to see the effect of the product visually. In case of determination of cleansing activity photographic evaluation was adopted. In this method the photograph of skin before and after rinsing of skin were taken out and effect of product was determined.

RESULTS AND DISSCUSSION

In-Vitro studies:

1) Determination of physical parameter of face wash

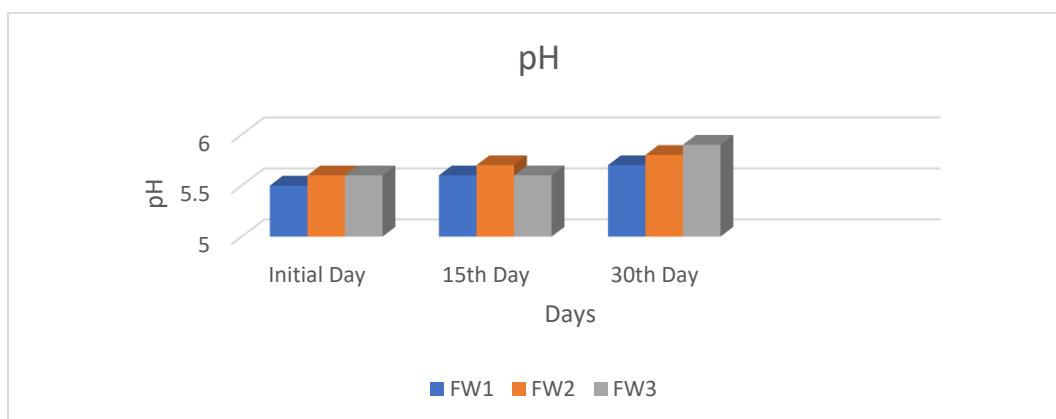
Table no 5: Parameters of face wash

Sr. No.	Parameters	FW1	FW2	FW3
1	Appearance	Clear	Clear	Clear
2	Colour	Colourless	Colourless	Colourless
3	Consistency	Not Good	Good	Good
4	Tacky Feel	No	No	No

2) Determination of pH of Face wash

Table no 6: pH of Face wash

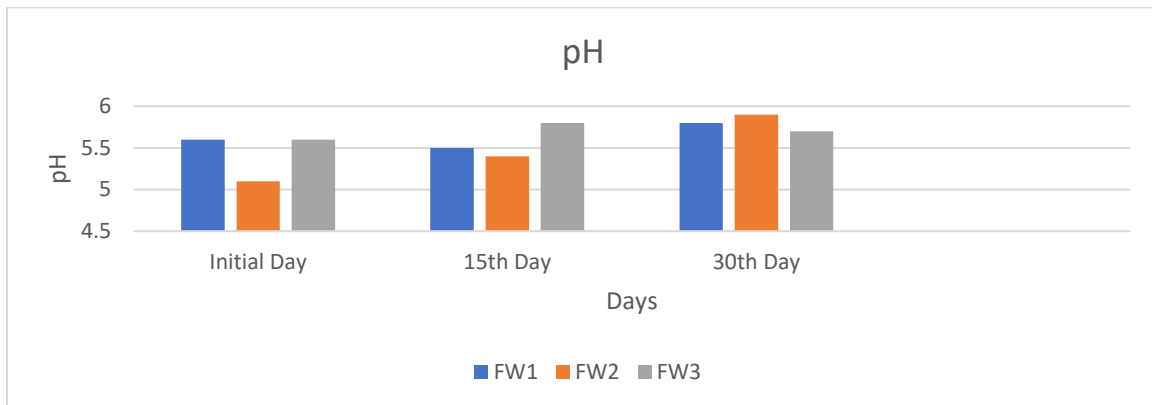
Sr.No.	Time interval	FW1	FW2	FW3
1	Initial Day	5.5	5.6	5.6
2	15 th Day	5.6	5.7	5.6
3	30 th Day	5.7	5.8	5.9



1) Determination of pH by using Curry leaves and Bael leaves

Table no 7: Determination of pH

Sr. No.	Time interval	FW1	FW2	FW3
1	Initial Day	5.6	5.1	5.6
2	15 th Day	5.5	5.4	5.8
3	30 th Day	5.8	5.9	5.7



3) Determination of viscosity

Table no 8: Determination of viscosity

The viscosity of face wash determine by using Brookfield Viscometer. The values obtained from the sample noted.

Sr. No.	No. of days	FW1	FW2	FW3
1	Initial Day	7250cp	7200cp	6950cp
2	15 th Day	7150cp	7100cp	6800cp
3	30 th Day	7120cp	6840cp	6750cp

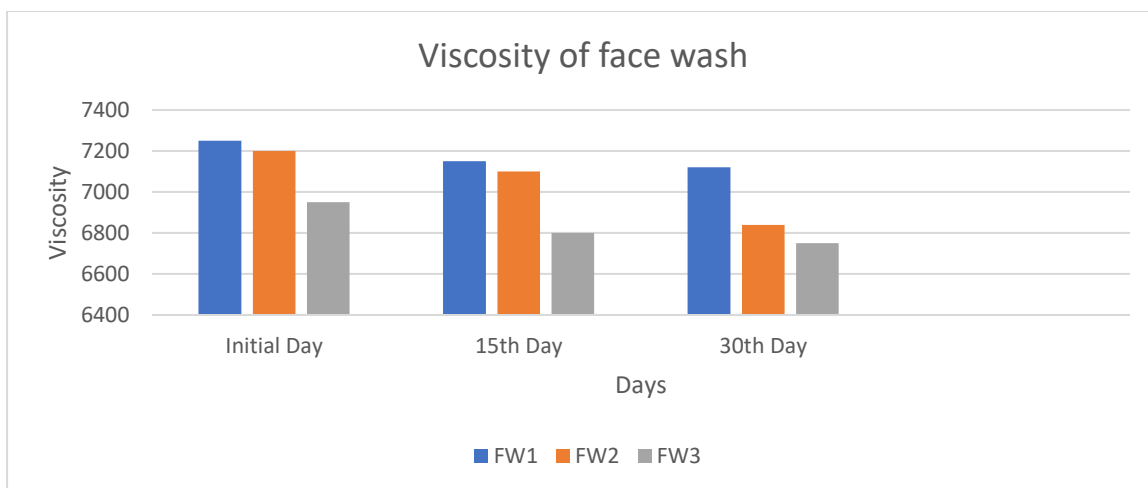
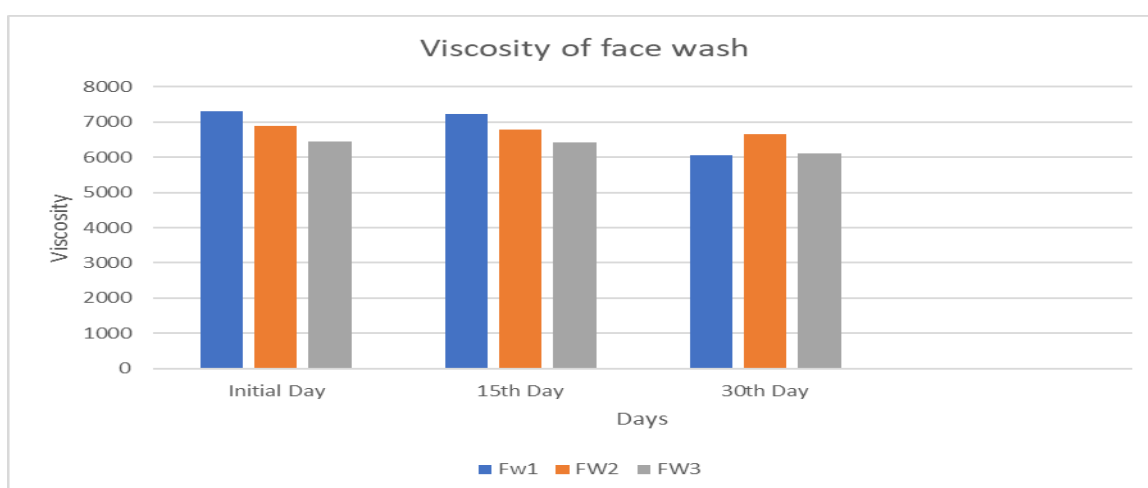


Table no 9: Determination of viscosity of face wash with Bael leaves and Curry leaves

Sr. No.	Time interval	FW1	FW2	FW3
1	Intial Day	7312cp	6900cp	6450cp
2	15 th Day	7220cp	6780cp	6423cp
3	30 th Day	6059cp	6660cp	6100cp

It was observed that viscosity of formulation was found to be which was good. Therefore formulation passes the test.



4) Determination of Foaming Power

Table no. 10 Determination of Foaming Power

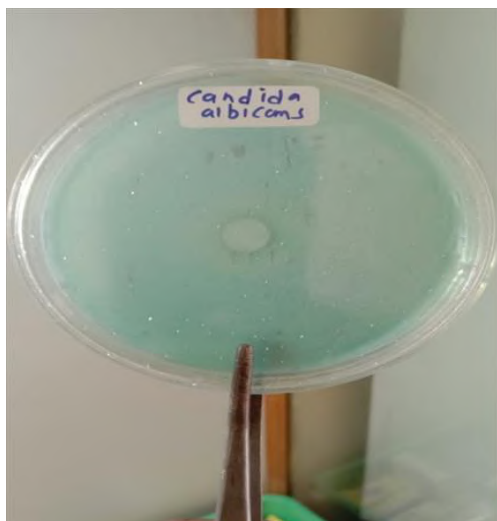
Sr. No	Determination of foaming	Result
1	Foaming	64

Determination of Microbial Testing:^[50,51,52]

5) Determination of Microbial Testing

Interpretation of result:

Although there is some correlation between the size of the zone of inhibition and the susceptibility of the organism to the antibiotic, the former is a function of many variables e.g density of the inoculum, depth of the medium, diffusibility of antibiotic etc. The size of the inhibition zone at which the organism is considered Resistant, Intermediates or sensitive is given in the zone size interpretative chart as a part of this literature.



In-Vivo Studies

1) Table no. 11 Skin irritation study:

Parameters	Skin irritation
FW1	No irritation
FW2	No irritation
FW3	No irritation

2) Photographic Evaluation

The study of effectiveness of product was done by the help of the volunteer study. This was carried out human volunteers. Face wash were applied on skin. The photograph were taken before and after application of product.



CONCLUSION

At Present because of availability of cosmetic products in market, consumers are giving special attention Towards the selection of cosmetic product to develop a well standard formula; the new product viz. herbal face wash was formulated by incorporating active extract singly and also in combination for good effect.

Anti-acne face wash was selected for sebum regulation activity because anti-acne face wash Contain good quality of extracts which helps to reduce sebum secretion and helps to remove oil and reduce pimple. Face wash prepared on synthetic base containing polymer, surfactant, humectant and preservatives etc. One formulation was selected from prepared base formulation on the basis of physical parameter for futher incorporation. Incorporation of active and sebum regulation property. Different formulation were prepared with varying concentration of actives i.e anti-acne face wash with curry laves and bael leaves. Evaluation studies like physical parameter, pH, viscosity, stability was done for selecting the final batch. In-Vivo study of final batch was taken. Cleansing activity were determine photographically.

Over the post few year, several methods are developed for an efficient cleansers with profound effect for various applications. There are various types of cleansers available depending on purpose and need. Curry leaves and bael leaves are used to remove acne and clear scars from the skin. Anti-acne face wash is used to remove all the acne from the skin and reduce the scars. The single formulation Shows all the activities like sebum regulation and moisturization. Curry leaves and Bael leaves is the key active ingredient of face wash helps to remove dirt from the skin and acne. So it is concluded that, the formulation of anti-acne face wash give the satisfactory result to the skin.

REFERENCE

1. Chim, C. (2016). *American Academy of Dermatology*. Kathleen Vest.

2. K. kameshwarrao*, T. K. (2019, 16). International Research Journal of Pharmaceutical and Biosciences. pp. 10-25.
3. Nast A, Dréno B, Bettoli V, et al; European Dermatology Forum. European evidence-based (S3) guidelines for the treatment of acne. J Eur Acad Dermatol Venereol 2012;26(suppl 1):1-29
4. Anderson KL, Dothard EH, Huang KE. Frequency of primary nonadherence to acne treatment. JAMA Dermatol 2015;151:623-66.
5. Zouboulis CC, Bettoli V. Management of severe acne. Br J Dermatol 2015;172:27-36.
6. Archer JS, Chang RJ. Hirsutism and acne in polycystic ovary syndrome. Best Pract Res Clin Obstet Gynaecol 2004;18:737-54
7. Bhate K, Williams HC. Epidemiology of acne vulgaris. Br J Dermatol 2013;168:474-85.
8. Gieler U, Gieler T, Kupfer JP. Acne and quality of life – impact and management. J Eur Acad Dermatol Venereol 2015;29(suppl 4):12-4
9. Shrama, s. (2017). Anatomy, Skin (Integument),Epidermis. *ResearchGate*.
10. Herskovitz I, Macquhae F, Fox JD, Kirsner RS. Skin movement, wound repair and development of engineered skin. 2016 Feb;25(2):99-100.
11. Formulation, manufacturing and quality control by P.P Sharma 97-105.
12. Dnyaneshwar S. Solanki*, 01 May 2020, *World journal of Pharmaceutical Research*, Volume 9, Is 2541-2557.
13. Nivetha K, Sunmathi D, Madu Bharathi C, Journal of Emerging Technologies and Innovation Research June 2019, Volume 6, Issue 6.
14. Anastasia Pontryagina, Reinhard Miller, Michael Pletnev, *Institute of Physical Chemistry, Bulgarian, Academic of science octomber 15*.
15. Hanan Al Harbi, Dr. Uma M. Irfan * and Dr. Sarah Ali ejpmr, 2016,3(10), 382-387.
16. Ji Young Yoon, J. Y. (2015). Activity-Guided Purification Identifies Lupeol, a Pentacyclic Triterpene, As a Therapeutic Agent Multiple Pathogenic Factors of Acne. In *Journal of Investigative Dermatology* (Vol. 135, pp. 1491-1500).
17. Biological activities of crude extracts and chemical constituents of Bael, *Aegle marmelos* (L.) Corr November 2009 Indian Journal of Experimental Biology 47(11):849-61.
18. Anastasia Pontryagina, Reinhard Miller, Michael Pletnev, *Institute of Physical Chemistry, Bulgarian Academy of Sciences*, October 2015.

19. Ramin Mostafalu, Abbas Banaei, Fatemeh Ghorbani 3 June 2015.
20. Propylene Glycol
<https://www.sciencedirect.com/science/article/pii/B9781455707171000727#!> 10 December 2012.
21. Safety Assessment of Triethanolamine and Triethanolamine-Containing Ingredients as Used in May 2013 International Journal of Toxicology 32(3 Suppl):59S-83S
DOI:[10.1177/1091581813488804](https://doi.org/10.1177/1091581813488804)
22. Safety Assessment of EDTA & Salts as Used in Cosmetics May 10, 2019.
23. Safety review of phenoxyethanol when used as a preservative in cosmetics.
24. November 2019. Journal of the European Academy of Dermatology and Venereology 33(S7):15- 24 DOI:[10.1111/jdv.15944](https://doi.org/10.1111/jdv.15944).
25. Indian Pharmacopia Vol-1 Page No.62-66.
26. ICH Harmonised Tripartite Guidelines, Stability testing of New Drug Substance and Products. ICH Committee, 2003:8.
27. Ganesh Misal, Gouri Dixit, Vijay Gulkari, Formulation and evaluation of Herbal Gels" Indian Journal of Natural Products and Resources, Vol3(4), 501-505, December.
28. B.M More, S.N. Sakharwade, O.M. "Formulation and Evaluation of gel contains various Activities" American Journal of Pharmaceutech Research ISSN No. 2249-3387, 2(5), 2012.
29. Kartheinz, Schrader, Andreas Domsch, "Cosmetology" Theory and Practice" Vol-1, Page, No. 199-224.
30. Mukhopadhyay, D. P. (2010 Jul). Dr. Partha Mukhopadhyay. Indian Journal of Dermatology, 2–6.
- 31 . Badam L, Bedekar S.S., Sonawane K.B. and Joshi S.P. (2002), “ Ivitro antiviral activity of Bael (Aegle marmelos Corr.) upon human Cox sackiviruses B1-B6, j. Commun Dis, 34 Page No.88.
32. International Journal of Current Pharmaceutical Review and Research Volume 1, Issue 3, February - April 2011 Medicinal Values of Bael (Aegle marmelos) (L.) Corr.
33. Guideline on the treatment of acne, European dermatology Forum (Sepetmber 2011) Fulton J, Acne vulgaris, Medscape, (Aug 2011) Acne vulgaris: NICE CKS (June 2009) Smith

RN, Mann NJ, Braue A , el: A low-glycemic-load diet improves symptoms in acne vulgaris patients; *Am J Clin Nutr.* 2007 Jul; 86(1); 107-15.

34. Authors: Azimi H, Fallah-Tafi M, Khakshur AA, Abdollahi M.

A review of phytotherapy of Acne Vulgaris: Perspective of new pharmacological treatments

35. Over the counter Acne Treatment *The journal of clinical and aesthetic dermatology.*

Author: Ashley Decker, BS, MA and Emmy M, Graber MD.

36. Author: Charles Lynde MD FRCPC and Anneke Andriessen PhD. University of Toronto-Canada Antibiotic Resistance: Shifting the paradigm in Topical Acne treatment *DRUGS DERMATOL*:2014:13

Shannon Hann BSc, Jasdeep Shrama MD, Jennifer Klotz MD.

37. Foucade Karine Nadau, Galderma S.A.

Topical wash composition for use in acne patients. EP 27399 A2, 2014 April-9

The invention relates to a topical wash composition comprising: 10 a) At least one surfactant b) a zinc salt of gluconic acid, c) a salt or derivative of glycyrrhizic acid or of

glycyrrhetic acid. *J Clin Aesthet Dermatol.* 2013 Dec; 6(12): 19-27 PMID: PMC3997205

The role of Glycyrrhetic Acid in treatment of Acne Vulgaris Importance of Cleanser James Q. Del ROSSO, DO,

FAOCD.

38. Agak et al., 2014 G.W. Agak, M. Qin, J. Nobe, *et al.*

39. Aldana et al., 1998 O.L. Aldana, D.B. Holland, W.J. Cunliffe

Variation in pilosebaceous duct keratinocyte proliferation in acne patients *Dermatology*, 196 (1998), pp. 98-99

40. Guy et al., 1996 R. Guy, M.R. Green, T. Kealey Modeling acne *in vitro* *J Invest Dermatol*, 106 (1996), pp. 176-182.

41. Harper and Thiboutot, 2003 J.C. Harper, D.M. Thiboutot

Pathogenesis of acne: recent research advances *Adv Dermatol*, 19 (2003), pp. 1-10

42. Lee et al., 2014 W.R. Lee, K.H. Kim, H.J. An, *et al.* The protective effects of Melittin on *Propionibacterium acnes*-induced inflammatory responses *in vitro* and *in vivo* *J Invest Dermatol*, 134 (2014), pp. 1922-1930

43. E. Makrantonaki, R. Ganceviciene, C. Zouboulis **An update on the role of the sebaceous gland in the pathogenesis of acne** *Dermatoendocrinol*, 3 (2011), pp. 41-49.

44. Phytochemical Evaluation, Antimicrobial Activity, and Determination of Bioactive Components from Leaves of *Aegle marmelos* Neelam Pathak Volume 2014 |Article ID 497606 | <https://doi.org/10.1155/2014/497606>

45. L. Badam, S. S. Bedekar, K. B. Sonawane, and S. P. Joshi, “*In vitro* antiviral activity of bael (*Aegle marmelos* Corr.) upon human coxsackieviruses B1-B6,” *Journal of Communicable Diseases*, vol. 34, no. 2, pp. 88–99, 2002.

46. Evaluation of Bioactive Compounds, Pharmaceutical Quality, and Anticancer Activity of Curry Leaf (*Murraya koenigii* L.) February 2014

47. Curry Leaf (*Murraya koenigii*): A Spice with Medicinal Property November 2017

48. Antimicrobial effect of curry leaves on *Staphylococcus aureus* – An *In vitro* Study DOI: [10.5958/0974-360X.2019.00559.6](https://doi.org/10.5958/0974-360X.2019.00559.6) Volume - 12, Issue - 7, Year - 2019.

49. World Health Organization Expert Committee on Biological Standardization 1992.

Technical report series 822. W.H.O., Geneva.

50. CLSI: Clinical and Laboratory Standards Institute. 2012. Approved standard M100-S22.

Performance standards for antimicrobial susceptibility tests, 10th ed. CLSI, Wanyne, pa.

51. EUSAST. European Committee on Antimicrobial Susceptibility Testing. EUCAST QC

Tables V1 .2. 2010.

52. Habeeba Shaikh*, Siddiqua Shaikh and Dr. Priya Rao World Journal of Pharmaceutical research Department of Pharmacognosy, Pravara Rural College of Pharmacy, Pravaranagar, Loni Volume 9, Issue 6, 850-863.

In Vitro Evaluation of Antibacterial Activity of *Murraya koenigii* L. In vitro evaluation of antibacterial activity of *Murraya koenigii* L.

In Vitro Evaluation of Antibacterial Activity of *Murraya koenigii* L. In vitro evaluation of antibacterial activity of *Murraya koenigii* L.

Formulation and Evaluation of Anti-aging Cream by using Mushroom Extract

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ABSTRACT:

The main objective of work is to formulate Anti-Aging cream by using Mushroom Extract. Today, there is a growing consumer demand for cosmetics containing natural and/or organic ingredients as paving their way into cosmetics, such as ceramides, lentinan, schizophyllan, omega 3, 6, and 9 fatty acids, carotenoids, resveratrol, and others. Many mushroom ingredients possess potent antioxidant, as well as anti-inflammatory, properties, which are used frequently. These compounds show excellent antioxidant, anti-aging, anti-wrinkle, skin whitening, and moisturizing effects, which make them ideal candidates for cosmetics products. Formulation FW2 shows anti-aging properties which also showed good Rheological characteristics, pH, greater active content. Hence this study showed that F2 was the best formulation for anti-aging cream. According to In-Vivo study, the product has no skin irritation and redness form after applying on the skin.

Keywords : Anti-aging, Mushroom, Antioxidant, Moisturizing and Sajor-caju

INTRODUCTION:

Now-a-days herbal extracts are used in the cosmetic preparations for augmenting beauty and attractiveness. Herbal cosmetics are classified on the basis of dosage form like- cream, powder, soaps, solutions etc. and according to part or organ of the body to be applied for like: cosmetics for skin, hair, nail, teeth and mouth etc. The use of cosmetics requires both their efficacy as well as minimal risk of skin irritation/skin sensitization. This is influenced by their formulation, nature of their use and quantity and quality of ingredients. Mushrooms are rich in protein, vitamins, minerals, and excellent sources of β -glucan, selenium, thiamine, riboflavin, niacin, pantothenic acid, and folic acid, etc. It has reported that **mushrooms** provide beneficial effects as invigorating vital energy, maintaining one's optimal weight, favoring longevity, and avoiding unnecessary aging. Recently mushrooms have drawn worldwide attention as the most interesting natural sources with diverse and unique bioactivities, including immunomodulatory, antioxidant, anti-inflammatory, antidiabetic, antibacterial, antifungal, antiviral, antitumor, hepatoprotective, reducing glucose and lipidic levels. Sajor-caju gives best anti-aging properties. Many mushroom ingredients possess potent antioxidant, as well as anti-inflammatory, properties, which are frequently used in an effort to address cosmetic concerns, such as fine lines, wrinkles, uneven tone, and texture. [33],[34]



Sajor-caju Mushroom

MATERIALS AND METHODS

Glycerol mono stearate, Sodium laureth sulfate, Distilled water, Lanolin, Glycerin, Stearic acid, Bees wax, Mushroom extract, Phenoxy ethanol and Perfume are used for anti-aging cream.

Table No. 1 Base Formulation

Sr. No.	Ingredients	FW1	FW2	FW3
1	Glycerol mono stearate	3.1gm	3gm	3.5gm
2	Sodium laureth sulfate	0.4 gm	0.3 gm	0.4 gm
3	Distilled water	76 ml	77 ml	76 ml
4	Lanolin	3gm	3gm	3.5gm
5	Glycerin	4ml	4ml	4.5ml
6	Stearic acid	3gm	3gm	3.2gm
7	Bees wax	5.5 gm	5.5 gm	5.5 gm
8	Perfume	q.s	q.s	q.s
9	Phenoxy ethanol	q.s	q.s	q.s

We selected FW2 Because its shows best results

Table 2: Formulation by using mushroom active

Sr. No.	Ingredients	FW1	FW2	FW3
1	Glycerol mono stearate	3.1gm	3gm	3.5gm
2	Sodium laureth sulfate	0.4 gm	0.3 gm	0.4 gm
3	Distilled water	76 ml	77 ml	77 ml
4	Lanolin	3gm	3gm	3.5gm

5	Glycerin	4ml	4ml	4.5ml
6	Stearic acid	3gm	3gm	3.2gm
7	Bees wax	5.5 gm	5.5 gm	5.5 gm
8	Mushroom extract (<i>sojar-caju</i>)	1ml	2.2 ml	2.5ml
9	Perfume	q.s	q.s	q.s
10	Phenoxy ethanol	q.s	q.s	q.s

We selected FW2 Because its shows best results

Procedure

Firstly use clean and dry apparatus.

Part A – The water- soluble components like sodium laureth sulfate, glycerine, Distilled water (70%), are dissolved in an aqueous phase and mix it well. These are heated to 70°C on Hot plate.

Part B – The oil-soluble components like Bess wax, Glycerol mono stearate(GMS), Stearic acid, lanolin are dissolved in oil phase and mix it well. These are heated to 70°C on hot plate.

After that we incorporate oil in water and at 40°C add perfume preservative and mushroom extract.

Procedure is same in base formula but extract is added after evaluation

EVALUATION

In- Vitro Studies

Determination of Physical Parameters

- 1) Color :** The color of the cream was observed by visual examination. The result was shown in table no.3
- 2) Odour:** The odour of cream was found to be characteristics.
- 3) State :** The state of cream was examined visually. The cream was semi-solid state was shown in table no.3
- 4) Consistency :** The formulation was examined by rubbing cream on hand manually. The cream having smooth consistency.
- 5) pH :** pH of prepared herbal cream is measured by using pH paper. The average pH value of cream is 6.5 formulation FW2
- 6) Non-irritancy test :** Herbal cream formulation was evaluated for the non-irritancy test. Preparation shown no redness and irritancy. Observation of the state was done for 24 to 28 hours.
- 7) Viscosity :** The viscosity of cream was done by using viscometer at the room temperature. Viscosity of formulated cream was determined by brook field viscometer at

30 rpm using spindle no.s05. The viscosity of cream was in the range of, 472,000 to 25,438 cp which indicates that the cream is easily spreadable by small amount of shear.

The formulated cream shows the viscosity within range i.e.39,077cp.at temperature 37°C.

In-Vivo Studies

Determination of moisture content of skin by Corneometer

Principle : Corneometer is device which is equipped with a moisture sensitive probe which is used to determine the accurate moisture content of stratum corneum. Hence it plays important role in determining the moisturizing activity of product on stratum corneum after its application on skin.

Apparatus : Corneometer equipped with a probe.

Procedure : The volunteers were selected and the probe of Corneometer was applied onto the selected part of skin before application of product and the reading was recorded. The selected part of skin was rinsed with product allowed to dry properly and again the probe was applied onto the skin and reading was recorded. The volunteers were allowed to wash the selected area of skin with the product twice a Day and then same procedure was followed 14 days. Within these intervals the readings were recorded after 7th Days and then 14th Days and the graphs were plotted.

Results and Discussion

Determination of Physical Parameters

Table 3. Results of anti-aging cream

Sr. no	Parameters	Results
1	Color	White
2	Odour	Characteristics
3	State	Semi-solid
4	Consistency	Smooth
5	pH	6.5
6	Spreadability	Good

7	Non-irritancy	Non-irritant
8	Viscosity	39,077
9	Phase separation	No phase separation
10	After feel	Emollient

Table no 4: Ph of Anti-aging cream

Sr.No.	Time interval	FW1	FW2	FW3
1	Initial Day	6.5	5.6	5.6
2	15 th Day	5.6	6.7	6.6
3	30 th Day	6.7	6.5	6.9

Non-irritancy test : Anti-aging cream formulation was evaluated for the non-irritancy test. Preparation shown no redness and irritancy. Observation of the state was done for 24 to 28 hours

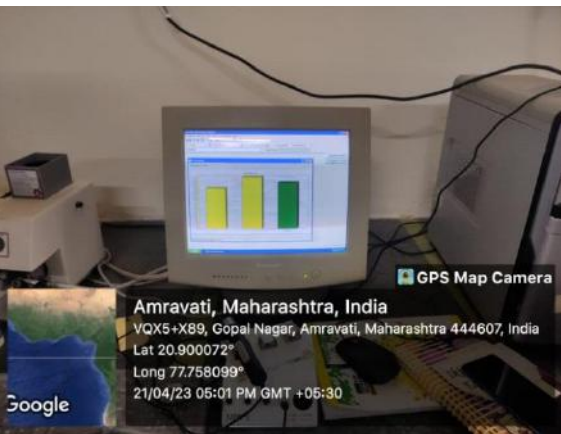
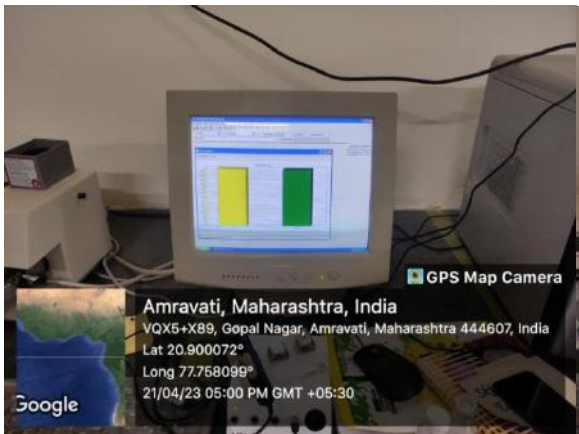
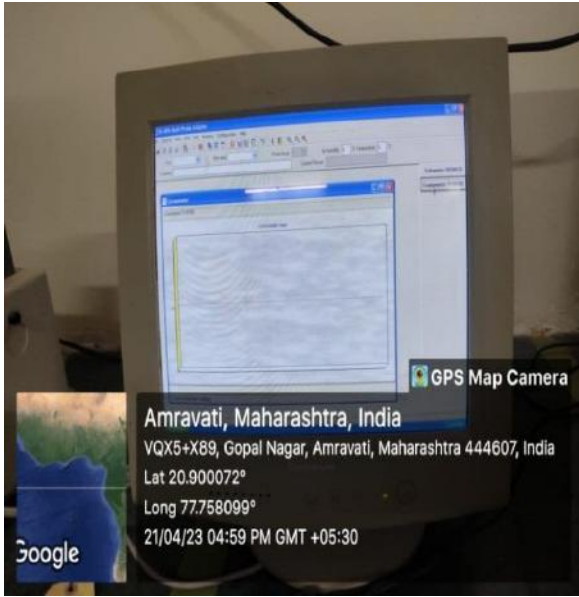
Determination of viscosity

Table no 4: Determination of viscosity

The viscosity of face wash determine by using Brookfield Viscometer. The values obtained from the sample noted.

Sr. No.	No. of days	FW1	FW2	FW3
1	Initial Day	72500cp	6200cp	6950cp
2	15 th Day	71530cp	71000cp	68080cp
3	30 th Day	71820cp	39,077cp	67500cp

Determination of moisture content of skin by Corneometer



Corneometer analysis before application

Corneometer analysis after application

Result : The moisturizing activity was carried out by using Corneometer. It was observed that before application of cream, the moisture content of skin was less and after application of Cream moisture content was increased.

Photographic Evaluation The study of effectiveness of product was done by the help of the volunteer study. This was carried out human volunteers. Face wash were applied on skin. The photograph were taken before and after application of product.



Before and After application of anti-aging cream

CONCLUSION

Mushroom (*sojar-caju*) in different ratio to get multipurpose effect such as whitening, antiwrinkle, antiaging and sunscreen effect on skin. As we know that it is not possible to increase the extent of efficiency of medicinal and cosmetic property of single plant extract. The study indicated that the formulation was found to be more stable with constant pH, homogenous, emollient, non-greasy and easily removed after the application. The stable formulations were safe in respect to skin irritation and allergic sensitization. The present study was aimed to develop and formulate the herbal cream containing Mushroom (*sojar-caju*) extract which may maintain aging is a gradual process that results in a dysfunction and reduced reserve capacity to all body organs. The benefits of an effective anti-aging skincare regime include retaining the skin's firmness, refining the skin tone, reducing the appearance of fine lines and wrinkles, and boosting brightness and radiance. Several types of mushrooms are used in topical cream, serums, and facial preparation as anti-aging ingredients

REFERENCE:

1. Ahmad, M.F.; Ahmad, F.A.; Azad, Z.; Ahmad, A.; Alam, M.I.; Ansari, J.A.; Panda, B.P. Edible mushrooms as health promoting agent. *Adv. Sci. Focus* **2013**, *1*, 189–196. [[CrossRef](#)]
2. Antignac, E.; Nohynek, G.J.; Re, T.; Clouzeau, J.; Toutain, H. Safety of botanical ingredients in personal care products/cosmetics. *Food Chem. Toxicol.* **2011**, *49*, 324–341. [[CrossRef](#)] [[PubMed](#)]
3. Akhtar, N., nz-zaman, S., Khan, B., Haji, M., Khan, S., Ahmad, M., Rasool, F., Mahmood, T. and Rasul, A (2011). Evaluation of various functional skin parameters using a topical cream of *Calendula officinalis* extract. *African journal of pharmacy and pharmacology* Vol. 5(2), pp. 199-206, February 2011.
4. Akinyele BO, Odiyi AC, Comparative study of the vegetative morphology and the existing taxonomic status of *Aloe vera*, *Journal of plant sciences*, 2007; 2: 558-563.
5. Bashir, A.; Vaida, N.; Dar, M.A. Medicinal importance of mushrooms—A review. *Int. J. Adv. Res.* **2014**, *2*, 1–4.
6. Badalyan, S.M. The main groups of therapeutic compounds of medicinal mushrooms. *Med. Mycol.* **2001**, *3*, 16–23.
7. Calabrese EJ. Principles of animal extrapolation. CRC press; 2017 Nov 22.
8. Camassola, M. Mushrooms—The incredible factory for enzymes and metabolites productions. *Ferment. Technol.* **2013**, *2*. [[CrossRef](#)]
9. Cheung, P.C. Mushrooms as Functional Foods; John Wiley & Sons: Hoboken, NJ, USA, 2008; pp. 1–34.
10. Chang, S.T.; Wasser, S.P. The role of culinary-medicinal mushrooms on human welfare with a pyramid model for human health. *Int. J. Med. Mushrooms* **2012**, *14*, 95–134. [[CrossRef](#)] [[PubMed](#)]
11. . El Enshasy, H.A.; Hatti-Kaul, R. Mushroom immunomodulators: Unique molecules with unlimited applications. *Trends Biotechnol.* **2013**, *31*, 668–677. [[CrossRef](#)] [[PubMed](#)]
12. Gediya SK, Mistry RB, Patel UK, Blessy M, Jain HN Herbal plants: used as cosmetics, *J Nat Prod Plant Resour*, 2011; 1: 24-32.
13. Hoffman, M.MD(2021). *Human Anatomy*.

14. Hyde, K.D.; Bahkali, A.H.; Moslem, M.A. Fungi—An unusual source for cosmetics. *Fungal Divers.* **2010**, *43*,1–9. [[CrossRef](#)]
15. Kalač, P. A review of chemical composition and nutritional value of wild-growing and cultivated mushrooms. *J. Sci. Food Agric.* **2013**, *93*, 209–218. [[CrossRef](#)] [[PubMed](#)]
16. Kuroda Y, Hara Y, Antimutagenic and anticarcinogenic activity of tea polyphenols, *Mutation Research/Reviews in Mutation*, 1999; 436: 69-97.
17. Lopez-Ojeda, W., Pandey, A., Alhajj, M., Oakley, A. (2021). Anatomy , skin (integument) [Updated 2021 Oct 22]. In : StarPearls [Internet]. Treasure Island (fl): StarPearlsPublishing ; 2022 Jan.
18. Miles, P.G.; Chang, S.T. *Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact*, 2nd ed.; CRC Press: Boca Raton, FL, USA, 2004; pp. 1–26.
19. Mueller, G.M.; Schmit, J.P. Fungal biodiversity: What do we know? What can we predict? *Biodivers. Conserv.* **2007**, *16*, 1–5. [[CrossRef](#)]
20. Millikan, L.E. Cosmetology, cosmetics, cosmeceuticals: Definitions and regulations. *Clin. Dermatol.* **2001**, *19*,371–374. [[CrossRef](#)]
21. Okoh OO, Sadimenko AP, Asekeen OT, Afolayan AJ, The effects of Drying on the chemical components of Essential oils of *Caledula officinalis* L. *African J Biotechnol*, 2008; 7: 1500-1502.
22. Pandey S, Meshya N, Viral D, Herbs play an important role in the field of cosmetics, *International Journal of Pharm Tech Research*, 2010; 2: 632-639.
23. Poucheret, P.; Fons, F.; Rapior, S. Biological and pharmacological activity of higher fungi:
24. Prajakta N.Dongare, Ravindra L. Bakal, Prashant V. Ajmire, Purna A. Patinge, Manisha P. More and Jagdish V. Manwar, (2021). An Overview on Herbal Cosmetics and Cosmeceuticals, IBSS's Dr. Rajendra Gode institute of Pharmacy, Mardi Road Amravati 444602 (M.S) India.
25. Shivanand P, Nilam M, Viral D. Herbs play an important role in the field of cosmetics. *International Journal of PharmTech Research*. 2010;2(1):632-9.
26. Sharma A, Shanker C, Tyagi LK, Singh M, Rao ChV, Herbal Medicine for Market Potential in India : An overview, *Academic Journal of Plant Sciences*, 2008; 1: 26-36.

27. Sumit K, Vivek S, Sujata S, Ashish B. Herbal cosmetics: used for skin and hair. *Inven. J.* 2012 Oct 10;2012:1-7.
28. Sumit, K., Swarankar, V., Sharma, S., Baldi, A.(2012).Herbal Cosmetics: used for Skin and Hair. *Cosmeceuticals* Vol.2012, issue4 [ISSN 0976-3864]
29. Top 7 Advantages of using Natural Cosmetics.(2007)
30. U.S. Food and Drug Administration, “Parabens”.
31. Wasser, S.P. Current findings, future trends, and unsolved problems in studies of medicinal mushrooms.*Appl. Microbiol. Biotechnol.* **2011**, 89, 1323–1332. [[CrossRef](#)] [[PubMed](#)]
32. Year retrospective analysis. *Cryptogam. Mycol.* **2006**, 27, 311–333.
33. Mohamed, M.F.; Refaei, E.F.; Abdalla, M.M.; Abdelgalil, S.H. Fruiting Bodies Yield of Oyster Mushroom (*Pleurotus Columbinus*) as Affected by Different Portions of Compost in the Substrate. *Int. J. Recycl. Org. Waste Agricult.* 2016, 5, 281–288. [[CrossRef](#)]
34. Mostafa, D.M.; Allah, S.F.A.; Awad-Allah, E.F. Potential of *Pleurotus Sajor-Caju* Compost for Controlling *Meloidogyne Incognita* and Improve Nutritional Status of Tomato Plants. *Power* 2019, 2, 4.

Cutaneous Benefits of Snow Mushroom in Cosmetics

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Abstract:

Tremella fuciformis, also known as snow mushroom, is an edible mushroom that has historically been popular in herbal and Asian medicine and cuisine. Also have excellent moisturizing and antioxidant properties. The main polysaccharide ingredients have been extracted and used as treatment in a variety of conditions, demonstrating positive effects in a range of biological functions including those involved in antioxidation, antitumor, antidiabetic and immunomodulatory, Studies have demonstrated the role this extract may play in skin antiaging, photoprotection, wound healing, and barrier protection. Most studies have been limited to in vitro and in vivo animal models. Future clinical research is needed to further understand the role of T. fuciformis in dermatology. This review will discuss the existing research findings and potential future applications for T. fuciformis as a treatment in skin conditions.

Keywords: Snow Mushroom, antioxidants, Anti-Aging, Photoprotection, wound healing.

Introduction:

Mushroom have been valued as a tradition source of natural bioactive compounds and recently been exploited for potential component in cosmetics industry. The Tremella fuciformis typically called as ‘yin er’ silver ear fungus, snow mushroom and white jelly mushroom and was discovered in china. Termella polysaccharides are major components in Termella fuciformis. The name mushroom refers to a fruiting body, formed by several hyphae that grow upwards and produce spores basidiospores.



Snow Mushroom in Fig no. 1

History

The article titled 'Research on tonic *Termella fuciformis*' in journal of Natural History, 1914 . Cultivation techniques began in 1968. Snow mushrooms are native to subtropical and tropical regions around the world including China, Japan and in other Asian countries.

Technical aspects:

INCI: Tremella Fuciformis Sporocarp Extract

Appearance: White or light yellow

Ph: 5.5-7.5

Odour: Characteristic

Solubility: Water soluble

COSMOS-approved: yes

Ecocert: yes

Bioactives:

- Polysaccharides
- Phenolic Compounds
- Flavonoids
- Vitamine D
- Fatty acids
- B-glucan

Dry Skin Signs ,Causes and problems sings:

- Itching
- Scaling

- Redness

Causes

Bath, swimming and showers. Frequent showering with hot water breakdown the lipid layer. Same change with heavy chlorinated.

Harsh Scrubbing of Skin.

Tight clothing or compression. Tight clothing and compression can increase the risk of dry skin. And worsen the condition of dry skin.

Problems of Dry Skin:

Xerodermatic

Xeroderma, is a skin condition characterized by excessively dry skin.

Detergents such as washing powder and dishwashing liquid can cause xeroderma.

Desquamation

Desquamation is the natural process in which skin cells are created, sloughed away, and replaced.

Nonpathologic visible desquamation can be observed after immersion of the skin in warm or hot water.

In pathologic desquamation, such as that seen in the Stratum Corneum become thicker, imparting a “dry” or scaly appearance to the skin

Wrinkles A wrinkle, also known as a is a fold, or crease in otherwise smooth surface, such as on skin sun damage, smoking and poor hydration . Age wrinkling in the skin is promoted by habitual facial expressions, aging.

NMF:

In addition to keratin, which can bind a substantial amount of water, the stratum corneum contains a number of other hydrophilic agents. These materials are called natural moisturizing factors (NMF).

The NMF concentration varies as a function of age and skin depth.

The conversion of filaggrin to NMF occurs as the corneocytes are moving to the stratum corneum it is possible for the outermost skin layers to maintain an adequate water supply when exposed to dry environments Although the corneocytes are biologically dead, but biochemically they are active there are number of enzymes in corneocytes and they need nmf for example when desquamation occur these enzyme weaken the forces hold corneocytes and they need water that NMF provide for desquamation process.

Cosmetics Uses:

Moisturizing effect: The water content in stratum corneum is important factor in appearance and function of skin. T. fuciformis polysaccharides have been developed for use in cosmetics on account of their excellent skin moisture retention. The polysaccharide isolated from a hot water extract of a Tremella mushroom without adding a chemical reagent was found to have a novel effect of inhibiting melanin formation effects and lightening the spots on the skin when applied to the skin.

It is used in Cream, Lotions, Serums, and facial preparations as Cosmetics ingredients. It shows Anti-inflammatory and wound healing properties used in cosmetics. Tremella fuciformis are loaded with Vitamine D which also helps makes it great for healing acne lesions.

Snow Mushroom VS. Hyaluronic Acids:

Benefits of Hyaluronic acid

Hyaluronic acid is already present in our body that fills out, plumps up and firms our skin thereby keeping it free of wrinkles and fine lines.

Hyaluronic acid can hold up to 1,000 times its weight in water, which helps to hydrate the skin.

Benefits of Snow mushroom

Tremella generates a natural flexible hydration film on the skin that reinstates dry skin to its optimally hydrated and mobile state, enabling it to develop elasticity and a fit appearance.

The polysaccharide from Tremella Mushroom was applied to skin topically.

The water holding capacity of the skin and horny layer was greatly improved and had better results than the Hyaluronic Acid control.

Extraction Processes:

In the past most studies have focused on the extraction of polysaccharides from the fruiting body and mycelium.

The generally adopted polysaccharide extraction method is to stir the pulverized fruiting bodies in hot water for several hours.

After the extraction method is selected, the supernatant is collected by centrifugation or filtration, and the residue is generally extracted three-times.

The precipitate is collected by centrifugation and then freeze-dried or low temperature dried to obtain crude polysaccharide.

Conclusion:

Antioxidant will protect against free radical damage for the prevention of various diseases and aging. A significant advantage in antioxidant compounds extraction from mushrooms is that fruit bodies or mycelium can be manipulated to produce active compounds in a relatively short period of time. Snow mushroom extract is a moisturizing ingredients which is capable of moisture retention on the skin and the small particles penetrate more easily to the skin than hyaluronic acid. There are various products in the market that uses the power of Snow mushroom extract to get better result to the consumer.

Reference:

1. Ruixia Wang*, H. C. (2015). Scientific Explorations of the Snow Fungus (*Tremella fuciformis* Berk.) in Republican China: A Brief Review. *Indian Journal of History of Science*, 340-344.
2. Yang, D., Liu, Y., & Zhang, L. (2019). Tremella polysaccharide: The molecular mechanisms of its drug action. In D. Yang, & L. Zhang (Ed.), *Progress in Molecular Biology and Translational Science* (Vol. 163, pp. 383-421). China: ELSEVIER. Doi:<https://doi.org/10.1016/bs.pmbts.2019.03.002s>

3. Wu, Y.-j. (18 October 2018). Structure, bioactivities and applications of the polysaccharides from. *International Journal of Biological Macromolecules*, 1005-1010.
4. Connelly, M. (2019, August 28). Snow Mushroom Could be the New Hyaluronic Acid. *Cosmetics & Toiletries*.
5. Palmer, A. (2020, June 2). Desquamation Process and the Outer Layer of Skin. *Verywellhealth*.
6. Declercq L, Muizzuddin N, Hellemans L, et al. Adaptation response in human skin barrier to a hot and dry environment (abstract). *J Invest Dermatol* 2002; 119:716.
7. *Phytocare-PH Snow Mushroom Extract* 2019.
8. Fowler, J. (2012, JULY). Understanding the Role of Natural Moisturizing Factor in Skin Hydration.

Use on snail secretion as multifunctional cosmetic active.

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Abstract- Snail mucus is material of a natural origin that is a source of valuable active ingredients. Due to the content of vitamins, allantoin, acids and proteins fulfilling specific roles, snail mucus has many applications used in skin care. Snail mucus accelerates the healing of wounds and sunburns. It nourishes the skin, reduces imperfections, and protects against free radicals. The varied composition allows the use of snail mucus according to the needs of the skin.

Products that contain snail mucus make it possible to rejuvenate and beautify the skin. They can be used to treat skin diseases, such as melanoma, acne, and inflammation, as well as burn wound infections. The presence of a very large amount of nutrients makes snail mucus widely used in cosmetics and medicine, but at the same time, it makes it impossible to produce it artificially in the laboratory.

Index Terms- Mucus, Mucin,

I. INTRODUCTION

Intigue in the mucus slime trails left by snails and slugs date back to ancient Greece, where they utilized the mucus for its ability to reduce inflammation and the signs of aging. Today snail mucus is still used in skin care products by various companies and is a growing market whose value is expected to approach \$770 million by 2025. Despite its commercial applications, the field of mucus research remains surprisingly underdeveloped. The primary constituent that is responsible for the properties of mucus are secreted mucins, a family of heavily glycosylated proteins produced in epithelial cells in most animals. Mucins are either bound to the plasma membrane or secreted out of the cell, and each type has major differences in their functions and capabilities (Dhanisha et al., 2018). Membrane bound mucins are glycolipids that act as markers for cell signaling and also protect the cell from extracellular affronts that might lead to damage, such as infections and physical strain (Van Putten and Strijbis, 2017). Secreted mucins can be either gel forming or non-gel forming biopolymers. Secreted biopolymers form mucous membranes macroscopic scale. These mucosal membranes account for a large portion of the surface area of multicellular organisms exposed to the environment. In humans, mucosal membranes account for 99% of the bodies surface area (Sompayrac, 2012; Maet al., 2018; Cerullo, 2020). Each snail species secretes multiple distinct functional mucuses. The mucus produced by a snail's foot is used for adhesion and for lubrication, allowing the snail to stick onto or walk across any surface, even while inverted.

Snail slime is a clear, slightly amber liquid with a pH value of 4.80 and a density of 1.02 g/ml. It contains many active ingredients, including: allantoin, elastin, collagen, proteins, antioxidants, enzymes, metal ions, proteoglycans, glycosaminoglycans, vitamins, minerals as well as mucin, mitamycin AF and achacin. The mucus obtained from snails is a cosmetic raw material, rich in many ingredients that exhibit beneficial effects on human skin. It can be found mainly in facial care products as it demonstrates regenerative properties of the skin after mechanical damage or sunburn and reduces imperfections and discoloration. Moreover, snail mucus promotes the longevity of fibroblasts and the structure of the extracellular matrix, thus delaying the symptoms of skin ageing. Such valuable properties of snail mucus for human skin were the reason to describe in this work the production, the qualitative and quantitative composition, features and potential cosmetic and medicinal utilization based on literature data.

Additionally, the mucus produced on the back of the snail is used for microbial defense and tissue hydration. Certain snail species have specialized uses for mucus.

For example, *Falsilunatia eltanini* (Moon Snail) uses mucus to protect their eggs, and *Tikoconus costarricanus* (Costa Rican Land Snail), uses mucus for load-bearing activities, such as to hide from the Sun on the bottom of leaves during droughts (Gould et al., 2019; Barrientos, 2020). Recent advances in omics (genomic, transcriptomic, proteomic, glycomics) technologies have expanded the exploration of gastropod mucins as a scientific resource with wide ranging applications across chemistry, biology, biotechnology, and medicine. For example, the antimicrobial properties of snail mucus are being used to combat disorders seen in humans ranging from gastric ulcers, to post-surgical-related infections (Amah et al., 2019; Gentili et al., 2020). Mucins are also being coupled with approved therapeutics in order to potentiate the drug's abilities to cure diseases, such as diabetes and ulcerative colitis (Gugu et al., 2020). Additionally, snail mucins are being investigated in a vast array of other biotechnical applications that exploit their surfactant-like properties (Petrou and Crouzier, 2018). Despite their potential, little is known about how the hierarchical mucin structures account for their diverse functional properties damage, such as infections and physical strain (Van Putten and Strijbis, 2017). Secreted mucins can

be either gel forming or non-gel forming biopolymers. Secreted biopolymers form mucous membranes macroscopic scale. These mucosal membranes account for a large portion of the surface area of multicellular organisms exposed to the environment.

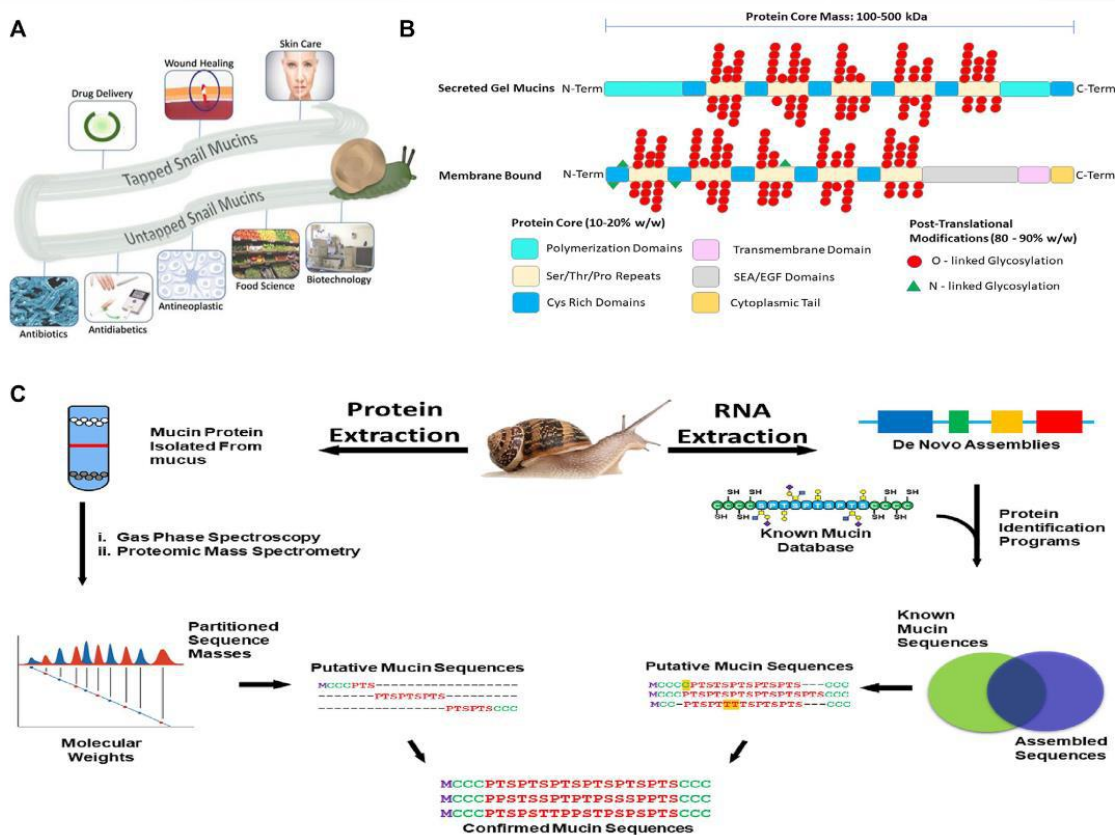


FIGURE 1 | (A) APPLICATIONS OF SNAIL MUCUS. SNAIL MUCUS HAS BEEN USED FOR SKIN CARE, WOUND HEALING AND REJUVENATION, AND DRUG DELIVERY. SNAIL MUCUS IS BEING EXPLORED IN FOOD SCIENCE, IMPLANT COATINGS, AND OTHER BIOTECHNICAL SECTORS ARE CURRENTLY RESEARCHING MUCINS TO BE EXPLORED FOR POTENTIAL USE. (B) A 2-DIMENSIONAL REPRESENTATION OF THE MUCIN STRUCTURES. MUCINS ARE CHARACTERIZED BY TWO PARTS OF THEIR STRUCTURE, THEIR PROTEIN CORE, AND THEIR GLYCAN BRANCHING. THE PROTEIN CORE IS A PROTEIN SEQUENCE OF VARIABLE LENGTH DEPENDING ON THE MUCIN GENE, WHICH HAS BEEN FURTHER MODIFIED WITH GLYCOSYLATION BRANCHES. THE PROTEIN STRUCTURE, HOWEVER HAS MULTIPLE DOMAINS, AND THESE DOMAINS VARY DEPENDING ON THE FUNCTION AND THE CELLULAR LOCATION OF THE MUCIN. THE GLYCAN BRANCHES ARE SUGAR BRANCHES RANGING FROM 3 TO 18 SUGARS, AND MAKE UP THE MAJORITY OF THE MUCIN MASS. SHOWN ARE 2 DIMENSIONAL REPRESENTATIONS OF THE DIFFERENT TYPES OF MUCINS, AND THEIR STEREOTYPICAL FEATURES. (C) APPLYING AN INTEGRATED OMICS APPROACH TO IDENTIFY SNAIL MUCIN SEQUENCE, STRUCTURE, AND FUNCTION. PATH 1(LEFT) EXTRACT CRUDE MUCIN PROTEINS AND SEPARATE FROM THE CELLULAR DEBRIS TO OBTAIN SEQUENCE MASSES FROM SPECTROSCOPIC AND MASS SPECTROMETRIC ANALYSES. PATH 2(RIGHT) RNA EXTRACTION FROM MUCUS GLANDS OR WHOLE ANIMAL FOLLOWED BY DE NOVO ASSEMBLY OF MUCIN GENE SEQUENCES TO GENERATE A DATABASE TO BLAST AGAINST BY A COMPARISON OF ASSEMBLED SEQUENCES TO A KNOWN MUCIN DATABASE, WE OBTAIN PUTATIVE MUCIN SEQUENCES. COMBINING THE PROTEOMIC AND RNA PIPELINES WE CONFIRM THE NATIVE TYPE MUCIN SEQUENCE FOR FURTHER ANALYSIS.

I. CONTENTS OF SNAIL MUCILAGE :

Snail mucus contains allantoin, collagen, elastin, glycolic acid, natural peptides and proteins, vitamins A, C and E, as well as antioxidants (e.g. polyphenols) and enzymes (superoxide dismutase - SOD and glutathione S-transferase - GST). Among the metal ions, copper (Cu), iron (Fe) and zinc (Zn) were found. The other ingredients are proteoglycans, glycosaminoglycans - including hyaluronic acid, copper peptides, and antimicrobial peptides, as well as lactic acid, matrix metalloproteinases and their inhibitors. Snail mucus also contains mucin, mitamycin AF and achacin. Mucin is the main macromolecular component of mucus, which is responsible for its regenerative properties. Mucin contains active antimicrobial proteins against gram-positive and gram-negative bacteria. Their activity was found against *Pseudomonas aeruginosa* AP9 and *Bacillus*. Snail mucus is composed of ingredients such as Proteins (Collagen and Elastin), Hyaluronic acid, Copper peptides, Antimicrobial peptides, Antioxidants, Glycolic acid, Allantoin, and more. All of these components are beneficial for your skin in different aspects – that's what gives snail mucin its many benefits.

Collagen and elastin: Natural proteins that form the connective tissues in the body. Collagen promotes skin strength, while elastin provides skin elasticity.

Glycolic acid: An exfoliant often used to remove layers of dead skin and curb hyperpigmentation.

Allantoin: An organic compound that moisturizes the skin, which may have anti-inflammatory effects and promote wound healing.

II. SNAIL MUCINS AS ANTIMICROBIAL AGENT

Antibiotic-resistant bacteria are becoming an increasingly prevalent issue without many viable solutions. Because mollusks lack adaptive immunity, they depend on physical barriers and innate immunity for protection against pathogenic agents (Gerdo1,2017). For most snails, the foot has the most contact with

surfaces that are contaminated with pathogens and parasites, and secretion of mucus along the feet protects against such microbes.

BIOSLAB (Rio de Janeiro) was used for microbiological testing. The antimicrobial activity was performed by diffusion wells according to the method described by Shriyan et al. (1995). BHI broth was inoculated with the microorganisms and incubated at 37 ° C/24 horas. After this period, the inoculum was adjusted to McFarland scale tube 0.5 (1.5 x 10⁸ CFU) in saline. Was inoculated by spreading on plates containing Mueller-Hinton Agar m and Sabouraud agar inocula adjusted to the McFarland scale. We used 5 mL, 10 mL and 20mL respectively, of mucus containing the feeds, which were deposited into wells and incubated for 24 hours at 37 ° C. The inhibitory activity was determined by measuring the zone of inhibition.

III. Snail mucous as multifunctional cosmetic active

Snail mucus has moisturizing, nourishing, soothing, exfoliating, cleansing, anti-wrinkle and ultraviolet radiation-absorbing properties. It reduces acne, wrinkles and stretch marks as well as the signs of skin photoaging and also damage caused by free radicals. Trapella et al. proved that mucus obtained from *Helix Complex* can promote cell migration and support the wound-healing process. *H. aspersa* mucus has an antibacterial effect and accelerates the reconstruction of damaged skin. In turn, Gentili et al. proved that the mucus obtained from this snail species was protective against damage caused by ozone, thus highlighting the possibility of using a given raw material as a new method of protection against contamination. Lim et al. showed in in vitro studies that the active snail mucus extract had a positive effect on skin ageing (including transepidermal water loss (TEWL), number of wrinkles, skin roughness and elasticity). Whereas Mencucet al. showed that the solution extracted from snail mucus (GlicoPro ®) reduces the biomarkers of inflammation and eye damage. The anti-inflammatory.

One of the earliest mucuses evaluated for antimicrobial activity was that of *Achatina fulica* (Giant African Land Snail) Mucus from *A. fulica* demonstrated promising antibacterial activity against the Gram-positive bacteria, *Bacillus subtilis* and *Staphylococcus aureus*, and the Gram-negative bacteria, *Escherichia coli* and *Pseudomonas aeruginosa*. The mucus secretions of *A. fulica* inhibited the bacterial growth of both *S. aureus* and *S. epidermidis* when applied via wound dressing films on a mouse model.

The wound dressings improved the maturation of granulation tissue and the rate of collagen deposition, which are known to expedite the healing process. In a similar study, the mucus of *Helix aspersa* demonstrated antimicrobial activity against several strains of *Pseudomonas aeruginosa*. Further, the mucus of both *A. marginata* and *A. fulica*, were utilized as wound dressings on 28 clinical wound samples collected with known common infections. The mucus showed anti-bacterial potency against *Staphylococcus*, *Streptococcus*, and *Pseudomonas* isolated from wounds. In the same study, when compared to seven common antibiotics, including amoxicillin, streptomycin, and chloramphenicol, some of the mucus secretions were more inhibitory to infections than commercial antibiotics. Understanding the antimicrobial properties of snail mucus is an active and growing area of research. analgesic and moisturizing properties of the cornea were proven. Due to the above, the mucus can be used in the treatment of atopic dermatitis, psoriasis, burns, ulcers and acne.

IV. Antioxidant activity of snail mucus

Brieva et al. discovered that the mucus of *H. aspersa* contains antioxidant activities of superoxide dismutase and glutathione-S-transferase. Therefore, the richness of our sample in biomolecules is the basis of their antioxidant activity. The identified compounds have been found to possess anti-inflammatory properties and inhibit angiogenesis, a process crucial for tumor growth. As a result, they help in restoring the immune system. In addition to their antioxidant properties, these compounds exhibit a range of biological activities, including anticoagulant, antiallergic, anti-inflammatory, and vasodilatory activities. These activities could also be explained by the presence of hydroxyl groups in phenolic compounds that can trap free radicals. Furthermore, these antioxidant properties have been reported and confirmed in the mucus of *H. aspersa* Muller due to the presence of allantoin, whose antioxidant properties have been demonstrated. The main function of antioxidants depends on their ability to reduce oxidative damage. Hatukulipi et al. confirmed that the mucus of *H. aspersa* was found to have anti-inflammatory and antioxidant properties, which helped in reducing colon inflammation. Various bioactive compounds and antioxidant properties were identified in extracts from different parts of several snail species. Due to their antioxidant properties specifically, their ability to donate a hydrogen atom-reductones are crucial to iron reduction capability. Similarly, the beneficial substances in *H. aspersa* Muller mucus can combine with radicals, giving electrons to transform them to more stable molecules and stopping the free radical chain reaction.

V. It Contain Anti-Aging Properties

“Snail mucin is known for its anti-aging properties due to its collagen and elastin content,” researchers investigated the effects of a skin care regimen containing snail secretion filtrate in women between the ages of 45 and 65 years. At the end of the three-month trial period, researchers found that the women who followed the regimen experienced “significant improvements in skin roughness, firmness and elasticity”

VI. It Aid in Wound Healing

Snail mucin may also be used as a wound-healing agent in skin care. One 2016 in vitro study found that snail mucin had antibacterial effects on bacteria isolated from wounds. The study involved African snails, which secrete a substance called achacin that kills bacteria by generating hydrogen peroxide . The allantoin in snail mucin may prove useful for minor cuts, acne and scarring, according to reseacherThe anti-inflammatory properties of snail mucin have also been used to treat burns and radiation dermatitis. The mechanism of action is thought to involve the antioxidant properties of snail mucin and the resulting control of the free radicals that contribute to inflammation and skin injury

VII. It Moisturize the Skin

Snail mucin contains substances that trigger the production of hyaluronic acid, a natural substance that retains moisture, and is found in the eyes, skin and joints. This increased hyaluronic acid could reduce dryness and help the skin stay hydrated.

VIII. Sun Damage Recovery

One 2021 study in mice found that oral intake of snail mucin could reduce symptoms of ultraviolet B (UVB) radiation, a type of radiation emitted by the sun that could lead to sunburn, aging and skin cancer. However, more research is needed to confirm similar effects in humans.

IX. It Can Help Exfoliate Skin

The glycolic acid in snail mucin can act as a gentle exfoliant, revealing brighter and smoother skin, Additionally, glycolic acid can break down keratin (a protein that helps form the hair, skin and nails), which helps eliminate rough or dry patches of skin. It’s also used as an exfoliant in skin care products targeted to address acne and post-inflammatory hyperpigmentation.

CONCLUSION

Snail mucus having multiple actions such as inflammatory process during wound healing, soothes sun exposure action, it also acts as hydrating, moisturizing, anti-aging, it can also helps to exfoliate the skin, Snail mucus is a potential promising material to be developed into a drug to accelerate multifunctional . However, it is necessary to test the toxicity, biocompatibility, and stability of the 96% snail slime gel to produce a useful cosmetic active.

ACKNOWLEDGMENT

I would like to thank my reserch guide **Dr. Lalit.K.Vyas** Vidya Bharati Mahavidyalaya Amravati (Phd cosmetic technology) for their guidance and overall support.

REFERENCES

1. Maxwell McDermott 1, Antonio R. Cerullo 1, James Parziale 1, Eleonora Achrak 1,Sharmin Sultana 1, Jennifer Ferd 1, Safiyah Samad 1, William Deng 1,Adam B. Braunschweig 1,2,3 and Mandë Holford 1,3, 4,5.

2. Angulo DEL, do Amaral Sobral PJ. Characterization of gelatin/chitosan scaffold blended with aloe vera and snail mucus for biomedical purpose. *Int J Biol Macromol.* 2016;92:645-653. <https://doi.org/10.1016/j.ijbiomac.2016.07.029>
3. Eliza Wargala 1 , Agnieszka Zalewska 1, Martyna Sławska1 , Izabela Kot Student Scientific Association of Biologists - Biocosmetology Section, Faculty of Environmental Biology .University of Life Sciences in Lublin, Akademicka 15, 20-950 Lublin. Snail mucus as an innovative ingredient used in the cosmetology and medical industry.
4. Zając K. Sekretne życie ślimaków. *Wszechświat.* 2016;117(4-6):137-140.
5. Dankowiakowska W, Domagalska B. Simak lądowe jako źródło surowców o potencjalnym wykorzystaniu w kosmetologii i dermatologii. *Po 1 J Cos metol.* 2018; 21: 114-120.
6. Trap Ella C, Rizzo R, Gallo S, et al. Helix Complex snail mucus exhibits pro-survival, proliferative and pro-migration effects on mammalian fibro-blasts. *Sci Rep.* 2018;8(1):1-10. <https://doi.org/10.1038/s41598-018-35816-3>.
7. Advancing Discovery of Snail Mucins, Function and Application Maxwell McDermott 1, Antonio R. Cerullo 1, James Parziale , Eleonora Acharak 1,Sharmin Sultana 1, Jennifer Ferd 1, Safiyah Samad 1, William Deng 1,Adam B. Braunschweig 1,2,3 and Mande Holford 1,
8. Dr. Sajic. A 2020 clinical trial in the *Journal of Clinical Aesthetic Dermatology* investigated the effects of a skin care.
9. Dusan Sajic, M.D., Ph.D., a board-certified dermatologist and anti-aging specialist at derma Skin Institute in Ontario, Canada.
10. The Potential of Snail (*Achatina Fulica*) Mucus Gel as a Phytopharmacology to Accelerate the Inflammation Process during Wound Healing Josaphat B Rosanto¹ , Cahya Y Hasan² , Rahardjo³ , Antonius Surya⁴

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Development of shampoo with superior hair conditioning properties of Lipoaminoacid technology

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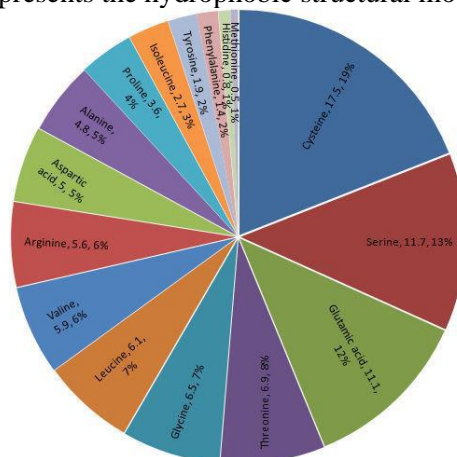
Abstract- Scalp hair forms an important part of overall appearance of human body and contributes heavily to the impression it may create about one's personality. Thus making 'cleansing and beautifying' the hair an area of importance. Hair care is ever-present human habit which is often driven by conscious or sub conscious social and evolutionary pressures. Hence this report is devoted to design the shampoo formula and lipoaminoacid technology catering to specific needs of the category, also a superior functional delivery is obtained against a benchmark through careful consideration and selection of active ingredients in experiment approach.

Apart from basic cleansing that a shampoo can provide, study of beautification and hair health improvement that a shampoo can deliver still remains a huge platform of further research and exploration with evolving consumer lifestyle. Living tissues are made of amino acids, building blocks of life, creating proteins- collagen, elastin. "Essential" amino acids cannot be synthesized on their own. The use of cosmetics & supplements are the only way to supply them for a healthy strong substrate. Non-essential- amino acids can be produced by the body. But with age, the production slows down, resulting in unbalanced skin & hair. A lipoaminoacid is the association of an amino acid & a fatty chain. The fatty chain being the vector of the amino acid to its target. By masterizing the lipid profile of substrate and by combining specific amino acids with the right vector for perfectly targeted activity on skin & hair.

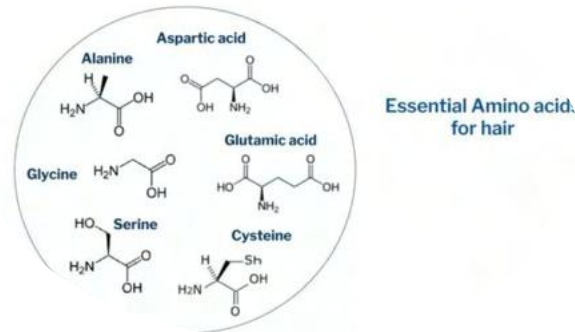
Key Words- Cleansing, Conditioning, lipoamino acid, proteins, surfactant, hair morphology.

I. INTRODUCTION

Hair a composition of living organism often idealizes for beautification purpose and have protective mechanism and health implications are made of amino acid which is a fibrous and helical protein with 90- 95% Keratin in the form of helical structure. As the insolubility of keratin in water it represents the hydrophobic structural mode.

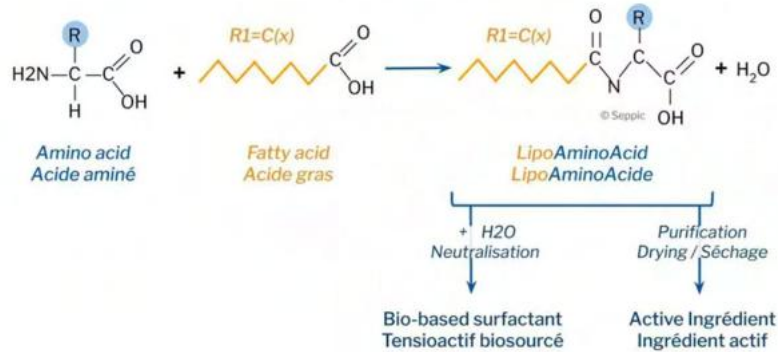


Amino acid given the diversity of their structure and omnipresence in nature, constitute an essential resource for the creation of bio-inspired ingredients. As essential components of proteins, amino acids are encoded by the DNA of the cells of all living beings and play a determining role both in the structure of organisms, and their biological metabolisms. Originating from plant sources or biotechnologies, they are carboxylic acids with an amine functional group. While their general structure is $\text{NH}_2 - \text{HCR} - \text{COOH}$, they differ in terms of the R group side chain and as the well-known fact of main constituent of hair is protein which is altogether amino acid.



Amino acid transformation

Amino acids are naturally hydrophilic molecules, potentially anionic or cationic depending on the pH. Grafting one or more hydrocarbon chains gives them an amphiphilic character, which amplifies their biological effects or surface properties. This is the essence of lipoaminoacid technology. On the one hand, grafting hydrocarbon chains (acylation) improves their solubilization in hydrophobic media (lipophilization). This facilitates their vectorization in living media and increases their bioavailability to create active ingredients with multiple biological targets. On the other hand, depending on the hydrocarbon chain selected, the amphiphilic character gives the possibility of creating biosourced surfactants. One advantage is that lipophilization processes are carried out in a single step at room temperature without sophisticated catalysts. The sources of lipophilic chains essentially come from fatty acid derivatives, which themselves originate from the oleochemical sector. Following this transformation, the lipophilized amino acids, also called lipoaminoacids, are subjected to two types of finishing operations. These come in two forms, either as aqueous solutions with a lipoaminoacid concentration of between 20 and 40%, or else in powder form with a high concentration of lipoaminoacids (>90%). In both cases the compositions, whether liquid or solid, are perfectly defined, and each constituent analytically quantified.



Lipophilization / acylation reaction

Lipoaminoacids, concentrated active ingredients for multiple purposes Acylation technology combines various amino acids and fatty acids with a chain length of 8 to 16 carbons that exist in nature. Adding a purification and drying step creates an inexhaustible source of concentrated active ingredients that can be used for cosmetics with a wide variety of biological targets

Selection of active ingredients:

1. Glycosphingolipids – Glycolipids (Highly purified Wheat extract)
2. Hydrolyzed Wheat protein extract

Final Formula:

Sr no	Ingredients	% Quantity Placebo	% Quantity with Active (with Hydrolysed wheat protein)	% Quantity with Active (Glycosphingolipids – Glycolipids)

1	Deminarlised Water	25.24	23.24	23.24
2	Di Sodium EDTA	0.1	0.1	0.1
3	Sodium lauryl ether sulphate	39	39	39
4	Cocomonoeethanolamide	1.5	1.5	1.5
5	Ethylenglycolmonostearate	1.5	1.5	1.5
6	cocoamidopropyl betaine	5	5	5
7	xiameter 1785 Emulsion	3	3	3
8	Deminarlised Water	5	5	5
9	Gaur Hydroxy Propyltrimonium Chloride	0.06	0.06	0.06
10	MCIT MIT (Euxyl K120)	0.1	0.1	0.1
11	NaCl	0	0	0
12	Deminarlised Water	7.5	7.5	7.5
13	TRIquat(TRI K 10L)	0.5	0.5	0.5
14	water	4	4	4
15	Perfume(pompodour imp4)	0.5	0.5	0.5
16	Proteol APL	5	5	5
17	Glycosphingolipids – Glycolipids	0	0	2
18	Hydrolysed Wheat protein	0	2	0
	Total	100	100	100

Analysis Data:-

Details	% Quantity Placebo	% Quantity with Active (with Hydrolysed wheat protein)	% Quantity with Active (Glycosphingolipids – Glycolipids)
pH	6.5	6.2	6.13
Viscosity	11230	12140	12420
Moisture content (% w/w)	76.8%	77.1%	77.32%

Stability report: 1Month:-

Batch Number-12	Condition			
	RT	REF	50°C	45°C/75 RH
PH	5.59	NA	NA	5.52
Viscosity(S.6 at 10 rpm)	11000cp	NA	NA	12800cp
M.C in %	77.58%	NA	NA	78.18%

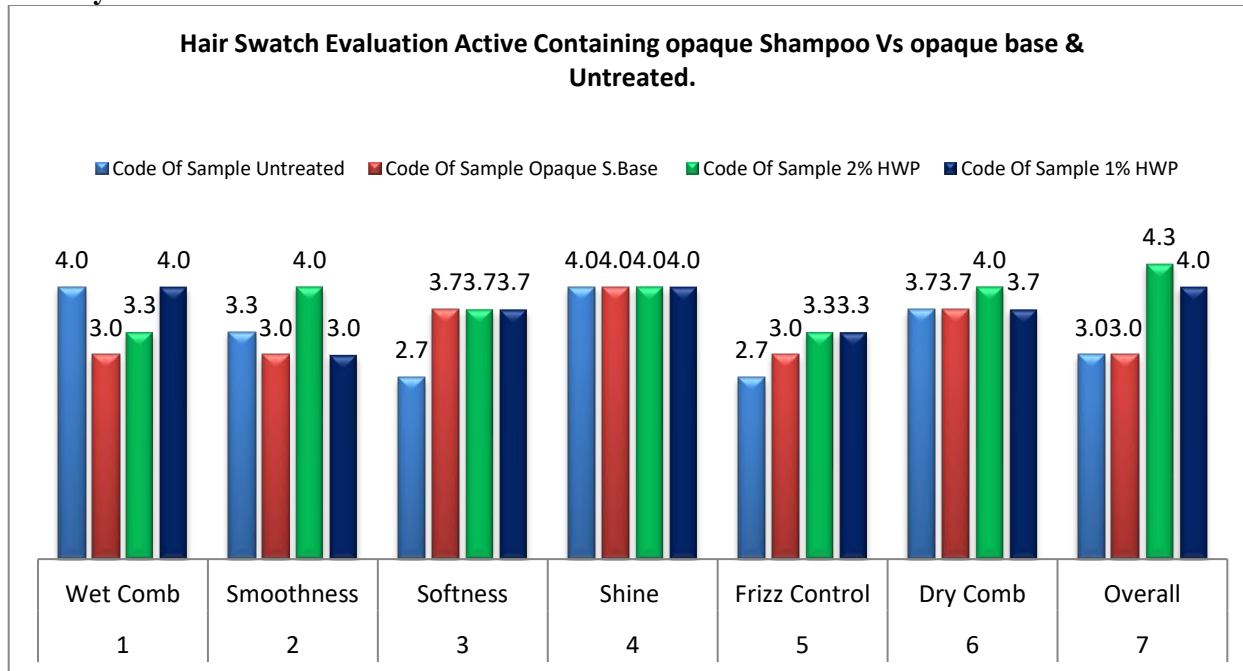
2 Month

Batch Number-12	Condition			
	RT	REF	50°C	45°C/75 RH
PH	6.29	NA	NA	6.2
Viscosity(S.5 at 10 rpm)	13500cp	NA	NA	13200cp
M.C In %	76.37%	NA	NA	76.55%

3 Months

Batch Number-12	Condition			
	RT	REF	50°C	45°C/75 RH
PH	6.27	NA	NA	6.14
Viscosity(S.05 at 10 rpm)	14000cp	NA	NA	14480cp
M.C in %	75.93%	NA	NA	75.88%

Sensory evaluation of hair swatch:



IN VITRO INSTRUMENT EVALUATION OF ACTIVES

The impact of actives on hair swatches through Diastron instrument for wet combing and dry combing force measurement and hair strength through tensile strength tester.

Study Objective:

To evaluate conditioning efficacy of actives through wet combing and dry combing force data. To evaluate strength imparted to hair shafts by the actives through tensile hair strength tester.

Instrument details:

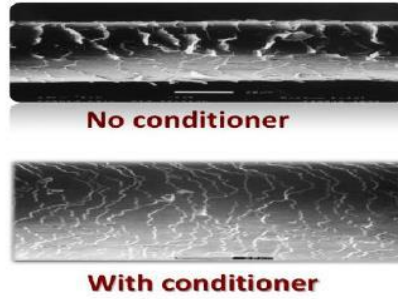
A) Wet combing and dry combing force calculated with help of Diastron instrument:

- Diastron calculates combing force required to comb through hair tress.
- When conditioning shampoo is applied on hair, less force is required, that means conditioning effect of shampoo on that particular hair tress is good

- It is helpful technical measurement of product performance with respect to conditioning that provide guidance to formulation chemist, while also potentially being useful in claim derivation and product marketing.



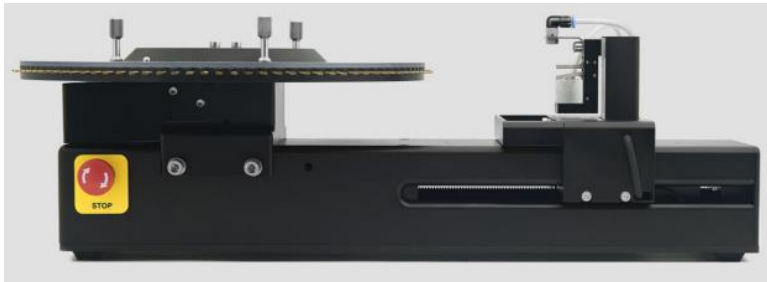
Diastron Combing



Hair Fiber

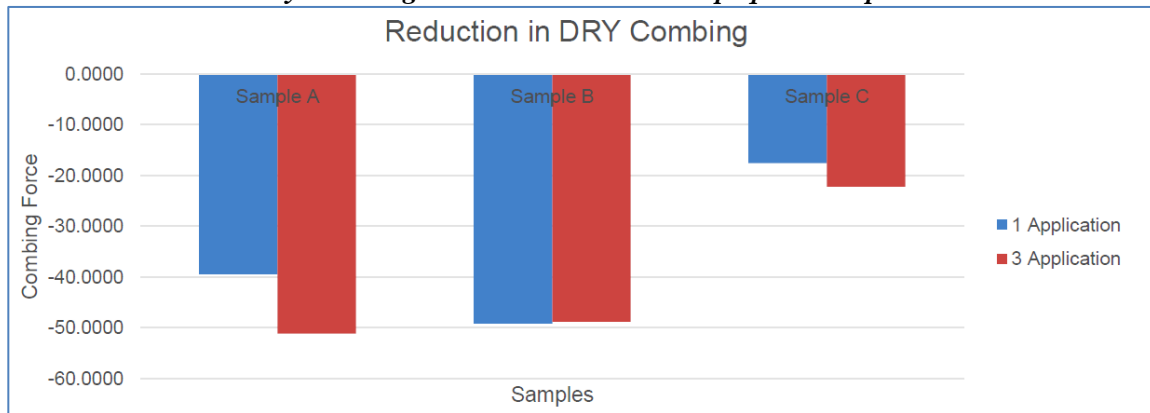
B) Tensile strength testing using Di-Stron instrument:

- Tensile testing is one of the most widely used methods in hair care industry, where strength of hair shaft can be determined by measuring the force used to break the shaft.
- More the force required to break the hair shaft post product application, better is the efficacy of product for against hair breakage.
- This method helps obtain claims in hair care industry related to hair strength, hair damage repair, hair hydration claims, etc.



Study Protocol: Wet and Dry Combing through Diastron Instrument:

Category	Details using Shampoo
Test Model	•9 Indian Semi Bleached Hair Tresses divided in to 3 groups (0.25 g each)
Materials	•Shampoo sample A, B and C as received
Treatments	•Group 1: Sample A •Group 2: Sample B •Group 3: Sample C
Instrument	Dia-Stron MTT175 Miniature Combing Tester
Treatment Methods	•Hair tresses were Washed with 10% SLES solution, and tested as Untreated Wet and Dry •Hair was then treated and washed with 0.5 g of shampoo A, B and C for 1 min •Hair dried under ambient conditions between cycles
Conditions	Water Temperature: 30°C ± 2, Relative Humidity: 50% ± 5, Room Temperature: 20°C ± 2
* Protocol remains same for Transparent and Opaque shampoo evaluation	

Dry Combing Force Reduction with Opaque Shampoo**Observations-**

- Shampoo A (with Glycosphingolipids – Glycolipids (Highly purified Wheat extract) has shown reduction in DRY combing force as 39% after 1 application as compared to untreated
- Shampoo A (with Glycosphingolipids – Glycolipids (Highly purified Wheat extract) has shown reduction in DRY combing force as 51 % after 3 applications as compared to untreated
- Shampoo B (Hydrolyzed Wheat protein extract) has shown reduction in DRY combing force as 49 % after 1 application as compared to untreated
- Shampoo B (Hydrolyzed Wheat protein extract) has shown reduction in DRY combing force as 49% after 3 applications compare to untreated
- Shampoo C (Placebo) has shown increase in DRY combing force as 18% after 1 application compare to untreated
- Shampoo C (Placebo) has shown reduction in DRY combing force as 22% after 3 applications compare to untreated

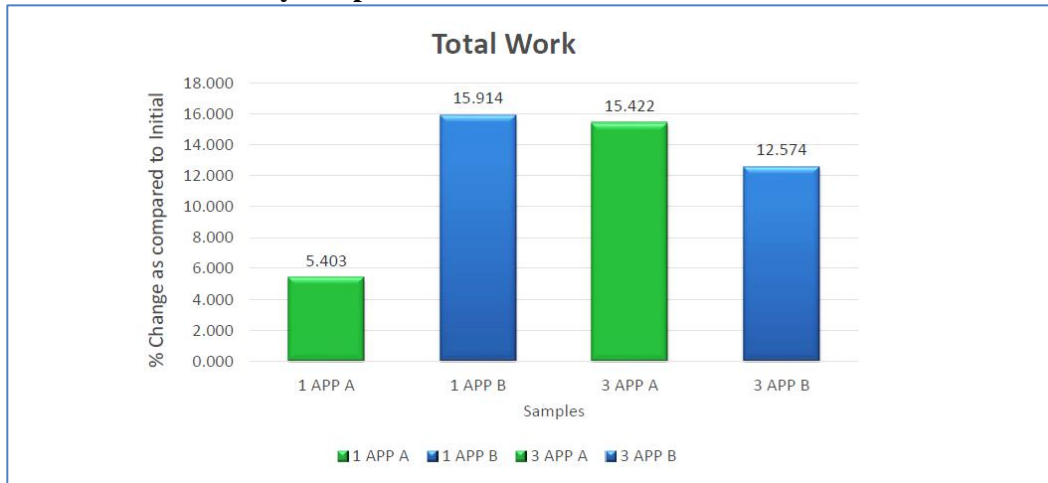
Study Protocol: Improvement in Indian Hair Tensile Properties:

Category	Tensile
Test Model	•3 swatches(5 g each) Partially bleached Indian Hair
Materials	•Control –Untreated Opaque Shampoo from JK Helen Curtis •Sample A •Sample B
Treatments	•Group 1: Untreated •Group 2: Sample A with 2% Quinoa Pro NPNF •Group 3: Sample B with 2% Barla Tein NPNF
Instrument (s)	Dia-StronMTT175 Miniature Tensile Tester & Dia-Stron Crimp Assembly System

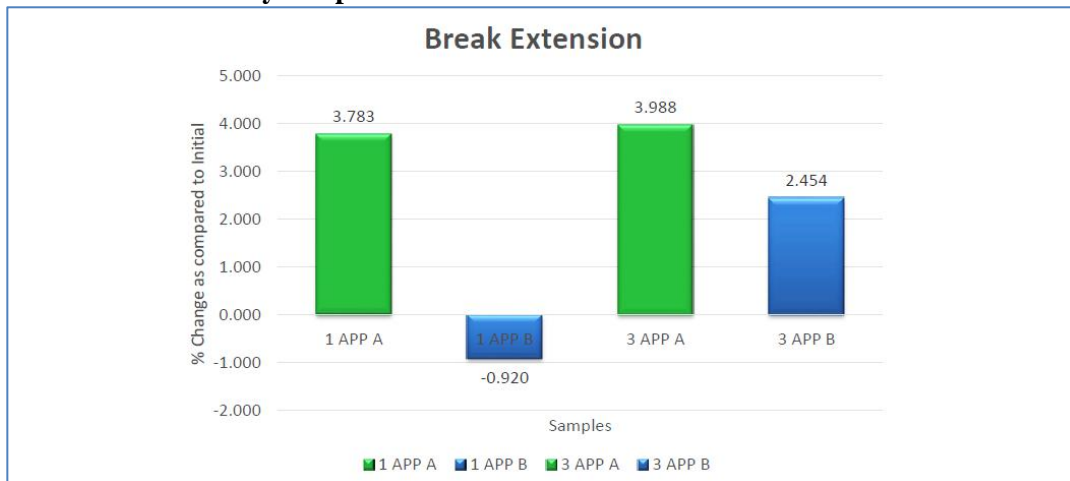
Treatment Methods	<ul style="list-style-type: none"> •Hair swatches were clarified with 10% SLES Solution and dried at ambient condition overnight •Hair was treated with 1 and 3 cycles of shampooing (1 min) for both set of sample A and B separately. Hair were dried at ambient conditions in between the cycles •Brass crimps were added to the ends of the fibres following Dia-Stron method. •Measurements were taken after 1 and 3 cycles (average of 50 fibres)
Conditions	Water Temperature: 30°C ± 2, Relative Humidity: 50% ± 2, Room Temperature: 20°C ± 2

Study Findings:

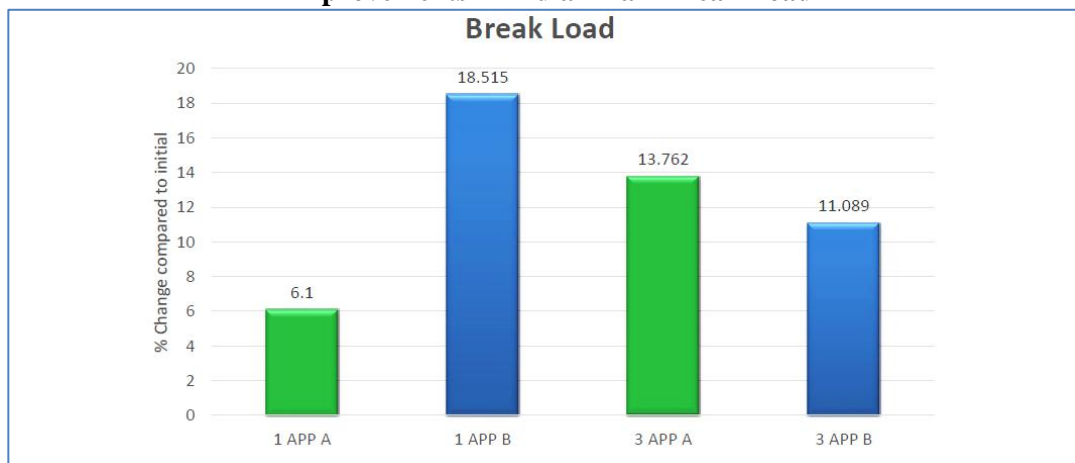
Study –Improvements in Indian Hair Total Work



Study –Improvements in Indian Hair Break Extension



Improvements in Indian Hair Break Load



Study Inference:

1. Both Barley Tein Pro and Quinoa pro NPNF have shown positive results in conditioning efficacy and hair tensile test against bases without actives.
2. Within the 2 actives Quinoa Pro NPNF has outperformed other active and shows a substantial improvement in both the tests in a wash off format.
3. Considering the baseline as untreated value, bases developed for both formats transparent and opaque have shown positive readings to a substantial extent. Hence efficacy of both bases – transparent and opaque is successfully validated through the above In Vitro Study.

REFERENCES

Books:

1. Surfactants: Organic Chemistry edited by Helmut W. Stache
2. Chemistry and Technology of Surfactants edited by Richard J. Farn
3. Handbook of Cosmetic Science and Technology edited by André O. Barel, Howard I. Maibach
4. Chemical and Physical Behaviour of Human Hair By Clarence R. Robbins,p.p105
5. Hair and Hair Diseases edited by Constantin E. Orfanos, Rudolf Happle
6. Herbal Cosmetics Handbook (3rd Revised Edition) By H Panda,p.p-311
7. Hair Care: An Illustrated Dermatologic Handbook By Zoe Diana Draelos p.p 36
8. Chemistry and Technology of Surfactants, edited by Richard J. Farn 32
9. Maria Fernanda Reis Gavazzoni Dias 1,2 1 Departments of Dermatology, Fluminense Federal University, Niterói, 2 Azulay Dermatology Institute, Rio de Janeiro, Brazil pp.5
10. Principles of Polymer Science and Technology in Cosmetics and Personal Care,edited by E. Desmond Goddard, James V. Gruber, p.p-452.(For Recommended Dosage form).

Formulation and Development of Hair Conditioner With Glycolic Acid and Sesame Seed Oil

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ABSTRACT:

The hair care market is one of the largest personal care markets all over the world. Hair care is important to a person's overall appearance. Washing the hair and scalp has become a near-universal practice. Good hair care is very important shampooing, conditioning and moisturizing the hair to restore healthy luster and sheen. In the past, the main aim of using hair care products was to clean the hair by removing spoilage and dirt. Today, hair care products are desired to provide additional benefits, such as beautifying the hair, making it easy to handle, or repairing damages. Hair care can be described as "preparations intended for placing in contact with the hair and scalp, with the purpose of cleansing, promoting attractiveness, altering appearance, and/or protecting them in order to maintain them in good condition".

The main objectives of the present study is to design and development of Hair care product for the damage and dry hair and maintained healthy looking hair. Studies have shown that glycolic acid penetrates throughout the hair shaft, and effect that persists even after the hair dries. Glycolic acid when used in hair care products it gives following application.

KEYWORDS : Hair care, Hair Conditioner, Glycolic Acid, Sesame Seed Oil, Stability testing, Physiochemical parameters.

INTRODUCTION –

Hair care can be described as "preparations intended for placing in contact with the hair and scalp, with the purpose of cleansing, promoting attractiveness, altering appearance, and/or protecting them in order to maintain them in good condition". Conditioners are one of the most popular hair care products. A conditioner consists of moisturising ingredients such as oils, humectants, silicones, butters, and emollients that nourish the hair and replenish it with moisture. Some conditioners also contain special proteins that help bind split-ends. Conditioners work by forming a protective coating around the cuticles. This coating helps cut the frizz, makes the hair soft, and also helps prevent damage from environmental aggressors. Conditioners are used to decrease friction, detangle the hair, minimize frizz and improve combability. Conditioners act by neutralizing the electrical negative charge of the hair fiber by adding positive charges and by lubricating the cuticle that reduces fiber hydrophilicity.

Hair is an imperative part of the human body which protects the scalp. Hair Conditioner is a hair care product, which is applied to the hair and hair tips after shampoo in order to condition the hair and then it is rinsed out. Hair Conditioner is used to improve the manageability and to enhance lustrous look of hair. Its main purpose is to reduce friction between the hair strands to

allow easier brushing and combing. Hair conditioners are skin care product that are applied to the ends of the hair and later used for cleansing, conditioning the hair, and rinsing. It is used to make the hair shiny and smooth. Increases the luster of hair. Mainly prevents hair breakage, reduces split ends and improves manageability. Its main purpose is to reduce friction between hairs, making brushing and combing easier.

Conditioners are available as liquids, creams, or gels. The main ingredients in hair conditioners are the conditioning ingredients. There are various types of conditioning agents available, including lipids, silicones, quats, protein derivatives, silicones, and glycols, among others. The product is beneficial to all types of hair. It works by restoring moisture, and smoothing the cuticles of the hair follicles. Hair conditioner comprising of powerful antioxidants can reduce UV damage to the hair including hair colour changes and protein damage.

CHARACTERISTICS OF GOOD CONDITIONER: -

1. Premium Moisture - The inherent quality that must exist is the conditioner must provide maximum moisture. It should be super hydrating and restore natural oils removed from hair from daily styling and shampooing. Emollients and humectants will provide moisture and shine.

2. Slip baby - In addition to moisture, a good conditioner will provide slip and thus have detangling ability. Slip is imperative to length retention and effective detangling.

3. Consistency - A thick and creamy conditioners. The conditioner must be able to absorb and protect at a high level, which means it needs to penetrate the hair shaft. This can be achieved by using a water based conditioner.

4. Leaves hair feeling uber soft

5. Good Ingredients- If you are partial to all natural ingredients, reading the ingredients is essential. Once you identify what your hair responds positively to, this will aid in your selection process.

BENEFITS OF CONDITIONER: -

1. It provides shine and smoothness
2. It tames split ends and flyaway hair
3. It improves manageability
4. It reduces the fiber hydrophilicity
5. It hydrates the hair

TYPES OF CONDITIONERS: -

1. Rinsed-out conditioners - Rinse-Out conditioners work by closing the cuticle scales of the hair. This is because they can be rinsed quickly and instantly. Their balanced composition and instant results often complement shampoos as a pre-wash, co-wash, or after-wash accessory. They contain ingredients that deliver instant moisturization and softness to hair. They are often made of mild yet hydrating ingredients that make them better suited for natural or straight hair.
2. Leave-in Conditioners - These conditioners are made with nourishing ingredients that penetrate the shaft to nourish strands. They are generally lighter, and the composition contains a fine blend of penetrative agents to maintain hair's softness. This product comes

in different forms, such as liquids, creams, or sprays. Leave in conditioners also help protect your hair from chlorine and salt.

3. Deep Conditioners - Deep Conditioners or hair masks are treatments that will help hydrate, repair or nourish you hair. They are designed to provide an even more potent effect than everyday conditioners. These usually have a thicker consistency.
4. Cleansing Conditioners - These are the ones that you can also wash your scalp and hair with (these are also known as co washes). Their cleansing properties will help remove residue and buildup and they are best for thick, curly hair as it helps to maintain moisture.



GLYCOLIC ACID HAIR BENEFITS

1. As the simplest alpha hydroxy acid (AHA) and smallest fruit acid, glycolic acid easily penetrates the cuticle layer of hair shafts. This characteristic allows glycolic acid to attach itself to keratin—a fibrous protein that protects hair from damage and promotes hair growth and length—to further strengthen hair and decrease breakage.

Glycolic acid is an alpha-hydroxy acid (or AHA, as it is commonly seen on product bottles) that can be naturally derived and acts as a gentle exfoliant. AHAs are typically made up of things like sugar cane, citrus fruits, grapes, and even sour milk. Additionally, the size of the molecule itself is so small, it actually allows the acid to travel further, and deeper, within your skin and hair, making it more effective.

3. Glycolic acid's effectiveness in hair care applications that include
 - a. Revitalizing shampoos
 - b. Conditioners
 - c. Detanglers

d. Hair and scalp masks

Specifically, adding cosmetic-grade glycolic acid to a conditioner or a hair treatment product aid moisturizes both hair and scalp by improving the penetration and delivering the active ingredients into the hair shaft and skin. Also, glycolic acid in conditioning formulations provides moisturizing-like effects and softness that helps prevent hair breakage, giving hair overall better manageability.

4. Glycolic Acid: Protecting Hair from the Inside Out

Traditional hair conditioning agents repair and protect the exterior of the hair shaft. Less commonly known is that the hair shaft's interior can also suffer damage and weaken the hair shaft. The cortex—made of keratin—gives hair its pigment and provides hair's structural integrity, strength, and swelling/stretching ability. Chemours has demonstrated that glycolic acid penetrates the hair shaft, stabilizes the keratin within, and provides stronger, more manageable hair.

The biggest takeaway from glycolic acid and hair is its ability to help with dandruff. By moisturizing and exfoliating the scalp, glycolic acid will actually help treat and keep dandruff at bay. What's key here is the gentle exfoliation using the small AHA molecules along with the moisturization. Most other dandruff treatments focus on stripping the scalp of its woes, rather than removing and replacing what it lacks. On the flip side, glycolic acid can help balance an oily scalp as well. This again harkens back to its exfoliation properties, which in turn increase cell turnover. Regular cell turnover on the scalp, just like on our face, helps balance our skin and keep our follicles happy. While glycolic acid may become your scalp health holy grail, it is important to remember that all good things come in moderation. Overusing glycolic acid on the scalp or leaving it on too long too frequently can actually cause irritation and further flakiness issues, as well as weaken your hair. Limit your use of this product to once, maybe twice a week if that, and no more than 20 to 30 minutes at a time.

Material and Methods:-

List of ingredients required:

1. Ceto stearyl alcohol - VBMV, Amravati
2. Shea butter- VBMV, Amravati
3. Glyceryl monostearate - VBMV, Amravati
4. Sesame seed oil - VBMV, Amravati
5. Iso-propyl-myristate- VBMV, Amravati
6. Behentrimonium chloride - Solvay Novacare
7. Cetrimonium chloride Solvay Novacare
8. Argon oil- VBMV, Amravati
9. Guar hydroxy trimonium chloride- Solvay Novacare
10. Dimethicone - VBMV, Amravati
11. Phenoxy ethanol - VBMV, Amravati
12. Water - Ganesh scientific, Amravati
13. Glycolic acid - Chemico health and beauty India Pvt.Ltd. Mumbai
14. Glycerin- VBMV, Amravati

List of equipment: -

- 1) pH meter – Labline, Mumbai
- 2) Brook field Viscometer – Brookfield engineering labs
- 3) Round electronic Hot plate – Bio Technics India, model BTI-22
- 4) Remi Motor– Remi Elektrotechnik Ltd. Vasai, Type – RQ- 122
- 5) Stability chamber – Labline
- 6) Humidity chamber – Bio techno lab
- 7) Weighing balance – VBMV, Amravati

Method of preparation of Hair Conditioner -**Base Formulation of Hair****Conditioner Table no. 1: -**

Sr.no.	Ingredients	Quantity for 100 gm			
		F1	F2	F3	F4
1.	Ceto-stearyl alcohol	6	5	5.5	5
2.	Glyceryl monostearate	1.5	1.2	1	2
3.	Emulsifying wax	0.8	1	0.5	0.4
4.	Light liquid paraffin	1.2	2.2	3	2.5
5.	Behentrimonium chloride	3	1	2.5	2
6.	Cetrimonium chloride	1	2	1	1.2
7.	Argan oil	0.8	1	0.4	0.6
8.	Iso-propyl myristate	1	3	1.5	2
9.	Jaguar (GHTC)	1	0.5	0.4	0.3
10.	Glycerine	1.2	0.8	1.5	1
11.	Phenoxy ethanol	0.2	0.2	0.2	0.2
12.	Citric acid	0.42	0.12	0.12	0.12
13.	Water	80	81	81	82
14.	Dimethicone	1,5	0.8	1	0.7
15.	Perfume	0.1	0.2	0.3	0.4

PROCEDURE –

- 1) Clean all apparatus and weigh all the ingredients properly.
- 2) Phase A i.e., oil phase was weighed accurately in a beaker and Phase B i.e. water phase in another beaker.
- 3) Both phases are heated on hot plate until it melts completely and reaches up to temperature 70 -80°C

- 4) Pour Oil phase in Water phase with slow stirring as it is oil in water type of emulsion.
- 5) Mix both the phases properly with continuous slow stirring.
- 6) Add Cetrimonium chloride and dimethicone (silicone oil) in it when it reaches to 50 -45°C,
- 7) When it reaches to proper texture and consistency check pH and pH was adjusted by citricacid.
- 8) At last step add perfume with slow stirring check if it affects viscosity.
- 9) Pour the product in proper clean container.

Optimization of Hair Conditioner Base-

Optimization of formulation means selection of a stable formulation which is carried out on the basis of various parameters such as appearance, color, feel, odour, Spreadability, etc. The optimization of hair conditioner base was carried out after a particular time period and at different temperature. The optimization of hair conditioner base was done on the basis of above-mentioned parameters and the results are as follows,

Sr. No.	Parameters	Formulation			
		F1	F2	F3	F4
1.	Appearance	-	++	+++	+++
2.	Colour	++	++	++	+++
3.	Spreadability	+	++	++	+++
4.	Flowability	-	++	++	++
5.	Odour	++	+++	+++	+++
6.	Feel	-	+	++	+++

Table – Showing Characteristic of Hair Conditioner Base

Abbreviation: - (+) = good, (++) = better, (+++) = best, (-) = average

Based on the results obtained from the stability study of hair conditioner base of formulation F1, F2, F3, and F4, “**base F4**” was selected for the final formulation as it shows all desired properties.

Incorporation of glycolic acid and sesame seed oil in final base formulation of hair conditioner

After the optimization of hair conditioner base, as per optimization results F4 was selected and now active was added into the formulation into different concentration.

Table – Formulation of hair conditioner with glycolic acid sesame seed oil

Sr.no.	Ingredients	Quantity for 100 gm		
		F1	F2	F3
1.	Ceto-stearyl alcohol	5	5	5
2	Glyceryl monostearate	2	2	2
3.	Emulsifying wax	0.4	0.4	0.4
4.	Light liquid paraffin	2.5	2.5	2.5
5	Behentrimonium chloride	2	2	2
6.	Cetrimonium chloride	1	1	1
7.	Sesame oil	0.4	0.2	0.5
8.	Argan oil	0.6	0.6	0.6
9.	Iso-propyl myristate	1.5	1.5	1.5
10.	Jaguar (GHTC)	0.3	0.3	0.3
11.	Glycerin	1	1	1
12.	Phenoxy ethanol	0.2	0.2	0.2
13.	Water	82	82	82
14.	Dimethicone	0.7	0.7	0.7
15.	Glycolic acid	1	1.5	2
16.	Citric acid	0.2	0.2	0.2

PROCEDURE –

- 1) Clean all apparatus and weigh all the ingredients properly.
- 2) Phase A i.e., oil phase was weighed accurately in a beaker and Phase B i.e. water phase in another beaker.
- 3) Both phases are heated on hot plate until it melts completely and reaches up to temperature 70 -80°C
- 4) Pour Oil phase in Water phase with slow stirring as it is oil in water type of emulsion.

- 5) Mix both the phases properly with continuous slow stirring.
- 6) Add Cetrimonium chloride and dimethicone (silicone oil) in it when it reaches to 50 -45°C,
- 7) When it reaches to proper texture and consistency add Glycolic acid and check pH and pHwas adjusted by citric acid if necessary.
- 8) At last step add perfume with slow stirring check if it affects viscosity.
- 9) Pour the product in proper clean container.



Above formulation was optimized to check the stability of product after incorporation of active.

OPTIMIZATION

Table – Examination of hair conditioner base with active

Sr.no	Parameters	Day 1			Day 5			Day 8		
		F1	F2	F3	F1	F2	F3	F1	F2	F3
1.	Appearance	+++	+++	++	+++	+++	++	+++	+++	++
2.	Colour	+++	+++	++	++	+++	++	-	++	++
3.	Spreadability	++	+++	++	++	+++	++	++	+++	-
4.	Flowability	++	++	+++	++	++	+++	+	++	+++
5.	Odour	+++	+++	+++	+++	+++	++	+++	+++	++
6.	Stability	+++	+++	++	+++	+++	++	+	++	+

Abbreviations: - (+) = good, (++) = better, (+++) = best, (-) = average

Based on the above examination **formulation F2** was selected for the final formulation as well as evaluation.

Final Formulation of Hair Conditioner –

Table – Formulation of hair conditioner with glycolic acid sesame seedoil

Sr.no.	Ingredients	Quantity for 100 gm
1.	Ceto-stearyl alcohol	5
2.	Glyceryl monostearate	2
3.	Emulsifying wax	0.4
4.	Light liquid paraffin	2.5
5.	Behentrimonium chloride	2
6.	Cetrimonium chloride	1
7.	Sesame oil	0.2
8.	Argan oil	0.6
9.	Iso-propyl myristate	1.5
10.	Jaguar (GHTC)	0.3
11.	Glycerin	1
12.	Phenoxy ethanol	0.2
13.	Water	82
14.	Dimethicone	0.7
15.	Glycolic acid	1.5
16.	Citric acid	0.
17.	Perfume	0.3

The final formulation of hair conditioner was formulated using same procedure as mentioned for final base formulation. On the final formulation mentioned above further quality tests were performed as per the BIS (Bureau of Indian Standard).



Final Base Formulation of Hair

EVALUATION -

In- vitro evaluation of parameters:

A. Determination of physical parameter of Hair Conditioner

Appearance: Visually appearance of the formulation observed.

Colour: Colour of the formulation check visually.

Consistency: Consistency was check weather its satisfactory or poor or good.

Tacky feel: Tackiness were check after application on palm.

Odour : odour was check by smelling.

B. Determination of thermal stability –

Test for thermal stability –

A) Apparatus – humidity chamber / stability chamber controlled at 60-70 % RH and 37 +1°C.

Procedure -

1. Spread a 20 mm broad and 5 mm thick stripe from the material to be tested on the internal wall of beaker of 100 ml capacity in its total height. Keep the beaker for 8 hours in the humidity chamber at 45% – 50% relative humidity. Physical stability test of the formulation was carried out for two weeks at various temperature conditions like at 45°C temperature, room temperature, 4°C and 45% relative humidity in a close container.

C. Determination of pH –

Apparatus – a pH meter, beaker

Procedure: -

For oil-in water emulsions creams – Weigh accurately 5 + 0.01 g of the cream in a 100 ml beaker. Add 45 ml of water and disperse the cream in it for some time. The reading is recorded to Determine the pH of the suspension at 27°C using the pH meter.

D. Determination of Viscosity

Apparatus: Brookfield viscometer, beaker

The selection of spindles is based on the viscosity of the sample being tested, as the spindle needs to be able to rotate freely in the sample without getting stuck or jammed.

- Rheology experiment: Rotational spindle Brookfield viscometer (Model DV-I plus, LV, USA) instrument was used for rheology experiment. 100 mL of the conditioner is taken in a beaker and the spindle is dipped in it for about 5 min and then the reading is taken

The viscosity of hair conditioner was determined by using **spindle no. 5** at 10 to 100 rpm.

Stability study of conditioner

The sample of hair conditioner was kept at 5°C, room temperature 40°C. The changes in physical

appearance, color, feel etc were studied.

F. Accelerated stability study

Accelerated stability studies at various temperature for hair conditioner

Procedure:

The stability of the final formulation was checked at room temperature, 45°C ±2°C, and freeze thaw cycles. To ensure that a cosmetic remain stable till the consumers has used the entire cosmetic or has stopped using it, a number of special accelerated test procedures have been developed. The evaluation employs a combination of tests. This method of evaluation not only indicates stability of Base formulation but also indicates the stability of functional ingredient.

Cyclic Temperature Test:

These tests are not carried out at fixed temperature and humidity. In this test, temperature was changed cyclically every day e.g. low-high-low-high to stimulate the changes in temperature daily.

G. Determination of Spreadability Time:

Apparatus: Petri dish

Procedure:

Clean and dry Petri dish well to perform the test. Place 1 gm of Conditioner on outer side of the Petri dish on it, press a little. Kept a side for a min then note the diameter of sample in centimeter (cm) using scale.

In- vivo evaluation of parameters:

A. Determination of Patch test –

If there is no redness, itching, or irritation, then the conditioner is safe to use. However, if there is any redness, itching, or irritation, then the conditioner is not suitable for use and should be tested on another patch of skin.

B. Skin irritation:

The skin irritation was carried out on human volunteers. For formulated conditioner, five volunteers were selected and 1.0 gm of formulated product was applied on an area two square inch to the back of the hand and on small part of hair. The volunteers were observed for lesions of irritation.

C. Photographic Evaluation

The study of effectiveness of product was done by the help of the volunteer study. This was carried out human volunteers. Hair conditioner were applied on skin. The photograph were taken before and after application of product.

Results-

A. Determination of physical parameter of Hair Conditioner –

Sr. No.	Parameters	Quantity of glycolic acid		
		1 %	1.5 %	2%
1.	Appearance	Opaque	Opaque	Opaque
2.	Colour	Good	Very Good	Very good
3.	Spreadability	Good	Very Good	Good
4.	Flowability	Flowable	Flowable	Flowable
5.	Odour	Good	Very good	Good
6.	Feel	Very good	Good	Very good

Table - Determination of physical parameter of Hair Conditioner

It was observed that, Formulation FW2 parameters are satisfactory as compared to F1 and F3 hence **F2 selected**.

B. Determination of thermal stability –

Sr. No.	Thermal Stability	At 4° Temp.	At Room Temp.	At 45° Temp.
1.	Initial Day	Stable	Stable	Stable
2.	After 7 Days	Stable	Stable	Stable
3.	After 15 Days	Stable	Stable	unstable
4.	After 30 Days	Unstable	Stable	Stable

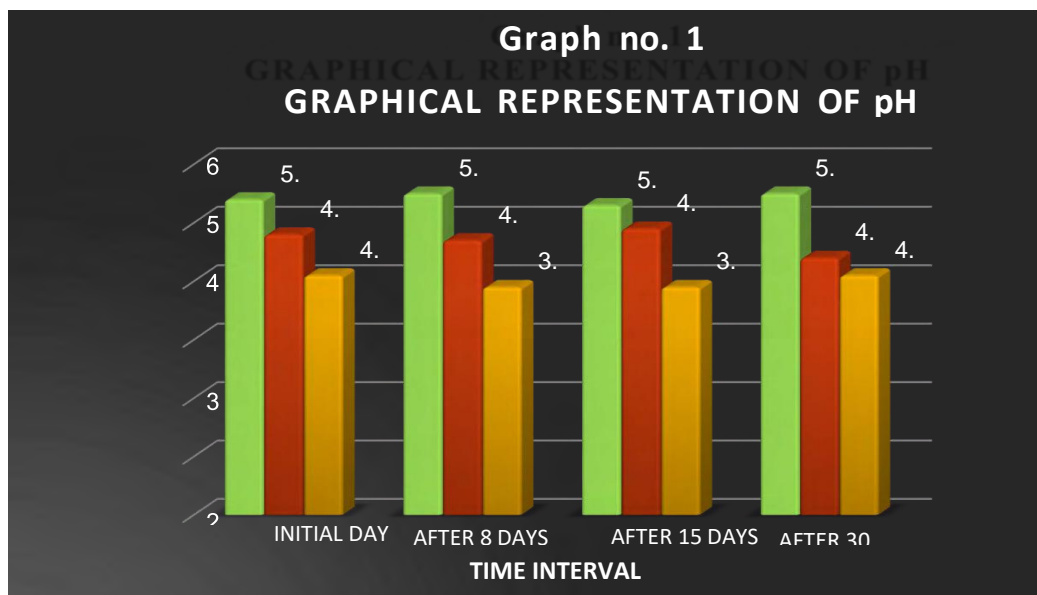
Table - Showing Thermal Stability of Conditioner

The product shall be taken to have passed the test if, on removal from the thermostat, no oil separation is observable.

C. Determination of pH –

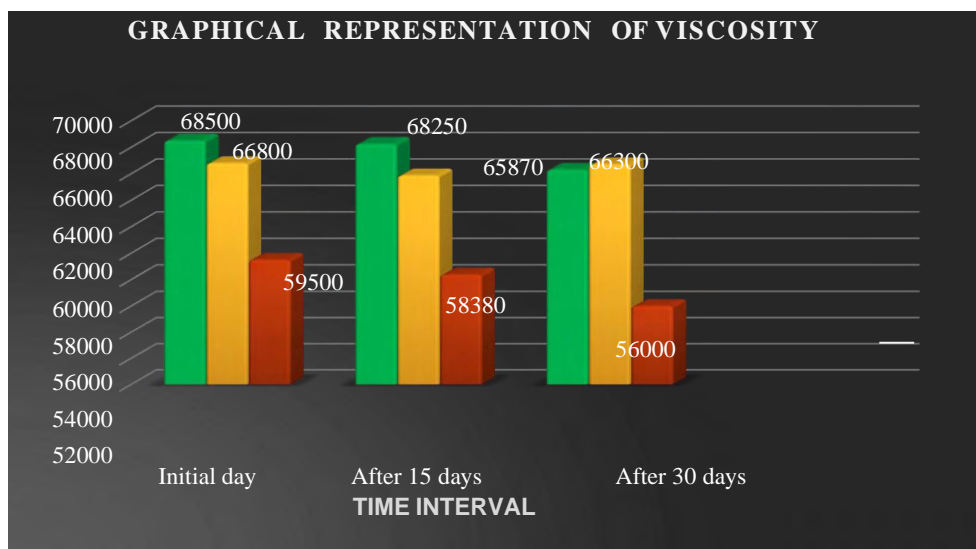
Parameter	Time interval	Result		
		1	2	3
pH	Initial day	5.4	4.8	4.1
pH	After 8 days	5.5	4.7	3.9
pH	After 15 days	5.3	4.9	3.5
pH	After 30days	5.5	4.4	3.6

Table - Determination of Ph



D. Determination of Viscosity -

Parameter		Result		
		1.	2	3
Viscosity	Initial day	68500 cp	66800 cp	59500 cp
	After 15 days	68250cp	65870 cp	58380 cp
	After 30 days	68300 cp	66710 cp	56000 cp



it shows that the product is viscous paste like and can easily be removable from its packing

E. Test For Stability Study –

Sr. No.	Parameter	F1	F2	F3
1	Appearance	++	++	++
2	Colour	++	++	++
3	Spreadability	+++	+++	++
4	Oily/tacky feel	++	++	++

Table - Stability study of conditioner:

F. Accelerated stability study

Accelerated stability studies at various temperature

Sr. no.	Parameter	Room Temperature			45±2°C			Freeze Thaw Cycle		
		F1	F2	F3	F1	F2	F3	F1	F2	F3
1	Appearance	NC	NC	NC	NC	NC	NC	SC	NC	NC
2	Colour	NC	NC	NC	NC	NC	NC	NC	NC	NC
3	Consistency	NC	NC	NC	SC	NC	SC	SC	SC	SC
4	Flowability	NC	NC	NC	NC	NC	NC	NC	NC	NC
5	Spreadability	NC	NC	NC	NC	NC	NC	SC	NC	NC
6	Feel on application	E	E	E	E	E	E	E	E	E

Table - Accelerated stability studies

NC= No Change, SC= slightchange, E = Excellent

From the above table, it is observed that F-2 had not changed its physical properties except for consistency at $45^{\circ}\text{C}\pm 2^{\circ}\text{C}$. Hence, it was stable. Therefore, there formulation, F-2 was selected for subjective study.

- Cyclic Temperature test

Sr.No.	Parameter	F1	F2	F3
1	Freeze Temperature	Stable	Stable	Stable
2	Room Temperature	Unstable	Stable	Stable
3	High Temperature	Unstable	Stable	Unstable

Table - Cyclic Temperature test

G. Determination of Spreadability Time:

Sr. No.	Spreadability	Result
1	Spreadability	3.5
2		3.4
3		3

Table - Determination of Spreadability

In- vivo evaluation of parameters:

A. Determination of Patch test –Table

Sr.no	Parameter	Results
1.	Immediate after application	No reaction
2.	After 1 hour	No reaction
3.	After 24 hours	No reaction

Result – The product passes the test as no reaction was occur.

C. Skin irritation:

Parameter	Skin irritation test
F1	No irritation
F2	No irritation
F3	No irritation

C. Photographic Evaluation -



CONCLUSION

From the above studies it is concluded that the hair conditioners show an excellent property of conditioning. Hair conditioner has a cationic surfactant which gives good cleansing action. Hair conditioner is one of the cosmetics which is widely used in daily life. They will act basically on shaft of the hair. The conditioner functions to impart manageability, gloss and antistatic properties to hair. Conditioners also attempt to recondition hair that has been damaged by chemical/mechanical trauma common sources of trauma. Include excessive brushing, hot blowing, drying, permanent hair waves, bleaching etc. This article gives an idea about hair parts, types, benefits, purpose, functions of conditioner and some commonly used ingredients in formulation of hair conditioner.

The main causes of hair damaged and dry are due to cheap hair product, styling hair with heat without protecting it and not replenishing moisture that is lost during styling, blow drying, harmful environment. So considering this present study was carried out formulate hair care product with active ingredient alpha hydroxy acid such as glycolic acid, in different concentration, and they were tested according to Indian standard.

Thus conclusion can be made that the conditioner containing active ingredient glycolic acid have been able to deliver positive benefits to hair by penetrating throughout the hair shaft, so enhancing softness, shine, elasticity and manageability of hair by conditioning, moisturizing allowing hair to better withstand heat and preventing breakage. The data from these experiments clearly shows that both healthy hair and bleached hair can benefit from the multiple positive effects of active.

REFERENCE –

1. Hair cosmetics : an overview – PMC, by MFRG Dias.2015
2. Anatomy and Physiology of hair, by Bilgen Erdogan.2017
3. https://en.wikipedia.org/wiki/Hair_Conditioner
4. What is Hair Conditioner?. Available at <http://www.wisageek.com/whatishairconditioner.htm>, accessed 3 December 2012
5. Technical Evaluation of Leave-in type Hair Conditioner Formulations
6. Hardy MH. The secret life of the hair follicle. *Trends Genet* 1992;8:55–61.
7. Nema RK, Rathod KS, Dube BK. Text book of cosmetics 1st edition 2009, 111.
8. DEVELOPMENT & EVALUATION OF AYURVEDIC CONDITIONER Jain Vatsala¹, Rao K. Shankar²
9. The Chemistry of Hair-care Products, JOHN F. CORBETT
First published: August 1976 <https://doi.org/10.1111/j.1478-4408.1976.tb03293.x>
10. Rumsha omar, september 15, 2022 - Glycolic acid on the scalp
11. <https://www.slideshare.net/ouowkw/hair-conditioner-13427429>
12. Tadros TF. Formulation of hair conditioners in shampoos. In: *Formulations: In Cosmetic and Personal Care* [Internet]. Berlin, Boston: De Gruyter; 2016: <https://www.degruyter.com/document/doi/10.1515/9783110452389-012/html>
13. Shipp JJ. Hair-care Products. In: Williams DF, Schmitt WH, editors. *Chemistry and Technology of the cosmetic and Toiletries Industry*. London: Blackie Academic and Professional; 1992. p. 32–54. Gray J. Hair care and hair care products. *Clin Dermatol*. 2001 Apr
14. Deckner G. What makes an effective hair conditioner formulation? [Internet]. Prospector Knowledge Center. 2018 [cited 2021 May 15]. Available from: <https://knowledge.ulprospector.com/8959/pcc-hair-conditioner-formulations>.
15. Leah. The Ingredients Of A Healthy Hair Conditioner [Internet]. [cited 2021 May 15]. Available from: <https://www.arelaxedgal.com/2014/10/healthy-ingredients-of-a-good-hair-conditioners.html>
16. Jennifer M. Stasko, Associate investigator, Dupont, "Determining the effect of on Caucasian Hair when Glycolic acid is used in hair care product" www.univarusa.com
17. Alpha hydroxy acid, www.en.wikipedia.com
18. Nanoscale characterization of human hair and hair conditioners
Author - Bharat Bhushan
19. Conditioning of Hair *By Myra A. Hoshowski*
Effect of rinse-off hair conditioner containing argan oil or camellia oil on the recovery of hair damaged by bleaching, Research ,Published: 25 May 2022, by Si

Hyun Lee & Cheunsoon Ahn

20. Determining the Effects of Glycolic Acid in Hair Care Products Cosmetics & Toiletries
<https://www.cosmeticsandtoiletries.com> › article › dete...
21. Determining the Effects of Glycolic Acid in Hair Care Products, Cosmetics & Toiletries
<https://www.cosmeticsandtoiletries.com/formulas-products/hair-care/article/21836184/determining-the-effects-of-glycolic-acid-in-hair-care-products>
22. Effects of Glycolic Acid on Human Hair Keratin - Christian Allan, Jeffrey Weeks –CrossChem, US, Florence Olechowski, Sabilla Digel PhD – Berg + Schmidt, Germany <https://www.coastsouthwest.com/effects-of-glycolic-acid-on-human-hair-keratin/>
23. <https://www.semanticscholar.org/paper/Determining-the-Effect-on-Caucasian-Hair-When-AcidStasko/4cfb5a2b219ac6c0cb683833db0303e48ddc1713>
24. <https://www.personalcaremagazine.com/formulation-details/2429/hair-conditioner>
25. Nancy Jeffries. Global Hair Care Report: a feel for Innovation. In Hair Care: From Physiology to Formulation, Edited by Angela Kozlowski, Allured Publishing, Carol Stream, Illinois 2008; pp23
26. Formulation and Evaluation of Hair Conditioner S. Lahari* , Shaguftha nazz, A. Sreeja, A. Gouthami, D. Anil, B. Jyothi -
https://ijprajournal.com/issue_dcp/Formulation%20and%20Evaluation%20of%20Hair%20Conditioner.pdf
27. <https://www.semanticscholar.org/paper/Determining-the-Effect-on-Caucasian-Hair-When-Acid-Stasko/4cfb5a2b219ac6c0cb683833db0303e48ddc1713>
28. <https://www.personalcaremagazine.com/formulation-details/2429/hair-conditioner>
29. Nancy Jeffries. Global Hair Care Report: a feel for Innovation. In Hair Care: From Physiology to Formulation, Edited by Angela Kozlowski, Allured Publishing, Carol Stream, Illinois 2008; pp23

FORMULATION AND DEVELOPMENT OF BODY MASK WITH ACTIVE DEAD SEA MUD

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ABSTRACT:

A body mask with active Dead Sea mud offers a mineral-rich skincare experience. The mud, sourced from the Dead Sea, is renowned for its high concentration of salts and minerals. When applied as a mask, it helps exfoliate, detoxify, and nourish the skin, promoting a smoother and more revitalized appearance. The mask's unique properties make it effective for deep cleansing and may contribute to improved skin texture and hydration.

An active dead sea mud-based body mask combines the purifying properties of dead sea mud with the benefits of a body mask. This unique formulation is rich in minerals like magnesium, calcium, and potassium, renowned for their skin-nourishing qualities. When applied, the mask helps in drawing out impurities, unclogging pores, and revitalizing the skin. Additionally, the dead sea mud's exfoliating effect can leave the skin feeling smoother and more radiant, making it a popular choice for spa-like treatments and skincare routines.

KEYWORDS:

Dead Sea Mud Mask, Dead Sea Mud, Body Mask, Clay Mask.

INTRODUCTION:

Body Mask

Masks are cosmetics product which have been used since long ago. Packs & masks are simple mix of chemicals & natural ingredients. colloidal & adsorptive clay & earth which are present in some packs will absorb grease and dirt from the facial skin. The main purpose of packs & masks is to achieve tightening and cleansing effect. Masks are just not for the face but are used all over the body.

You are likely well acquainted with face masks, those intended to unclog pores or for some other benefits, but what about masks for skin below the neck?

The concept of the body masks is simple. The same skincare active ingredients found in your favorite serums and moisturizers (like collagen, charcoal, and niacinamide, or some others) are formulated into larger tubs of beauty goop that's meant to be spread across your arms, legs, décolletage, butt, and elsewhere. Why body masks, you might you ask? Well, whether you're dealing with stubborn body acne, stretch marks, hyperpigmentation, wound healing, ageing or simply want to indulge in a nourishing beauty treatment, the benefits of body masking are actually kind of endless.

Dead sea mud powder

INCI NAME:- Maris limus (Sea Silt Extract)

The main chemical constituents of Dead Sea Mineral Mud Powder are: Dead Sea mud, Organic Matter, and Minerals (expressed in Oxides: Silicon Dioxide, Calcium Oxide, Magnesium Oxide, Sodium Oxide, Potassium Oxide, Iron Oxide, Aluminum Oxide, Phosphorous Pentoxide, Titanium Oxide, Sulfur Trioxide, Manganese Oxide, Zirconium Dioxide, Chromium Oxide, Zinc Oxide, Nickel Oxide, Copper Oxide, Indium Oxide, Chloride, and Bromide).

Dead Sea Mud is the grainy silt obtained from the shores of the Dead Sea. The mud collected is further processed to eliminate sand particles, dirt, etc., till a smooth paste-like solution and after further process the powder is obtained. It contains abundant sources of minerals like calcium, sodium, potassium, magnesium, etc. Color of this mud changes as per season as it is available in light grey color in summer whereas its colors might vary from dark grey to black in summer and rainy seasons.

The presence of natural medicinal properties in this mud powder makes it an essential ingredient to cure numerous skin diseases. Several cosmetic products also use Dead Sea Mud Powder as it does not contain any synthetic ingredients. The different forms of sea mud are added in mud baths, cleansing body and body masks as it has rejuvenating, exfoliating, and cleansing properties. This Mineral-rich salt maintains its reputation for having Soothing, Strengthening, Regenerative properties.

Cosmetic Uses:-

Cosmetically or topically in general, Dead Sea Mineral Mud is beneficial for dry, oily and normal skin types. It removes dead cells from the skin's surface, purges the pores of impurities, and balances the skin's oil production and pH level. While it remains warm and moist, usually for approximately an hour, Dead Sea Mud produces internal heat and stimulates circulation, which reduces the appearance of cellulite. Additionally, it accelerates the skin's detoxification process on the surface and in the tissues by gently drawing out visible and invisible impurities such as air pollution, allergens, dust, and dirt. As the mud dries, it exhibits gentle pulling action that draws out excess oil, tightens, and exfoliates to remove dead skin, which reveals a healthier layer of skin.

Furthermore, it enhances skin elasticity, reduces the appearance of pores, and smooths the appearance of fine lines and wrinkles.

Hair Benefits:

Makes hair thick and shiny, Eliminates excess fat content of hair, Relieves Dandruff, Strengthens the hair follicles and relieves of split ends, Increase scalp blood circulation.

MATERIALS AND METHODS:

Body Mask is prepared by using following ingredients and equipment.

Materials

Stearic acid, Glycerol monostearate, Shea butter, Cocoa butter, Glycerine, Coconut oil, Olive oil, Jojoba oil, Avacado oil, Propylene glycol, EDTA, Niacinamide, Water, Kaoline, Fuller's earth, Salicylic acid, Sepicalm vg, Vitamin E, Aloe Extract, Phenoxyethanol, Dead Sea Mud

List Of Equipment

Mechanical Stirrer, Spatula, Borosilicate Glassware, Weighing Balance, PH Meter, Hot Plate, Brookfield Viscometer, Corneometer.

Method:

Preparation of base formulation:

In any cosmetic preparation it is necessary to have stable formulation before Incorporation of active. Preparation of base formulation is important before incorporation of active ingredient, to prepare a stable cosmetic formulation. The Effectiveness and stability of product was depending upon the compatibility of active ingredients.

Sr.no	Ingredients	F1 For 100%	F2 For 100%	F3 For 100%
1	Stearic acid	1.5%	2%	2%
2	Glycerol monostearate	2%	2%	1.5%
3	Shea butter	1.5%	2%	1.5%
4	Cocoa butter	1.5%	2%	2%
5	Glycerine	2.5%	2.5%	2%
6	Coconut oil	2%	2.5%	3%
7	Olive oil	2%	1.5%	1.5%
8	Jojoba oil	1.5%	2%	2%
9	Avacado oil	1.5%	2%	2%
10	Propylene glycol	4%	3%	2.5%
11	EDTA	0.1%	0.1%	0.1%
12	Niacinamide	0.5%	0.8%	0.8%
13	Water	55.4%	56.3%	58.8%
14	Kaoline	9%	7%	8%
15	Fuller's earth	9%	7%	8%
16	Salicylic acid	0.5%	0.5%	0.5%
17	Sepicalm vg	0.3%	0.5%	0.5%
18	Vitamin E	1%	1%	1%
19	Aloe Extract	2%	2%	2%
20	Phenoxyethanol	0.2%	0.3%	0.3%

Table no.1

Procedure:

1. All the apparatus were cleaned and take all the ingredients as per the formulation of body mask.
2. Weigh all The Ingredients as per the formulation.
3. Heat oil phase upto 60⁰C and water phase upto 75⁰C seperately.
4. Then added oil phase into water phase by slow stirring.
5. Add clays by sprinkling on slow stirring into emulsion.
6. Then the mixture was continuously stirred until Uniform.
7. Half quantity of propylene glycol was added to water phase and remaining quantity of propylene glycol was mixed with salicylic acid for proper mixing and this slurry then added into emulsion.
8. At 45⁰ C added vitamine E oil, Sepicalm vg and Aloe extract.
9. Then added phenoxy ethanol drop by drop.
10. Clay base was stored in suitable container.
11. From the above formulation F2 was found to be most stable hence it was selected.

Parameter of base formulations of Body mask:

Sr. No.	Parameter	F1	F2	F3
1	Appearance	++	+++	+++
2	Colour	+	++	++
3	Consistency	+	+++	+++
4	Spreadability	++	+++	++
5	Feel	+	+++	+++
6	Odour	++	++	++
7	PH	6.4	6.6	6.3

Table no 2

Here, += Good, += Better, +++= Best

From the above observation formula F2 was Stable and it shows consistency, spreadability, and feel therefore it was selected and extract was added with different concentration and forward for in vitro study as per IS and in vivo study with human volunteer.

Final selection of base formulation:

Sr.no	Ingredients	Quantity For 100%
1	Stearic acid	2%
2	Glycerol monostearate	2%
3	Shea butter	2%
4	Cocoa butter	2%
5	Glycerine	2.5%
6	Coconut oil	2.5%
7	Olive oil	1.5%
8	Jojoba oil	2%
9	Avacado oil	2%
10	Propylene glycol	3%
11	EDTA	0.1%
12	Niacinamide	0.8%
13	Water	56.3%
14	Kaoline	7%
15	Fuller's earth	7%
16	Salicylic acid	0.5%
17	Sepicalm vg	0.5%
18	Vitamin E	1%
19	Aloe Extract	2%
20	Phenoxyethanol	0.3%

Table no 3

Parameters of final base Body mask:

Sr. no.	Parameter	Formulation

1	Apperance	+++
2	Colour	++
3	Consistency	+++
4	Spreadability	+++
5	Feel	+++
6	Odour	++
7	pH	6.6

Table no 4

Abbreviation

‘+’= poor, ‘++’=good, ‘+++’= Satisfactory

Form the above table of parameter has required property and has selected as a base formulation.

Formulation with Addition of Active Ingredient

Sr.no	Ingredients	F1 For 100%	F2 For 100%	F3 For 100%
1	Stearic acid	2%	2%	2%
2	Glycerol monostearate	2%	2%	2%
3	Shea butter	2%	2%	2%
4	Cocoa butter	2%	2%	2%
5	Glycerine	2.5%	2.5%	2.5%
6	Coconut oil	2.5%	2.5%	2.5%
7	Olive oil	1.5%	1.5%	1.5%
8	Jojoba oil	2%	2%	2%

9	Avacado oil	2%	2%	2%
10	Propylene glycol	3%	3%	3%
11	EDTA	0.1%	0.1%	0.1%
12	Niacinamide	0.8%	0.8%	0.8%
13	Water	56.3%	56.3%	56.3%
14	Kaoline	7%	7%	7%
15	Fuller's earth	7%	7%	7%
16	Dead sea mud powder	2%	3%	4%
17	Salicylic acid	0.5%	0.5%	0.5%
18	Sepicalm vg	0.5%	0.5%	0.5%
19	Vitamin E	1%	1%	1%
20	Aloe Extract	2%	2%	2%
21	Phenoxyethanol	0.3%	0.3%	0.3%

Table no. 5

Procedure:

1. All the apparatus were cleaned and take all the ingredients as per the formulation of body mask.
2. Weigh all The Ingredients as per the formulation.
3. Heat oil phase upto 60⁰C and water phase upto 75⁰C seperately.
4. Then added oil phase into water phase by slow stirring.
5. Add clays and Dead sea mud powder by sprinkling on slow stirring into emulsion.
6. Then the mixture was continuously stirred until Uniform.
7. Half quantity of propylene glycol was added to water phase and remaining quantity of propylene glycol was mixed with salicylic acid for proper mixing and this slurry then added into emulsion.
8. Then sepicalm vg was added.
9. At 45⁰ C added vitamine E oil and Aloe extract.
10. Then added phenoxy ethanol drop by drop.
11. Perfume Was Added In Required Quantity.
12. Clay Mask with active was stored in suitable container for further study.

Parameter of formulation of Dead Sea Mud Body Mask

Sr. No.	Parameter	F1	F2	F3
1	Appearance	++	+++	+++
2	Colour	+	+++	++
3	Consistency	+	+++	+++
4	Spreadability	++	+++	++
5	Feel	+	+++	+++
6	Odour	++	+++	++
7	PH	6.4	6.6	6.3

Table no 6

Here, += Good, += Better, +++= Best

From the above observation formula F2 was Stable and it shows consistency, spreadability, and feel therefore it was selected and extract was added with different concentration and forward for in vitro study as per IS and in vivo study with human volunteer.

Final formulation of Dead Sea Mud Body Mask

Sr.no	Ingredients	Quantity For 100%
1	Stearic acid	2%
2	Glycerol monostearate	2%
3	Shea butter	2%
4	Cocoa butter	2%
5	Glycerine	2.5%
6	Coconut oil	2.5%
7	Olive oil	1.5%
8	Jojoba oil	2%
9	Avacado oil	2%
10	Propylene glycol	3%
11	EDTA	0.1%

12	Niacinamide	0.8%
13	Water	53.3%
14	Kaoline	7%
15	Fuller's earth	7%
16	Dead sea mud powder	3%
17	Salicylic acid	0.5%
18	Sepicalm vg	0.5%
19	Vitamin E	1%
20	Aloe Extract	2%
21	Phenoxyethanol	0.3%

Table no 7

Parameter of final formulation of Dead Sea Mud Body Mask

Sr. no.	Parameter	Formulation
1	Apperance	+++
2	Colour	+++
3	Consistency	+++
4	Spreadability	+++
5	Feel	+++
6	Odour	+++
7	pH	6.6

Table no 8

Abbreviation

‘+’= poor, ‘++’=good, ‘+++’= Satisfactory

Form the above table of parameter has required property and has selected as a base formulation.

RESULT AND DISCUSSION:

To assure the consistency and quality of the product the analytical parameters play an important role. Analytical Process also gives brief idea about formulation. Mostly Analytical parameters for clay based body masks are pH, Spreadability.

A.In-vitro Evaluation

a)Determination of Physical Parameter

Appearance - Visual appearance of the formulation was observed.

Colour - Colour of the formulation also checked visually.

Consistency - Consistency was also checked whether it feels tacky or not.

Spreadability - If its Spreadable or not.

Result:

Sr. No	Physical parameters	F1	F2	F3
1	Appearance	Smooth Paste	Smooth Paste	Smooth Paste
2	Colour	Light Cream	Cream	Cream
3	Spreadability	Good	Good	Good
4	Consistency	Good	Better	Good
5	Odour	Pleasant	Pleasant	Pleasant

Table no 9

b) Determination Of pH

Body Masks are used for topical application, So their pH should be similar to that of the skin. To Ensure the required shelf life of clay mask, chemical inertness is essential i.e it should neither be too acidic nor too alkaline. Based on above point it was through the standard ph of skin should be in the range of 5.5-7.0. The Skin has acidic mantle and the pH of the body mask as per the standards should be in the range of 5.5 - 7.0

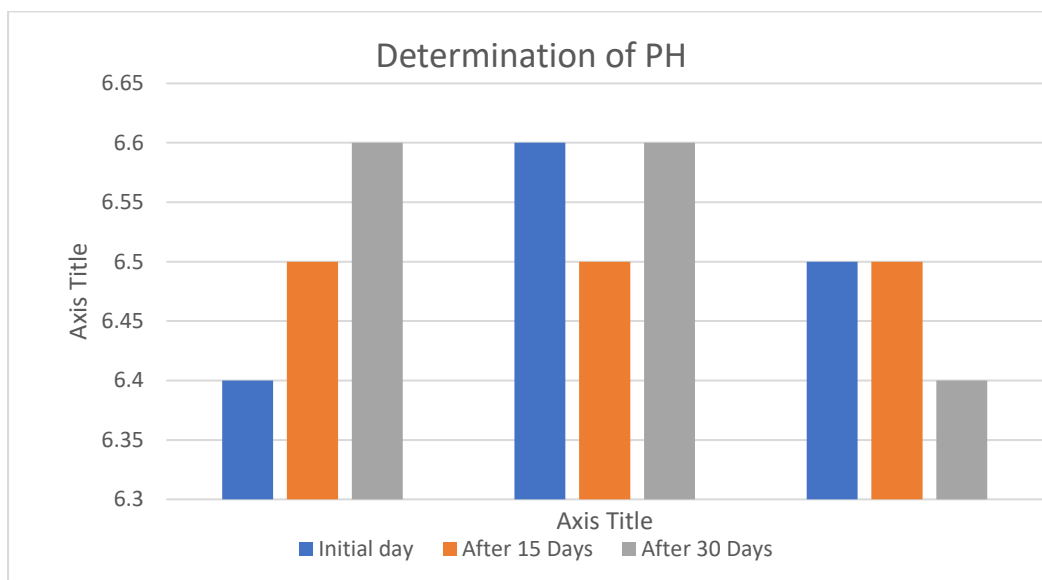
Procedure:- 2gm sample was taken in a 50 ml beaker and 8 ml distilled water was added and stirred. Then pH rod was dipped in the sample and the readings were noted pH was measured at 25°C.

Result:

Sr.No.	Time interval	F1	F2	F3
1	Initial Day	6.4	6.6	6.5
2	15 th Day	6.5	6.5	6.5
3	30 th Day	6.6	6.6	6.4

Table no 10

Determination of pH with graphical representation



From the above graph we can conclude that pH of the product at RT, 5 °C, 45 °C are comparatively equal (the pH Range is acceptable) In three Months as compares to initial value. The Product passed in PH value.

c) Determination of Spreadability Time:

Principle:- It is very important for any cosmetic product that after application the product must be easily spread over the skin. Spreadability is affected by many factor such as temperature, viscosity etc. The spreading time must be very less. The apparatus consists of a wooden block, with a movable glass slide with one end tied to weighted pan rolled on pulley.

Procedure:- 2 Gm Of sample was placed on a surface. A slide was placed on a surface. A slide was attached to a pan to which 20 gm of weight was added. The time seconds required to separate the upper slide from surface was taken as a measure of spreadability.

Result:-The product has good feel with excellent spreadability.

d) Accelerated Stability Studies

The purpose of stability testing of cosmetic product is to ensure that a new or modified products meets the intended physical, chemical quality standards as well as functionality and aesthetics when stored under appropriate conditions.

Because the development cycle of cosmetic manufacturer should design their products is relatively short each own stability testing program economically reasonable and efficiently address the testing required.

Because of the wide variety of cosmetic products 'standard' stability test cannot be prescribed. Manufacturers require the flexibility to modify testing protocols and to build a sound scientific basis for assessing stability of their own products. Thus, specific tests may be developed in order to be adapted to products having extended shelf lives. Stability tests can be conducted in real time or under accelerated conditions and should address the stability of a product under appropriate condition of storage, Transport and use.

Basically, there are three forms of stability tests:

Physical and chemical integrity tests which evaluate color, odour, pH value, Texture, flow and stability, Microbiological stability tests which evaluate the degree of contamination with bacteria, mold and yeast and packaging stability tests which evaluate the impact of packaging on the contained product.

Physical and Chemical Stability tests

This describe to approaches to predicting how well cosmetics will resist common stresses such as temperature extremes and light. Typically, manufacturers determine whether to perform such specialized testing based on the vulnerabilities of the particular cosmetics products and its anticipated shipping, storage, display and use condition.

Common test Procedures include :

1. Temperature Variations:

High temperature testing is now commonly used as a predictor of long term stability. Most Companies Conduct their high temperatures testing at 37° C. and 45°C. If a product is stored at 45 °C. for three months (and exhibits acceptable stability) then it should be stable at room temperature for three months and for excellent stability product must be stored at 25° C for a period of two years. The product should also be subjected to - 5 °C for three months.

2. Freeze Thaw Stability testing :

During Transportation of cosmetic products, it is uncommon for them to encounter extreme temperature conditions, such as freezing or over -Heating, thus it is necessary for cosmetic products to be able to withstand a certain degree of temperature changes in transport. Freeze thaw cycle testing is a part of stability testing that allow you to determine if your formula will remain stable under various conditions. This type of test puts your sample through a series of extreme, rapid temperature changes that it may encounter during normal shipping and for liquid based cosmetics.

These products may experience phase separation that can negatively may experience phase separation that can negatively affect the intended function.

Procedure:-Freeze thaw testing is conducted by exposing the product to freezing temperatures (approximately sssss. 10° C) for 24 hrs, and then allowing it to thaw at room temperature for

24 hrs. The Sample is then Placed in a higher temperature (approximately 45 ° C) for 24 hrs. The Sample is then analysed for significant changes are observed, you can be confident that the stability of product is sufficient for transport.

Report of Accelerated Stability Studies:

❖ Freeze thaw Cycle

Representation of freeze thaw cycle

Temperature	Cycle 1	Cycle 2	Cycle 3
RT	NC	NC	NC
5 ⁰ C	NC	NC	NC
45 ⁰ C	NC	NC	NC

NC= No Change

Table no 11

Result: From the above chart we can conclude that the product has passed the Freeze - Thaw cycle. It includes the appearance, Colour and odour of the product at RT, 5° C, 45° C.

❖ Temperature Variation test (Thermal stability test)

Result: From the above three graphs and freeze- thaw cycle, we can conclude that the product has passed thermal stability test. Because at all the temperatures the product remains constant in pH, Appearance and spreadability as well as in colour and odour.

e) Determination of viscosity

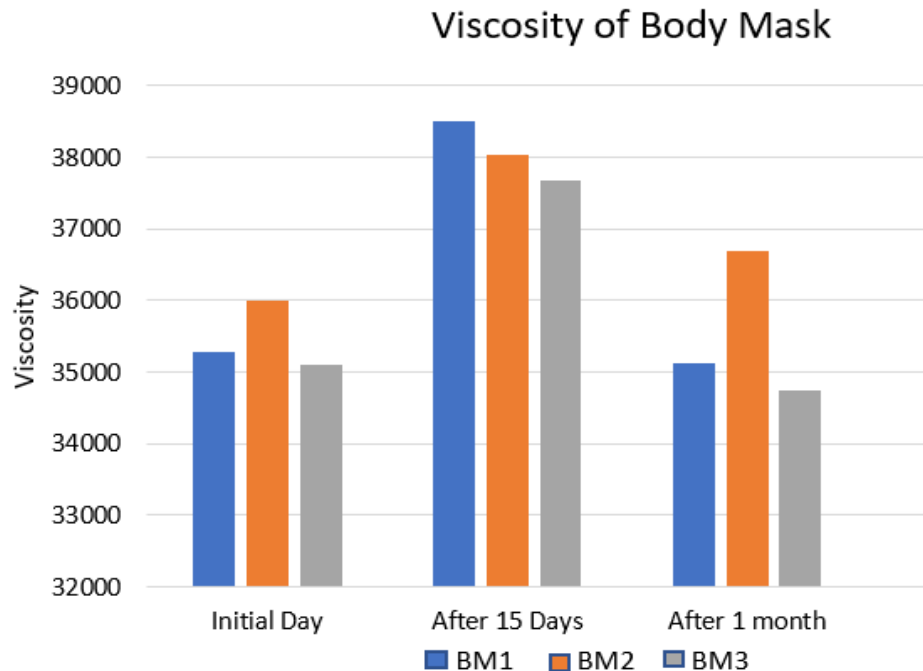
The viscosity of Body mask determine by using Brookfield Viscometer.

The values obtained from the sample noted.

Sr. No	Intervals	BM1	BM2	BM3
1.	Initial Day	35280cp	36010cp	35100cp
2.	15 th Day	38500cp	38040cp	37680cp
3.	30 th Day	35120cp	36700cp	34750cp

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Table no 12



B. In-vivo Evaluation

a) Determination of Patch Test

Patch test was performed on sensitive part of skin , eg. Blend of elbow. Popliteal space of skin behind ears. The Cosmetic was tested by applying to an area of 1sq. cm of skin. Central patches were also applied. The site of the patch was inspected after 24 hrs. There were no reactions and then test was repeated once more on the same side Since there was no reaction as the person was considered as not hoper sensitive and product pass the test.

Patch testing is usually used to detect allergic reactions to substances such as poisonous. ie. household chemicals, metals and their substances. It May be also be used to diagnose food allergies. Using this technique, we can test for allergies to as many as 60 different substances at the same time.

The test is very simple and accurate. First we will examine and clean the area to be tested . which is usually the upper back. Small samples of potential allergens are placed on our skin, and secured with a waterproof, medical tape. The patches well sealed, so they should not interfere with normal daily activities.

We will examine the tested skin and record data after you have worn the patches for 48 hrs and again 72 hrs. The information collected will help us determine if allergies to an of the tested substances are likely to be responsible for your symptoms.

Patch testing is painless,and causes minimal discomfort. However. You may experience itching under the patch. If you are allergic to any of the tested substances you may develop redness, small welts,or ocassionally small blisters. However, these are easily treated because a very small amount of the allergen is applied, and the area of contact is carefully confined by the

small patch. A Reaction to the patch test is a very good indication that we have identified the source of the problem, which is the most important step in solving.

Patch test for Clay mask:

N.R= No Reaction

Sr. No	Parameter	F1	F2	F3
1	Immediate after removal of product	NR	NR	NR
2	After 24 hours	NR	NR	NR
3	After 48 hours	NR	NR	NR

Table no 13

b) Photographic Evaluation:



Before Application



After application



c) Determination of moisture content of skin by corneometer

NOTE:- Only the best batch out of the three batches is tested by corneometer.

Principle: Corneometer is a device which is equipped with a moisture sensitive probe which is used to determine the accurate moisture content of stratum corneum. Hence it plays an important role in determining the moisturizing activity of a product on stratum corneum after its application on skin.

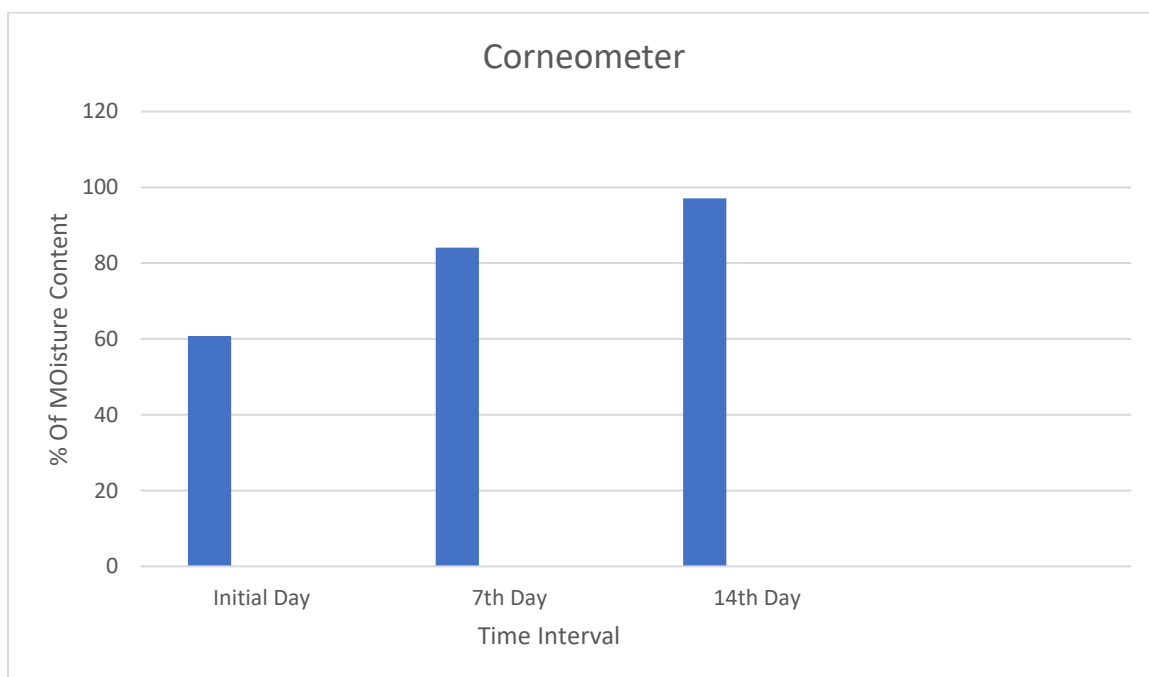
Apparatus: Corneometer equipped with a probe.

Procedure: The volunteers were selected and the probe of the corneometer was applied to the selected part of the skin before application of the product and the reading was recorded. Then the selected part of the skin was rinsed with water, allowed to dry properly, and again the probe was applied to the skin and the reading was recorded. The volunteers were allowed to wash the selected area of skin after application of the product twice a day, and then the same procedure was followed for 14 days. Within these intervals, the readings were recorded after 7th days and then finally on 14th days, and the graphs were plotted.

Result:

Sr. No.	Time Interval	% of Moisture Content
1	Intial	60.8
2	After 7 Days	84.1
3	After 14 Days	97.1

Table no 14



Analysis of Moisture Content using Coreometer:

The moisturising activity was carried out by using coreometer. It was observed that before application of body mask, the moisture content of skin was less and after application of body mask moisture content was increased.

CONCLUSION:

A body mask enriched with active Dead Sea mud presents a holistic skincare solution. With its potent blend of minerals, the mask offers deep cleansing, exfoliation, and nourishment for the skin. The application of this mud mask can contribute to a revitalized and smoother complexion, showcasing the benefits of harnessing the natural elements found in the Dead Sea for a luxurious and effective skincare experience. Furthermore, the mask's ability to detoxify

and hydrate the skin adds to its appeal, making it suitable for various skin types. Regular use may assist in promoting overall skin health, addressing issues such as impurities and uneven texture. The incorporation of active Dead Sea mud in a body mask aligns with a natural, mineral-driven approach to skincare, providing users with a rejuvenating and spa-like experience from the comfort of their own routine.

REFERENCES:

1. "Skin Cosmetics" in Ullmann's Encyclopedia of Industrial Chemistry, Wiley-VCH, Weinheim. doi:10.1002/14356007.a24_219
2. MASK AND SCRUB FOR FACE AND BODY by Dr. Javed Ali 2017
3. WWW.WEKIPIDIA.COM
4. Bonifant H, Holloway S. A review of the effects of ageing on skin integrity and wound healing. *Br J Community Nurs.* 2019 Mar 01;24(Sup3):S28-S33. [PubMed]
5. Laguens M, Rendon MI, Reeves WH. The effects of a new transdermal hydrating and exfoliating cosmetic body mask in the maintenance of skin. *Cosmetic Dermatol.* 2010;23(8):3
6. K. Sukenik, Balneotherapy for rheumatic diseases at the Dead Sea area, *Isr. J. Med. Sci.* 32, S16-S19 (1996).
7. Sutthiparinyanont S, Banpot C, Kumsuwan V, Kajthunyakarn W, Srisuk P, Chitropas P. Formulation and evaluation of facial mask from gelatinous pulp of Dillenia fruit. *Isan J Pharm Sci.* 2013;9(1):19820
8. Adams LK, Lyon DY, McIntosh A, Alvarez PJ. Comparative toxicity of nano-scale TO₂, SiO₂, and no water suspensions. *Water Science and Technology.* 2006;54:327-334. Altaner SP, Ylagan RF. Comparison of structural models of mixed-illite-smectite and reaction mechanisms of smectite illitization. *Clays and Clay Minerals.* 1997;45:517-533 Amofah G, Sagoe-Moses C, Adjei-Acquah C, Frimpong EH. Epidemiology of Buruli ulcer in Amansie *Tropical Medicine and Hygiene.* 1993;87:644-645
9. Arcasoy A, Cavdar AO, Babacan E. Decreased iron and zinc absorption in Turkish children with iron deficiency and *Haematologica.* 1978;60:76-84. Aufreiter geophagia. *Acta Hancock RGV, Mahaney WC, Stambolic-Robb A, Sanmugasdas K. Geochemistry and mineralogy of soils eaten by humans. International Design Development and Evaluation of Clay Mask Journal Nutrition.* 1997;48:293-305.
10. Elmore AR, Cosmetic Ingredient Review Expert Panel (2003). Final report on the safety assessment of aluminum silicate, calcium silicate, magnesium aluminum silicate, magnesium silicate, magnesium trisilicate, sodium magnesium silicate, zirconium silicate, attapulgite, bentonite, Fuller's earth, hectorite, kaolin, lithium magnesium silicate, lithium magnesium sodium silicate, montmorillonite, pyrophyllite, and zeolite. *Int J Toxicol,* 22 Suppl 1:37- 102.
11. Mitchell NJ, Kumi J, Aleser M, et al. (2014). Short-term safety and efficacy of calcium montmorillonite clay (UPSN) in children. *Am J Trop Med Hyg,* 91:777-85.
12. S. Halevy, H. Giryas, M. Friger, and S. Sukenik, Dead Sea bath salt for the treatment of psoriasis vulgaris: A double-blind controlled study, *J. Eur. Acad. Dermatol. Venereo.*, 9, 237-242 (1997).
13. Carretero MI, Pozo M. Clay and non-clay minerals in the pharmaceutical and cosmetic industries Part I. Active ingredients. *Appl Clay Sci.* 2010;47:171-81.

14. Carretero MI, Pozo M, Legido JL, Fernández-González MV, Delgado R. Gomez I, et al. Assessment of three Spanish clays for their use in pelotherapy. *Appl Clay Sci.* 2014;99:131-43. Khiari I, Meftch S. Sánchez-Espejo R, Cerezo P, Aguzzi C, López-Galindo A, et al. Study of traditional Tunisian media clays used in therapeutic and cosmetic mud-packs. *Appl Clay Sci.* 2014;101:141-
15. Carretero MI, Pozo M. Clay and non-clay minerals in pharmaceutical industry: part I. Excipients and medical applications. *Appl Clay Sci.* 2009;46(1):73-80. Zhang D, Zhou C, Lin C, Tong D, Yu W. Synthesis of clay minerals. *Appl Clay Sci.*
16. Carretero MI. Clay minerals and their beneficial effects upon human health. a review. *Appl Clay Sci.* 2002;21:1 55-63 Carretero MI, Legaly G. Clays and health: an introduction. *Appl Clay Sci.* 2007;36:1-3.
17. Bergaya F, Lagaly G. General introduction: clays, clay minerals, and clay science. In: Bergaya F, Theng BKG, Lagaly G. *Handbook of clay science.* Amsterdam: Elsevier; 2006. p. 1-18 16. Mores JDD, Bertolino SRA, Cuffini SL, Ducart DE, Bretzke PE, Leonardi GR. Clay minerals: properties and applications to dermocosmetic products and perspectives of natural raw materials for the therapeutic purposes - a review. *It J Pharm.* 2017;534:213-9
18. Viseras C, Aguzzi C, Cerezo P, Lopez-Galindo A. Uses of clay minerals in semisolid health care and therapeutic products. *Appl Clay Sci.* 2007;36:37-50.
19. Z. Maor, S. Yehuda, S. Magdassi, G. Meshulam-Simon, Y. Gavrieli, Z. Gilad, and D. Efron, Cream composition comprising Dead Sea mud, US Patent 6582709 (2003).
20. López-Galindo A, Viseras C, Cerezo P. Compositional, technical and safety specifications of clays to be used as pharmaceutical and cosmetic products. *Appl Clay Sci.* 2007,36:51-63.

The Persimmon fruit extract: Its Dermatological and Cosmetics Benefits

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Abstract

Persimmon is fleshy fibrous tropical, deciduous fruit belonging to *Ebenaceae* family. It is commonly cultivated in warm regions of the world including China, Korea, Japan, Brazil, Turkey, and Italy. In 2007, the global production of persimmon reached over 3.3 million tons, with 70.0 % from China, 10.0 % from Korea and 7.0 % from Japan. The persimmon is not so popular in European communities but its demand is increasing owing to consumer's awareness regarding its hidden health promoting potential. Mediterranean region is also suitable for persimmon production that has reached up to 110,000 tons.⁽¹⁾

Generally, over 400 species of persimmon are planted globally. Among these, *Diospyros kaki*, *Diospyros virginiana*, *Diospyros oleifera*, and *Diospyros lotus* are of significant importance. It is interesting that *D. kaki* (Japanese persimmon) is the most promising specie. The popular varieties grown in Japan.⁽¹⁾

Diospyros kaki belonging to family Ebenaceae, commonly known as persimmon is used as a medicinal plant in Chinese traditional medicine since many years for different ailments including cosmetics and dermatologic applications. Traditionally this plant is used to treat different skin conditions including pimples, skin eruptions and eczema. Present interest has been focused toward use of natural bioactive compounds in various curative and beautifying applications in dermatological and cosmeceutical disciplines.⁽²⁾

1. Introduction

A potent antioxidant and loaded with vitamins, Persimmon Extract has traditionally been used in Japan for its naturally purifying and deodorizing benefits. This prized, natural ingredient is particularly effective in eliminating Nonenal, the source of hormonal imbalance or aging body odor, leaving skin squeaky clean and freshly hydrated.⁽³⁾

Persimmon is enriched with many nutritious and bioactive components including proteins, sugar, lipids, vitamin A, vitamin B6, vitamin B12, vitamin D, ascorbic acid(AA), Vitamin E polyphenols, flavonoids and carotenoids. Elemental micronutrients present in persimmon fruit include potassium, sodium, iron, calcium and many others. The fruit have been used as a key ingredients in some marketed cosmetic products including soaps, deodorizing and purifying body lotion, body wash, skin toner and body serum (Mirai Clinical, 2017). Different reviews have been published about reported pharmacological activities and phytoconstituents profile of various parts of this plant, with very limited or no emphasis on its potential use in dermatology and cosmetics. This review describes available data about potential utilization of different parts of *D. kaki* and its bioactive phytoconstituents in different dermatological and cosmeceutical applications.⁽²⁾

Scientific data has revealed an excellent position of *D. kaki* in both dermatology and cosmetic discipline making it a valuable choice in respective field. Active principles from different plant parts have shown to possess anti-inflammatory, antiallergic, photo-protective, deodorant and anti-wrinkle effects with appreciable activities against tyrosinase, elastase, and collagenase enzymes. Promising antioxidant activity and skin whitening potential, augmented by reduction in sebum contents, and reduction in size and number of skin pores make it a suitable choice as cosmetic ingredient. Data has been summarized and presented on available molecular mechanism that can contribute toward phytoconstituents usage in cosmetics and dermatology mediated by different cellular pathways. Crude extracts and some of phytochemical obtained from this plant such as isoquercitrin and hyperin have better reported activities than well-known cosmetic ingredients viz., arbutin, kojic acid and hydroquinone with possibility of having no side effects. Photo protection against degenerative effects of UVA, UVB and gamma radiation can help skin to fight well against oxidative stress and reactive oxygen species.^[4] Further investigation need to be directed toward human subjects for evaluation of these reported activities for obtaining optimum commercial and industrial benefits from this valuable plant.^[2]

2. Phytochemicals of and cosmetics interest obtained from *Diospyros kaki*

2.1 Phenolic acids

Phenolics (or phenolic acids) are widely distributed aromatic secondary metabolites in plant kingdom. They contain an aromatic hydrocarbon and one or more than one functional hydroxyl (or carboxylic acid) group attached to it.^[16-17] They can be categorized into simple phenols bearing one phenol unit or polyphenols having multiple phenol units in chemical structure. They perform a range of different functions in plants and human being including structural maintenance and protection against oxidative stress disorders such as coronary heart disease, stroke and cancer.^{[23] [28][31][34-35]}

2.2 Flavonoids

Flavonoids, also called bioflavonoids are naturally occurring secondary metabolites of botanical origin having a general structure of 15-carbon skeleton comprised of two phenyl rings and one heterocyclic ring. More than 8000 phytoconstituents have been identified with this characteristic flavonoid structure. Basic benzo- γ -pyrone ring is subjected to different combinations of hydroxyl, methoxyl, and *O*-glycosyl group substituents resulting in numerous individual flavonoids.^{[22][29-30]}

Flavonoids are further classified into twelve different subgroups, however six of them have gained a significant dietary importance, including anthocyanidins, flavan-3-ols, flavonols, flavones, flavanones, and isoflavones^[33-34]. In *D. kaki* following examples are found in different parts of the tree including (I) anthocyanidins *e.g.* cyanidin, (II) flavan-3-ols *e.g.* (+)-catechin, (-)-epicatechin and (-)-epigallocatechin, (III) flavonols *e.g.* kaempferol (H), quercetin and their glycosides.^[12-14]

2.3 Carotenoids

[Carotenoids](#) are colored, fat soluble [pigments](#) generated as secondary metabolites in fruits, vegetables, [algae](#), [fungi](#), and some [microbes](#). Most important carotenoids include [beta-carotene](#), lycopene, lutein, and zeaxanthin. Carotenoids can be categorized into two groups *i.e.*, “xanthophylls” which are oxygenated carotenoids and “carotenes” being non-oxygenated. Approximately 700 carotenoids have been identified with around 100 being considered for their dietary benefits. They have wider applications in food, cosmetics and [nutrition](#) because of their color producing tendency and [free radical](#) scavenging activity. Peroxyl radicals, singlet molecular oxygen and superoxide anions are the major ROS formed in human skin exposed to UV [irradiation](#), which may result in [degradation](#) of lipids, proteins and [nucleic acids](#). Such degradation outcomes in various skin pathological conditions such as erythema, [pre-mature](#) skin aging and even dermatological [carcinomas](#). β -Carotene also known as “provitamin A” which resides in the skin imparting a golden yellow color, have no doubt a selective cosmetic value. Lutein and zeaxanthin provide protection to [retina](#) against oxidative damage to UV light. Lycopene can reduce erythema induced by UV light. ^{[19][24]}

2.4 Hydrolysable tannins

Another group of bioactive phytoconstituents present in persimmon are tannins. Tannins are comprised of either gallic acid subunits (e.g. hydrolysable tannins), flavone subunit (non-hydrolysable or condensed tannins) or phloroglucinol subunits (phloro-tannins)^[5]. Tannins from different sources have been studied for their [antiviral](#), antioxidant, pediatric [dermatoses](#), anti-inflammatory and radioprotective effects. Tannins have been used medically for many years and their importance in dermatological application have gained significant importance because of their [astringent](#) effects, management of superficial skin conditions, weeping, inflammation and itching with acceptable tolerability. ^{[10][32]}

Astringent feeling upon eating persimmon fruit is due to soluble tannins which are released from tannin vacuoles making complex with protein in [oral cavity](#). When these tannins are transformed into insoluble form, the fruit [loses](#) its astringent nature considerably. In persimmon major tannin present include flavanoellagitannin (molecule of [flavan-3-ol](#) attached with hydrolysable tannin through C-C linkage), procyanidinoellagitannin (proanthocyanidins and ellagitannins) and their degraded products such as gallo-catechin, catechin, catechin-gallate and galocatechin-gallate.^[25-27]

2.5 Terpenoids

Different triterpenoids have been separated from leaves of *D. kaki* including ursolic acid, 19-hydroxy ursolic acid and 19,24-dihydroxy ursolic acid, which demonstrated suppressive activity against stimulus induced super oxide generation and tyrosyl phosphorylation. Other terpenoids reported from leaves of *D. kaki* include lupeol, betulinic acid, betulinic acid (Yoshihira et al., 1971) and pomolic acid (Thuong et al., 2008). Coussaric acid and betulinic acid have been separated from leaves of persimmon plant. ^[18]

2.6 Ascorbic acid, vitamins A, D and E

Ascorbic acid (AA) is hexuronic acid lactone micronutrient being lipophobic in its nature. It cannot be synthesized by human being and hence should be supplied externally from food. AA performs different biochemical functions inside the body including synthesis and maintenance of collagen, immunostimulant, anti-aging, and skin rejuvenating agent, skin whitening effects, neuromodulator, anti-oxidant, free radical scavenger and antiviral. In the skin AA plays a vital role as a substrate for oxidative stressors and hence prevents damage to skin caused by ROS and other reactive oxidants produced as a result of UV exposure.^{[15][36-37]}

3. Dermatological and Cosmetics Benefits

3.1 Anti-inflammatory effects

Inflammation is a vital immune mechanism of innate immunity that protects body against various harmful factors. Inflammation is usually mediated by different exogenous and endogenous stimuli that may activate cellular immune system, which intern can produce some pro-inflammatory cytokines. Cyclooxygenase-2 (COX-2) in human skin, is a main key player in UV-induced inflammation, wrinkle formation, edema, epidermal hyperplasia and carcinogenesis. Antiallergic properties and potential use in prevention of dermatitis Skin is the largest protective organ at the interface between host and environment. It protects from pathogens as a physical barrier and defends our body against different allergens by activating immune system. Mast cells are widely distributed in mammalian tissues and play an important role in regulation of allergic inflammation in different immune mediated disorders. Mast cells upon activation can release histamine and other inflammatory mediators. Dermatitis is a common skin condition characterized by inflamed, red, itchy skin that may become blistered and weepy.^[11]

3.2 Antiallergic properties and potential use in prevention of dermatitis

Skin is the largest protective organ at the interface between host and environment. It protects from pathogens as a physical barrier and defends our body against different allergens by activating immune system. Mast cells are widely distributed in mammalian tissues and play an important role in regulation of allergic inflammation in different immune mediated disorders. Dermatitis is a common skin condition characterized by inflamed, red, itchy skin that may become blistered and weepy. There are different types of dermatitis and all of them are precipitated onto the skin by reacting with allergens or irritants. When allergens or irritants become in contact with skin, they may lead to a skin reaction, this condition is termed as contact dermatitis. A skin damage is usually seen with an irritant while an allergen initiates immune response advancing to allergic reaction. Atopic dermatitis or eczema occurs due to hypersensitivity to certain types of food (*e.g.* cow's milk) and/or allergens. Neurodermatitis is because of irritation to nerve endings down the skin, leading to sever itchy sensation and an irresistible desire to scratch the skin repeatedly resulting in thickening and redness of the skin.^[38]

3.3 Anti-radiation activity (protection against photo damage)

Electromagnetic radiation emitted from sun, is comprised of ultraviolet radiation (UVR; 200–400 nm), visible light (400–780 nm), and infrared (IR; 780 nm to 1 mm). International commission on illumination (CIE) divides UVR into three categories: UVA (315–400 nm), UVB (280–315 nm) and UVC (100–280 nm).^[6] UVC portion being most dangerous for skin, is entirely absorbed by the upper atmospheric layers. Human body needs a very limited UVA and UVB photons for vitamin D synthesis, longer exposure to UVR may lead to various skin abnormalities including photoaging and photocarcinogenesis through production of ROS, DNA damage, immunosuppression, photo-inflammation.

Polyphenol enriched extracts have been evaluated for their efficacy toward skin cancer with greatly promising outcomes indicating their potential role in preventing or curing different skin cancer condition.^[7-9]

3.4 Effects on sebum contents, oil contents, number and size of skin pores

Excessive sebum production and accumulation on the skin may increase the skin pore size. An effective skin cleanser is capable to reduce skin pore size by reducing production rate of sebum and promoting its removal from skin, hence reducing chances of comedones development. Careful face washing helps improve skin lesions and prevents acne development by washing away excessive sebum and avoiding hairfollicular obstruction. Many cosmetic ingredients used in skin cleansers have some unwanted effects, such as sodium lauryl sulphate may irritate the skin. Similarly, retinoid and its derivatives are known to be severe local skin irritants. Natural products usually have lesser side effects, that is why cosmetics industry is going through a shift from synthetic to natural cosmetic ingredients.^[20-21]

Extract from *D. kaki* folium, *Polygonum cuspidatum*, and *Castanea crenata* (DPC) loaded to cosmetic cleanser formulation was evaluated for its effects on skin parameters including number and size of skin pores and removal of sebum from the skin in 23 healthy volunteers. On application of test formulation containing DPC extract, oil contents decreased by 77.3%, number of skin pores were reduced by 24.83% and skin pore size was reduced by 71.43% as compared to the control formulation. The preparation was also capable to remove solidified sebum from skin and can facilitate removal of Demodex mites (causative microbe for rosacea and seborrheic dermatitis) from the skin. Further studies can be directed for evaluation of different formulation containing persimmon extract for their effects on other skin parameters using non-invasive *in-vivo* evaluation techniques.^[39]

3.5 Inhibition of melanogenesis (skin whitening effects)

Skin color is usually determined by four chromophoric substances known as carotenoids, hemoglobin, oxyhaemoglobin and melanin, the last being most abundant relatively. Melanin is produced by melanosomes which are present in the skin, eyes, inner ear, and hairs. In human being pigmentation may increase as a result of UV or solar light exposure to the skin, which in turn, stimulates melanin production by melanosomes. Melanin provides protection against UV radiations, skin burn and cancer. Melanogenesis is the production of melanin from melanocytes in basal epidermal layer. Every individual usually

have a particular number of melanocyte, however the skin color is not determined by the number of melanocytes, rather its being determined by melanin producing genes.⁽²⁾

3.6 Collagenase and elastase inhibition (prevention of wrinkle formation)

Collagen represents 30% of total protein in man with almost same weightage in other animals. Collagen can exist in 27 different types however, type I, II, and III are most prominent in man, comprising approximately 80–90% of total collagen in the body. Some body organs are relatively richer in collagen type-I including dermis, bones, tendon, and ligament while skin, blood vessels and intestine are enriched with type-III. In the skin collagen may be degraded by aging or by activity of collagenase, producing wrinkles. Collagen is produced by mature cells called fibroblasts. Firstly, procollagen is produced by fibroblasts, which is subjected to different modifications including proline and lysine hydroxylation. Cross linkage occurs as a result of proline hydroxylation producing strong collagen fibers.^[40]

Skin aging is usually estimated by wrinkles on the face. So extract of *D. kaki* can be used in cosmetic preparation as a natural whitening and anti-wrinkle agent. Persimmon leaves have long been used in Chinese medicines to treat different skin conditions traditionally including pimples, skin eruption and eczema. These traditional uses can be appreciated momentarily by cosmetic and dermatological beneficial profile of *D. kaki*.^[41]

3.7 Potent antioxidant activity

Skin aging being a dynamic process depends on both intrinsic and extrinsic factors, resulting in various skin changes at both esthetic and functional levels. Two distinct mechanism of skin aging are chronological aging (determined genetically) and photoaging due to repeated exposure to UV light resulting in microscopic changes in stratum corneum. UV radiations results in generation of ROS leading to oxidative damage and oxidative products which are indicators of oxidative stress. Skin damage caused by ROS is the major factor driving toward photoaging. Skin, acting as a physical barrier between internal body and environment, is also a major target for oxidative stress. It contains numerous biochemical molecules which are prone to oxidative damage induced by ROS, including lipids, proteins, carbohydrates, and DNA. UV radiation exposure is a major contributory factor in photoaging, so preventive strategies may include avoiding sun light exposure or by maintaining cellular redox balance caused by UV radiations. In both cases, i.e. chronological aging or photoaging, utilization of different antioxidants in various skin care products has produced promising result.^[25]

Food, especially fruits are a major source of antioxidants for the body. Persimmon fruits is enriched with many antioxidants including polyphenols, phenolic acids, flavonoids, carotenoids, tannins, proanthocyanidins, catechin, vitamins and others. Many reports have been published indicating potent radical scavenging activity of crude extracts and their purified fraction from different parts of *D. kaki*, and their effects on different biological functions have well been established. The antioxidants obtained from *D. kaki* have capability of scavenging ROS, hydroxyl ion radicals, superoxide radicals, peroxy radicals, singlet molecular oxygen species and shows metal chelating activity. Flavonoids from leaves can increase levels of catalase, super oxide dismutase, and glutathione peroxidase in a manner

better than rutin. Total antioxidant activity and total phenolic contents in persimmon were significantly higher than that of apple, grapes and tomato.^[42]

4. Conclusion

- From the above study it could be concluded that Persimmon fruit extract have shown to possess anti-inflammatory, antiallergic, photo-protective, and anti-wrinkle effects with appreciable activities against tyrosinase, elastase, and collagenase enzymes.
- Crude extracts and some of phytochemical obtained from this plant such as isoquercitrin and hyperin have better reported activities than well-known cosmetic ingredients viz., arbutin, kojic acid and hydroquinine with possibility of having no side effects. Photo protection against degenerative effects of UVA, UVB and gamma radiation can help skin to fight well against oxidative stress and reactive oxygen species.
- It could also be concluded that this extract has many cosmetics properties and could be used in various types of products such as:
 - Antiallergic products
 - Sunscreens
 - Skin whitening creams
 - Anti-wrinkle preparation
 - Deodorant preparations

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REFERENCES

1. Achiwa Y, Hibasami H, Katsuzaki H, Imai K, Komiya T. Inhibitory effects of persimmon (Diospyros kaki) extract and related polyphenol compounds on growth of human lymphoid leukemia cells. Biosci Biotechnol Biochem. 1997;61:1099-101.
2. Ahn HS, Jeon TI, Lee JY, Hwang SG, Lim Y, Park DK. Antioxidative activity of persimmon and grape seed extract: in vitro and in vivo. Nutr Res. 2002;22:1265-73.
3. Akagi T, Ikegami A, Yonemori K. DkMyb2 woundinduced transcription factor of persimmon (Diospyros kaki Thunb.), contributes to proanthocyanidin regulation. Planta. 2010;232:1045-59.

4. Akter MS, Ahmed M, Eun JB. Effect of blanching and drying temperatures on the physicochemical characteristics, dietary fiber composition and antioxidant related parameters of dried persimmons peel powder.
5. Int J Food Sci Nutr. 2010;61:702-12. Akyıldız A, Aksay S, Benli H, Kiroğlu F, Fenercioğlu H. Determination of changes in some characteristics of persimmon during dehydration at different temperatures. J Food Eng. 2004;65:95-9.
6. Antman EM, Jessup M. Clinical practice guidelines for chronic cardiovascular disorders: a roadmap for the future. JAMA. 2014;311:1195-6. Arnal L, Besada C, Navarro P, Salvador A. Effect of controlled atmospheres on maintaining quality of persimmon fruit cv
7. Rojo Brillante. J Food Sci. 2008;73: S26-30. Asgar MA, Yamauchi R, Kato K. Modification of pectin in Japanese persimmon fruit during the sundrying process.
8. Food Chem. 2003;81:555-60. Aviram, M. Modified form of low density lipoprotein and atherosclerosis. Atherosclerosis. 1993;98:1-9. Bae DK, Choi HJ, Son JH, Park MH, Bae JH, An BJ, et al.
9. The study of developing and stability of functional beverage from korean persimmon (*Diospyros kaki* L. folium) leaf. Korean J Food Sci Technol. 2000;32:860-6. Baldrick FR, Woodside JV, Elborn JS, Young IS, McKinley MC.
10. Biomarkers of fruit and vegetable intake in human intervention studies: a systematic review. Crit Rev Food Sci Nutr. 2011;51:795-815. Barry TN, Allsop TF, Redekopp C. The role of condensed tannins in the nutritional value of *Lotus pedunculatus* for sheep.
11. Effects on the endocrine system and on adipose tissue metabolism. Br J Nutr. 1986;56:607-14. Basta G, Schmidt AM, De Caterina R. Advanced glycation end products and vascular inflammation: implications for accelerated atherosclerosis in diabetes. Cardiovasc Res. 2004;63:582-92.
12. Baxter GF, Sumeray MS, Walker JM. Infarct size and magnesium: insights into LIMIT-2 and ISIS-4 from experimental studies. Lancet. 1996;348:1424-6. Bei W, Peng W, Ma Y, Xu A. Flavonoids from the leaves of *Diospyros kaki* reduce hydrogen peroxide induced injury of NG108-15 cells. Life Sci. 2005;76: 1975-88.
13. Bibi N, Khattak AB, Mehmood Z. Quality improvement and shelf life extension of persimmon fruit *Diospyros kaki*. J Food Eng. 2007;79:1359-63.
14. Bravo L, Saura-Calixto F, Goni I. Effects of dietary fibre and tannins from apple pulp on the composition of feces in rats. Br J Nutr. 1992;67:463-73. Bubba MD, Giordani E, Pippucci L, Cincinelli A, Checchini L, Galvan P.
15. Changes in tannins ascorbic acid and sugar contents in astringent persimmons during on-tree growth and ripening and in response to different postharvest treatments. J Food Comp Anal. 2009;22:668-77. Butt MS, Nazir A, Sultan MT, Schroën K. *Morus alba* L Nature's functional tonic. Trends Food Sci Technol. 2008;19:505-12. Chen KS, Zheng JT, Zhang SL, Gavin SR.
16. The role of ethylene in fruit ripening and softening. J Zhejiang Agr Univ. 1999;25:251-4. Chen K, Thomas SR, Keaney JF Jr. Beyond LDL oxidation: ROS in vascular signal transduction. Free Radic Biol Med. 2003;35:117-32. Chen XN, Fan JF, Yue X, Wu XR, Li LT. Radical scavenging activity and phenolic compounds in persimmon *Diospyros kaki* L cv Mopan. J Food Sci. 2008;731:C24-8.
17. Chen G, Wang Z Q, Jia J M. Three minor novel triterpenoids from the leaves of *Diospyros kaki*. Chem Pharm Bull (Tokyo). 2009;575:532-5. Cho IH, Gong JH, Kang MK, Lee EJ,

- Park JH, Park SJ, et al.
18. Astragalin inhibits airway eotaxin-1 induction and epithelial apoptosis through modulating oxidative stress-responsive MAPK signaling. *BMC Pulm Med.* 2014;14:122. Dauchet L, Amouyel P, Dallongeville J. Fruits, vegetables and coronary heart disease. *Nat Rev Cardiol.* 2009;6:599-608. Dembitsky VM, Poovarodom S, Leontowicz H, Leontowicz M, Vearasilp S, Trakhtenberg S, et al. The multiple nutrition properties of some exotic fruits: Biological activity and active metabolites. *Food Res Int.* 2011;44:1671–701.
 19. Deng H, Wen Q, Luo Y, Huang Y, Huang R. Influence of different extracts from persimmon leaves on the antioxidant activity in diabetic mice. *Zhong Nan Da Xue Xue Bao Yi Xue Ban.* 2012;37:469-73.
 20. Dewanjee S, Das AK, Sahu R, Gangopadhyay M. Antidiabetic activity of *Diospyros peregrina* fruit: effect on hyperglycemia hyperlipidemia and augmented oxidative stress in experimental type 2 diabetes. *Food Chem Toxicol.* 2009;47:2679-85.
 21. Dillard CJ, German JB. Phytochemicals: nutraceuticals and human health. *J Sci Food Agric.* 2000;80: 1744–56.
 22. Dixon AR, Xie DY, Sharma SB. Proanthocyanidins - a final frontier in flavonoid research? *New Phytologist.* 2005;165:9–28.
 23. Ercisli S, Akbulut M, Ozdemir O, Sengul M, Orhan E. Phenolic and antioxidant diversity among persimmon (*Diospyros kaki* L.) genotypes in Turkey. *Int J Food Sci Nutr.* 2007;59:477-82.
 24. Fennema OR. Loss of vitamins in fresh and frozen foods. *Food Technol.* 1977;31:32. Fiedor J, Burda K. Potential role of carotenoids as antioxidants in human health and disease. *Nutrients.* 2014;6:466-88.
 25. Gali HU, Perchellet EM, Klish DS, Johnson JM, Perchellet JP. Hydrolyzable tannins: potent inhibitors of hydroperoxide production and tumor promotion in mouse skin treated with 12-O-tetradecanoylphorbol 13-acetate in vivo. *Int J Cancer.* 1992;51:425–32.
 26. Gato N, Kadowaki A, Hashimoto N, Yokoyama S, Matsumoto K. Persimmon fruit tannin-rich fiber reduces cholesterol levels in humans. *Ann Nutr Metab.* 2013;62:1-6. Gaziano JM, Hennekens CH. 1993.
 27. The role of beta-carotene in the prevention of cardiovascular disease. *Ann N Y Acad Sci.* 1993;691:148-55. Gondo M, Tanaka N, Tanaka T, Shimomura K, Nakanishi F, Ishimaru KA. Naphthalene glycoside from callus cultures of *Diospyros kaki*. *Phytochemistry.* 1999;51:879-81.
 28. Gorinstein S, Zemser M, Weitz M, Halevy S, Deutsch J, Tilis K, et al. Fluorometric analysis of phenolics in Persimmons. *Biosci Biotechnol Biochem.* 1994;58: 1087-92.
 29. Gorinstein S, Bartnikowska E, Kulasek G, Zemser M, Trakhtenberg S. Dietary persimmon improves lipid metabolism in rats fed diets containing cholesterol. *J Nutr.* 1998;128:2023–
 7. Gorinstein S, Zemser M, Haruenkit R, Chuthakorn R, Grauer F, Martin-Belloso O, et

- al. Comparative content of total polyphenols and dietary fiber in tropical fruits and persimmon. *J Nutr Biochem*. 1999;10:36771.
30. Gorinstein S, Kulasek GW, Bartnikowska E, Leontowicz M, Zemser M, Morawiec M, et al. The effects of diets, supplemented with either whole persimmon or phenol-free persimmon, on rats fed cholesterol. *Food Chem*. 2000;70:303-8.
 31. Gorinstein S, Zachwieja Z, Folta M, Barton H, Piotrowicz J, Zemser M, et al. Comparative content of dietary fiber total phenolics and minerals in persimmon and apples. *J Agric Food Chem*. 2001;49:952-7.
 32. Gu H, Li C, Xu Y, Hu W, Chen M, Wan Q. Structural features and antioxidant activity of tannin from persimmon pulp. *Food Res Int*. 2008;41:208-17. Han J, Kang S, Choue R, Kim H, Leem K, Chung S, et al. Free radical scavenging effect of *Diospyros kaki* *Laminaria japonica* and *Undaria pinnatifida*. *Fitoterapia*. 2002;73:710-2.
 33. Hanasaki Y, Ogawa S, Fukui S. The correlation between active oxygens scavenging and antioxidative effects of flavonoids. *Free Radic Biol Med*. 1994;16: 845-50. Harima S, Nakano R, Yamauchi S, Kitano Y, Yamamoto Y, Inaba A, et al. Extending shelf-life of astringent persimmon *Diospyros kaki* Thunb fruit by 1MCP. *Postharvest Biol Technol*. 2003;29:318-23.
 34. Hertog MG, Kromhout D, Aravanis C, Blackburn H, Buzina R, Fidanza F, et al. Flavonoid intake and longterm risk of coronary heart disease and cancer in the seven countries study. *Arch Intern Med*. 1995;155: 381-6.
 35. Hibasami H, Achiwa Y, Fujikawa T, Komiya T. Induction of programmed cell death (apoptosis) in human lymphoid leukemia cells by catechin compounds. *Anticancer Res*. 1996;16:1943-6.
 36. Homnava A, Payne J, Koehler P, Eitenmiller R. Provitamin a (alpha-carotene, beta-carotene and betacryptoxanthin) and ascorbic acid content of Japanese and American persimmons. *J Food Qual*. 1990;13:8595.
 37. Igual M, Castello ML, Ortola MD, Andres A. Influence of vacuum impregnation on respiration rate mechanical and optical properties of cut persimmon. *J Food Eng*. 2008;86:315-23.
 38. Ikegami A, Eguchi S, Kitajima A, Inoue K, Yonemori K. Identification of genes involved in proanthocyanidin biosynthesis of persimmon (*Diospyros kaki*) fruit. *Plant Sci*. 2007;172:1037-47.
 39. Ikegami A, Akagi T, Potter D, Yamada M, Sato A, Yonemori K, et al. Molecular identification of 1-Cys peroxiredoxin and anthocyanidin/flavonol 3-Ogalactosyltransferase from proanthocyanidin-rich young fruits of persimmon *Diospyros kaki* Thunb. *Planta*. 2009;230:841-55.
 40. Park SY, Park SH, Jeon SM, Park YB, Lee SJ, Jeong TS, et al. Effect of rutin and tanic acid supplements on cholesterol metabolism in rats. *Nutr Res*. 2002;22: 293-5.
 41. Park YS, Jung ST, Kang SG, Delgado-Licon E, Ayala ALM, Tapia MS. Drying of persimmons (*Diospyros kaki* L.) and the following changes in the studied bioactive compounds and the total radical scavenging activities. *LWT-Food Sci Technol*. 2006;39:748-55.
 42. Paul M, Mehr, AP, Kreutz R. Physiology of local renin-angiotensin systems. *Physiol Rev*. 2006;86:747- 803. Piretti MV. Polyphenol constituents of the *Diospyros kaki* fruit. A review. *Fitoterapia*. 1991;1:3-13.

Formulation And Development of Skin Lightening Cream using Daisy flower Extract

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ABSTRACT

Skin Lightening cream using daisy flower extract is usefull in lightening skin tone or simply to obtain a lighter skin tone as whiter skin may be synonymous of wealth, health,youth and beauty in different culture. Also this cream gives the properties of Moisturising, Nourishing and the treatment of hyperpigmentation to the skin.

The cream is naturally safe as it contains natural flower extract, easy to formulate making it attractive in the cosmetic field. The cream is non-irritating, non allergic and non-toxic.

KEYWORDS

Skin Lightening preparation, Bellis perennis, melanin inhibition, melanosome uptake.

1.INTRODUCTION

INCI Name: - Bellisperennis (Daisy) Flower

Kingdom: Plantae – Plants

Botnical name: - Bellisperennis

Family: – Asteraceae or Compositae

Genus – Bellis L Aster

A brighting agent it is the perfect Natural solution for sunspot. The Daisy Flower is rich in antioxidants, along with malic acid & tartaric Acid this acid assists the skin firming and effective fighting the wrinkle. Daisy flower use on its own is the wonder fully scented and healing moisturizer also excellent for both the skin & hair.

It is effective in skin whitening and improving pigmentation. Other beneficial substances in daisy flower are antioxidants, malic, and tartaric acids (skin-firming natural acids).

2) MATERIALS AND METHOD

Sr.No	Materials	Properties
1	Bellisperennis (Daisy) Flower	Lightening agent
2	EDTA-disodiumsalt	Chealating agent
3	Propylene glycol	Humactant
4	Sodium benzoate	Preservative and anti corrosive
5	Liquid paraffin (light)	Hydrating and cleansing agent
6	Stearic acid	Thickening Agent
7	Cetostearyl alcohol	Opacifyingagent,surfactant-foam booster,viscosity increaser
8	Glyccerylmonosterate	Thickening, Emulsifying, Anti-Sticking, Dispersing.
9	Potassium hydroxide	pH adjuster
10	Iso propyl myristate	Emollient, Thickening Agent
11	Perfume	Lavender

Table no. 1s

Method of preparation of cream base

Ingredients	Base Formulation code				
	F1	F2	F3	F4	F5
EDTA-disodiumsalt	0.01	0.02	0.03	0.04	0.05
Propylene Glycol	1	2	3	4	5
Sodium Benzoate	0.40	0.40	0.40	0.40	0.40
Liquid paraffin	0.3	0.5	1	1.5	2
Stearic acid	9	10	11	12	13
Cetostearyl alcohol	0.3	0.5	0.7	0.8	1
Glyccerylmonosterate	0.3	0.5	0.7	0.8	1
Potassium hydroxide	0.3	0.4	0.5	0.6	0.7
Iso propyl myristate	0.3	0.5	1	0.5	2
Water	Up 100	Up 100	Up 100	Up 100	Up 100

F- Formulation

Table no. 2

preparation of cream base:

Step I: water phase was prepared by collecting distilled water and the water was remove aside from this for final volume makeup. Take EDTA- disodiumsalt, water soluble components methyl paraben, propyl, Glycerine, Pot hydroxide were dissolved in distilled water; heated up to 70-75⁰c.

Step II: Oil phase was prepared by heated propyl paraben, stearic acid, sunflower oil, cetostearyl alcohol, Glycerylmonostarate, Isopropyl Myristate heated up 70-80⁰c.

Step III: Oil phase was added in water phase at 80⁰c with continuous stirring for 20-25min and then it was homogenized till uniform emulsion is formed.

The finished products have cream like consistency.

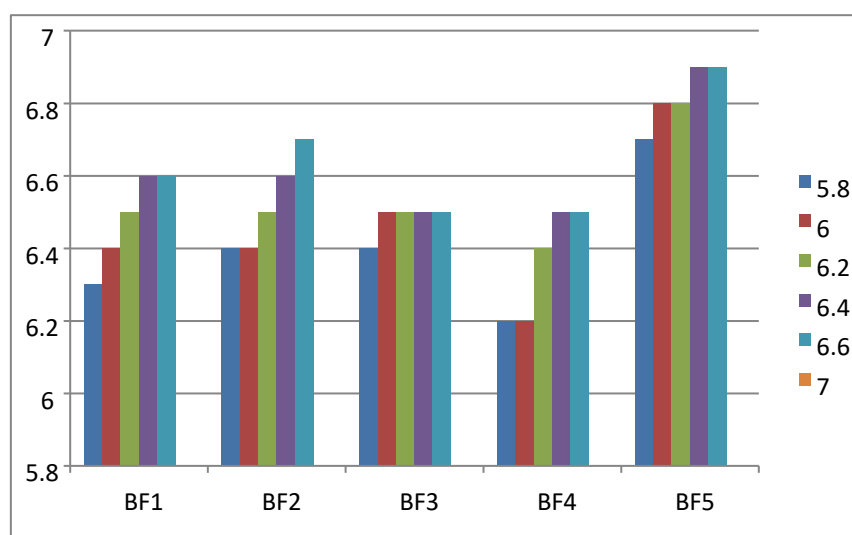
Base formulation i.e. F5 were selected for further studies.

3)EVALUATION OF BASE FORMULATION

a)Result of pH base formulation

Sr no.	Days	Base Formula code				
		BF1	BF2	BF3	BF4	BF5
1	0	6.3	6.4	6.4	6.2	6.7
2	7days	6.4	6.4	6.5	6.2	6.8
3	15days	6.5	6.5	6.5	6.4	6.8
4	21days	6.6	6.6	6.5	6.5	6.9
5	30days	6.6	6.7	6.5	6.5	6.9

BF- Base Formulation Table no.3



Discussion:From the above table the result was found that pH formulation BF4 and BF4 is desirable range. But BF1, BF2, BF5 have higher range.

b) Determination of Viscosity

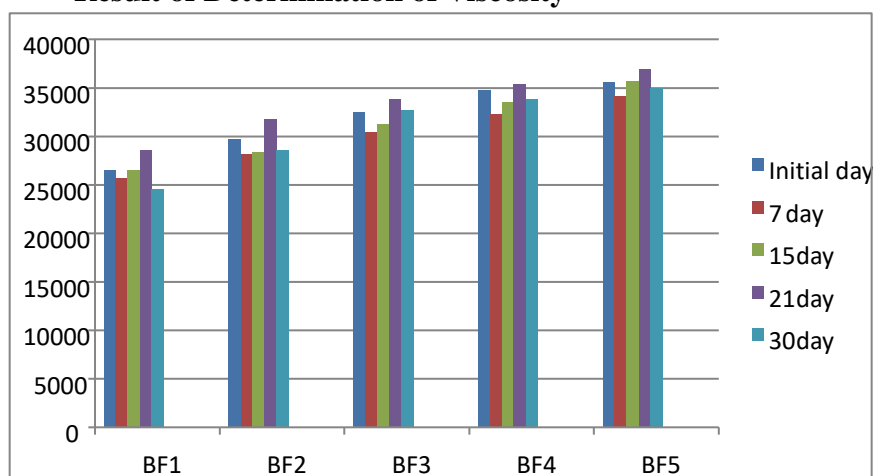
Viscosity test was performed for base formulation

Result of Determination of Viscosity

Sr. no	parameters	Base formulation code				
		BF1	BF2	BF3	BF4	BF5
1	Initial	26580cps	25670cps	26500cps	28560cps	24540cps
2	7 Days	29730cps	28130cps	28340cps	31760cps	28590cps
3	15 Days	32540cps	30450cps	31200cps	33890cps	32640cps
4	21 Days	34820cps	32240cps	33450cps	35340cps	33810cps
5	30 Days	35550cps	34100cps	35660cps	36900cps	34980cps

Table no.4

Result of Determination of Viscosity



Discussion: According to observation the formulation BF5 was good viscosity like lightening cream, formulation BF1, BF2, BF3, BF4 low viscosity as compare to BF5.

c) Stability study of base formulation

Formulation code	Physical Characteristics		
	Colour	Consistency	Feel
Initial day			
BF1	White	No Change	Smooth
BF2	White	No Change	Smooth
BF3	White	No Change	Smooth
BF4	White	No Change	Smooth

BF5	White	No Change	Smooth
After 7 days			
BF1	Pale White	Change	Smooth
BF2	White	Change	Smooth
BF3	White	No Change	Smooth
BF4	White	Change	Tacky
BF5	White	No Change	Smooth
After 14 days			
BF1	Pale White	Change	Smooth
BF2	White	Change	Tacky
BF3	Pale White	Change	Smooth
BF4	White	Change	Tacky
BF5	White	No Change	Smooth

Table no.5

Discussion: From the above observation, the formulation BF5 was stable into room temperature, other formulation i.e. BF1, BF2, BF3, BF4 change its viscosity.

d) Skin Irritation Test

parameter	Formulation				
	BF1	BF2	BF3	BF4	BF5
Skin Irritation	NI	NI	NI	NI	NI

NI- No Irritation

After applying cream base there was no irritation or redness even after 48 hours. Hence, the all formulation was non-irritant and safe for human being.

Discussion: For the all above observations the formulation BF5 was selected as final formulation of active incorporation because it showed good result for pH, thermal stability, stability study, viscosity, skin irritation test, etc.

Final Selection of Base Formulation

Ingredients	Base Formulation (BF5)
--------------------	-----------------------------------

EDTA-disodiumsalt	0.05
Propylene Glycol	5
Sodium Benzoate	0.40
Liquid paraffin	2
Stearic acid	13
Cetostearyl alcohol	1
Glyccerylmonosterate	1
Potassium hydroxide	0.7
Iso propyl myristate	2
Water	Up 100

Table no.6

4)Evaluation of Active cream base

Component%	Ingredients	Active Formulation code				
		AF1	AF2	AF3	AF4	AF5
Active Ingredients	Daisy flower oil	1	2	3	4	5
		13	13	13	13	13
Oil Phase	Steric acid	13	13	13	13	13
	Cetosteryl Alcohol	1	1	1	1	1
	Glyccerylmonostarate	1	1	1	1	1
	Iso Propyl Myristate	2	2	2	2	2
	Liquid paraffin	2	2	2	2	2
Water Phase	Disodium EDTA	0.05	0.05	0.05	0.05	0.05
	Potassium hydroxide	0.7	0.7	0.7	0.7	0.7
	Propylene glycol	5	5	5	5	5
	Sodium Benzoate	0.40	0.40	0.40	0.40	0.40
	Perfume	0.1%	0.1%	0.1%	0.2%	0.2%

Table no.7

Evaluation of Active base cream formulation

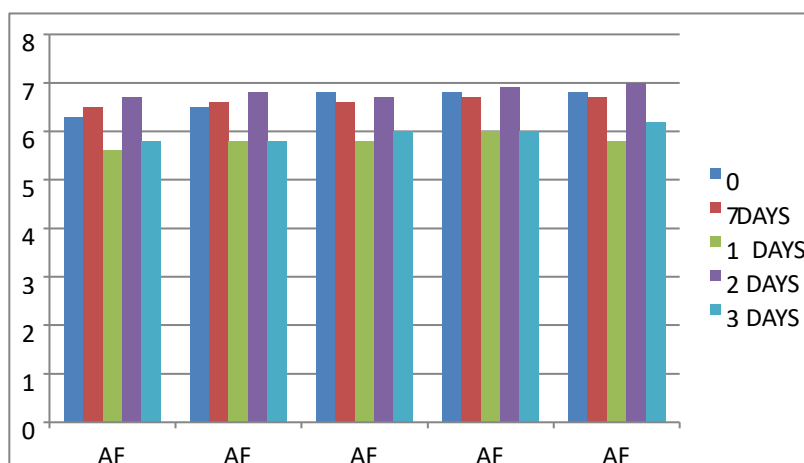
Different concentration of active ingredients was added selected base formulation i.e. Active base formulation and optimized. Based on the results the best formulation BF5 was selected for further dissertation work.

a) Determination of pH:

Result of pH base formulation

Sr no.	Days	Active Formulation code				
		AF1	AF2	AF3	AF4	AF5
1	0	6.3	6.5	5.6	6.7	5.8
2	7days	6.5	6.6	5.8	6.8	5.8
3	15days	6.8	6.6	5.8	6.7	6
4	21days	6.8	6.7	6	6.9	6
5	30days	6.8	6.7	5.8	7	6.2

Table no.8



Result of pH base formulation

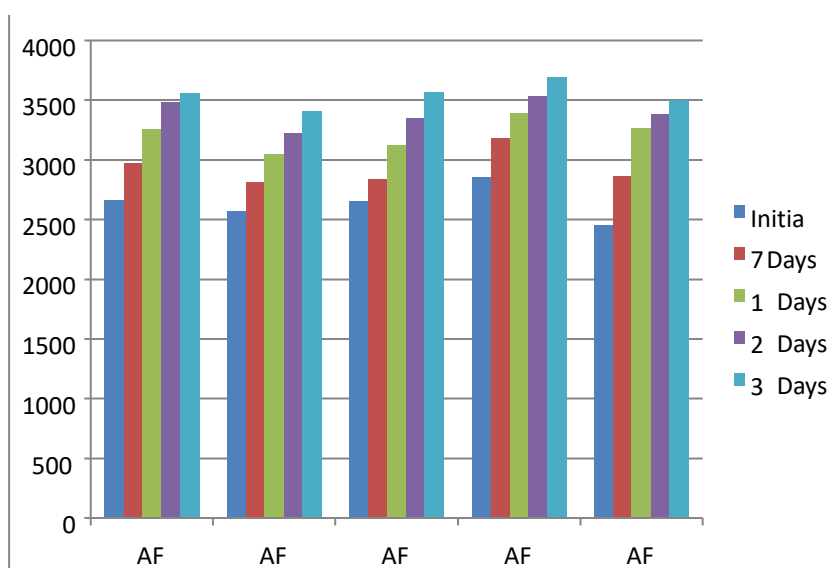
Discussion: From table After 8 days pH of AF1, AF5 decreases, AF2, AF4 increases, no change observed in AF3 observed after 15, 21 and 30 days the pH of AF2, AF4, have more pH which can irritation to skin, AF1 also more pH than normal skin pH, AF3 and AF5 more to normal pH range. Hence AF5 was selected.

b) Determination of Viscosity

Result of Determination of Viscosity

Sr. no	parameters	Base formulation code				
		AF1	AF2	AF3	AF4	AF5
1	Initial	26580cps	25670cps	26500cps	28560cps	24540cps
2	7 Days	29730cps	28130cps	28340cps	31760cps	28590cps
3	15 Days	32540cps	30450cps	31200cps	33890cps	32640cps
4	21 Days	34820cps	32240cps	33450cps <td 35340cps	33810cps	
5	30 Days	35550cps	34100cps	35660cps	36900cps	34980cps

Table no.9



Result of Determination of Viscosity

Discussion: According to observation the formulation AF5 was good viscosity like lightening cream, formulation AF1, AF2, AF3, AF4 low viscosity as compare to AF5. Hence, AF5 was selected.

c) Stability study

Table no .3.1 physical characteristics of skin lightening cream

Formulation code	Physical Characteristics		
	Colour	Consistency	Feel
Initial day			
AF1	White	No Change	Smooth
AF2	White	No Change	Smooth
AF3	White	No Change	Smooth
AF4	White	No Change	Smooth

AF5	White	No Change	Smooth
After 1 week			
AF1	Pale White	Change	Smooth
AF2	Pale White	Change	Smooth
AF3	Pale White	No Change	Smooth
AF4	White	Change	Tacky
AF5	White	No Change	Smooth
After 2 week			
AF1	Pale White	Change	Smooth
AF2	Pale White	Change	Tacky
AF3	Pale White	Change	Smooth
AF4	White	Change	Tacky
AF5	White	No Change	Smooth

Table no.10

d) Skin Irritation Test
Skin Irritation of Active base formulation

parameter	Formulation				
	AF1	AF2	AF3	AF4	AF5
Skin Irritation	NI	NI	NI	NI	NI

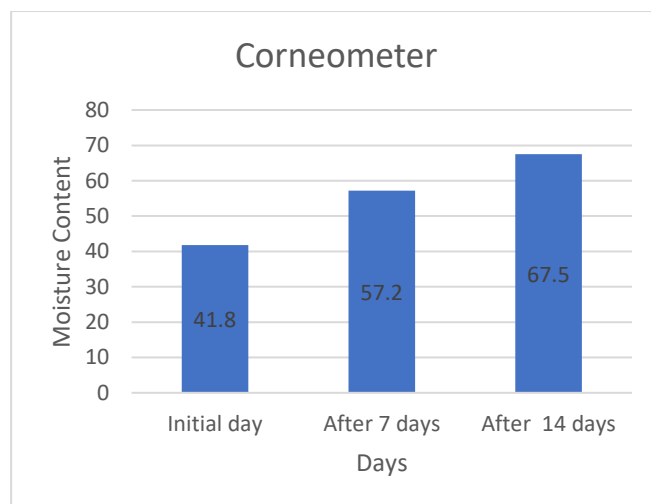
□NI- No Irritation

Discussion: After applying cream base there was no irritation or redness even after 48 hours. Hence, the all formulation was non-irritant and safe for human being.

e) Determination of moisturising property by using Corneometer

Table no. Analysis of moisturising activity by using Corneometer

Sr. No.	Time Interval	% of moisture Content
1	Initial day	41.8
2	After 7 days	57.2
3	After 17 days	67.5



Result of Moisture Content Using Corneometer

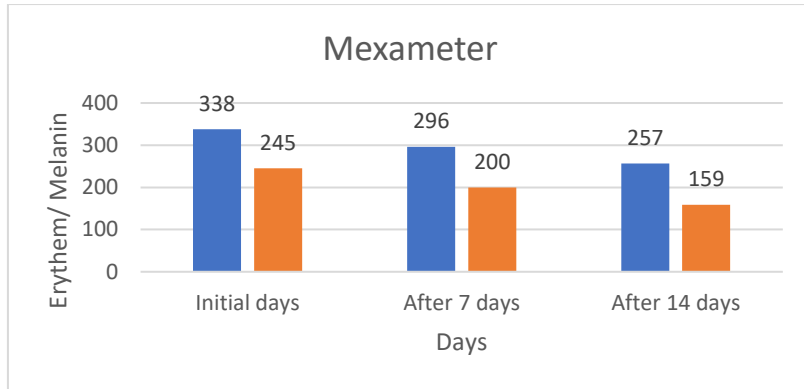
Discussion: The moisturising activity was carried out by using corneometer. It was observed that before application of skin lightening cream, the moisture content of skin was less and after application of skin lightening cream moisture content was increased.



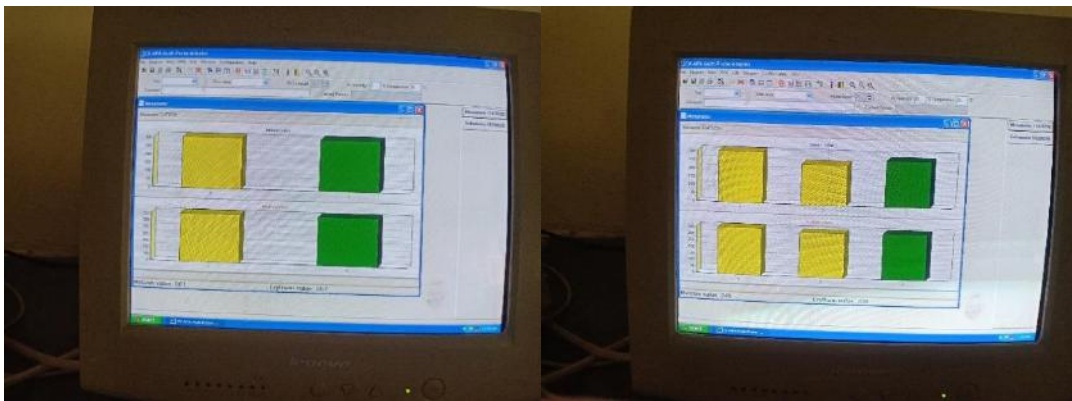
f) Determination of melanin by using Mexameter

Analysis of melanin by using mexameter

Sr.no	Time Interval	Melanin value	Erythem value
1	Initial day	245	338
2	After 7 days	200	296
3	After 14 days	159	257



Discussion: The melanin content was carried out by using mexameter. It was observed that before application of skin lightening cream, the melanin content of skin was more and after application of skin lightening cream melanin content was decreased.



Base Formulation

Active Base formulation

g) Photographic Evaluation

Photographic Evaluation was carried out for the formulation AF5. The study was done on volunteers for 21 days and photographs were taken after initial day, 7 days, 15 days and 21 days.



Initial day

After 7 days



After 15 days

After 21 days

Determination of photographic evaluation.

Discussion : For the picture shown in figure it was observed that, and Daisy Flower Oil proves itself as skin lightening agent.

Discussion: For the all above observations the formulation AF5 was selected as final formulation because it showed good result for pH, Viscosity, stability study, skin irritation test, decreased amount of melanin, microbial activity, etc.

Final selection of Active Formulation

Ingredients	Active Formulation (AF5)
EDTA-disodiumsalt	0.05
Propylene Glycol	5
Sodium Benzoate	0.40
Liquid paraffin	2
Stearic acid	13
Cetostearyl alcohol	1
Glyccerylmonosterate	1
Potassium hydroxide	0.7
Iso propyl myristate	2
Water	74.85

5)CONCLUSION

Skin lightening cream AF5 which was formulated showed a good physical characteristics, pH, spreadability, stability parameters like visual appearance, nature, viscosity, Absorption study, Hence, this study showed that AF5 was the best formulation for skin lightening cream.

The external application of skin lightening protective cream was studied at different time interval for 15 days on volunteers and it was observed that as compared to marketed cream it give better result. Photographic evaluation shows the improvements in skin tone, color and good moisturizing and softness of skin compared with standard skin lightening cream and protective cream. From the present work study it can be concluded that it is possible to develop creams containing herbal extract having good lightening property and to protect skin. From the result obtained in the study we can positively conclude that Daisy Flower Oil have significant lightening property.

6)REFERENCES

- 1) Anne Waugh, Allison Grant, Ross and Wilson Anatomy and Physiology, Churchill Livingstone Elsevier,11(1),2009: 353-358.
- 2) Gawkrödger DJ 'Dermatology, An Illustrated Colour Tex. 3rded.Edinburgh' , Churchill Livingstone.2002.page no.126-130
- 3) Tortora G.J; DerricksonB.principles of anatomy and physiology, 13end, Asia:john Wiley & Sons. volume 1st pvt Ltd,2011,pp.45-65.
- 4) Chu, D.H.,Overview of biology, development, and structure of skin.,2008.Caputo,R., Peluchetti , D., The junction of normal humanepidermis' A freeze fracture study. Journal of Ultrastructure Research., 1 (64),1977.,pp.44-61.
- 5) Lit –skin structure and function 2005; 10(3):1-11
- 6) Haake,A.R.,Hollbrook,K.,Eisen,A.,wolff,Austen,L.,Goldsmith,S.,Katz,(Eds).The structure and development of skin.'Fitzpatrick's dermatology in general medicine.,5thed.,1999.pp.70-111.
- 7) Chu,D.H., Overview of biology, development, and structure of skin., 2008.Caputo,R.,Peluchetti,D.,' The junction of normal humanepidermis, freeze fracture study.Jornal of Ultrastucture Research., 1 (64),1977.,pp.44-61
- 8) TortorasG.J.;DerricksonB.principlesof anatomy and physiology,13edn,Asia:John Wiley & Sons.volume 1st pvt Ltd,2011,pp.45-65.
- 9) Haake,A.R.,Hollbrook,K.,Eisen,A.,wolff,Austen,L.,Goldsmith,S.,Katz,(Eds).The structure and development of skin.'Fitzpatrick's dermatology in general medicine.,5thed.,1999.pp.70-111.
- 10) Stepp, M.A., Spurr-Michaud,s., Tisdale,A., Elwell,J.,&Gipson,I.K., Alpha 6 beta 4 integrin heterodimer is a component of hemidesmosomes. Proceeding of the National academy of Science of the United State of America, 87(22),8970-8974.
- 11) James,W.,Barger, T.G.,&Elston.,D.M., Andrews' dis-eases of the skin ; Clinical dermatology ,10edn., Philadelphia;Elsevier Saunders.
- 12) Gawkrödger DJ (2002) 'Dermatology, An illustrated colour Text. 3rd ed. Edinburgh, Churchill Livingstone.
- 13) Gerard J.Tortora Bryan, Derrickson, Principle of Anatomy and Physiology,John Wiley and Sons Pvt.Ltd.13(1),2011;154-165.

14) Wilkes G.L., Brown I.A, and Wiluer R.H., Ingredients used for semisolid dosage forms, Aug, 1972, 453.

15) Ross and Willson, in Health and Illness, 2010. (11th edition). Louis GM. 2016. Couples, 26-32.

16) Nanda S. Nanda, A. Khar R. K., Cosmetic Technology, Birla Publication Pvt Ltd; 1993. 238

17) P. P. Sharma Cosmetic Formulation, Manufacturing & Quality control 1, 4 ed. Skin lightening cream <https://www.researchgate.net>

18) Dweck AC. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3263051.pdf>

19) JEN-WEN LIN et al, flavonoids as mushroom tyrosinase inhibitors: a fluorescence quenching study [http://webcache.googleusercontent.com/search?Journal of food and Drug Analysis](http://webcache.googleusercontent.com/search?Journal+of+food+and+Drug+Analysis).

20) Vyas. K International Journal of Pharmaceutical and Clinical Research. <http://www.ijpcr.com> page no. 76-79

21) W. Zhu and J. Gao, Journal of Investigative Dermatology Symposium Proceedings [http://webcache.googleusercontent.com/search?J:downloads.hindawi.com/journals/13 page no. 20-24](http://webcache.googleusercontent.com/search?J:downloads.hindawi.com/journals/13/page+no.+20-24).

22) P. Burgar Skin Whitening Cosmetic in the Development Of Natural Skin Lighteners www.mdpi.com/journal

23) <https://Cream.com/essay/skin-lightening-research-paper>.

Research Article, World Journal of Pharmacy and Pharmaceutical Sciences www.wjpps.com

25) Nico S. International Journal of Molecular Science www.mbps.com/journal/ijms

ADVANCE FORMULATION & DEVELOPMENT OF SCRUB FACE WASH WITH ACTIVE KOJIC ACID

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ABSTRACT :

The objective of this work is to formulate and evaluate a cosmetic Instant Whitening Face Wash by using natural ingredient. Since the ancient times, there has been awareness among people regarding the use of plants for the essential needs of a healthy and beautiful skin. Scrub is a cosmetic product that contains slightly rough material that can remove dead skin cells. Natural ingredients such as Halimeda macroloba is potential to be used as scrub.

Keywords :- Subject Study, Facial scrub, Face Wash, Kojic Acid , Ph , Visvcosity

INTRODUCTION

Face wash is the products which are used to cleanse face without drying it out. Face wash is very helpful in removing dirt, oil and provide moisture to the skin. Face Wash are used to get rid from dirt, oil, pollution etc. A cleanser dissolves away excess oil makeup and grime from your face. These are oil soluble impurities. Facial skin is the delicate and ordinary soaps can cause it to lose moisture. The purpose of face wash may be to impart cleansing, anti-acne property and moisturizing effect to the skin. And it is commonly called as cleansers.

ACTIVE :

KOJIC ACID

Kojic Acid is a chelation agent produced by several species of fungi, especially *Aspergillus oryzae*, which has the Japanese common name *koji*.^{[2][3][4]} Kojic acid is a by-product in the fermentation process of malting rice, for use in the manufacturing of sake, the Japanese rice wine.^[2] It is a mild inhibitor of the formation of pigment in plant and animal tissues, and is used in food and cosmetics to preserve or change colors of substances.^[5] It forms a bright red complex with ferric ions.

Classification

INCI Name : Kojic Dipalmitate

Chemical Name / Synonyms : 2-palmitoyloxymethyl-5-palmitoyloxy- γ - pyrone; Hexadecanoic acid, 4-oxo-6-[[[(1-oxohexadecyl)oxy]methyl]-4H-pyran-3-yl ester; KAD

Trade Name : MC-KAD

CAS No. : 79725-98-7

Molecular Formula : C38H66O6

Molecular Weight : 618.9

Cosmetic Uses:

Kojic acid's properties allow it to be a bleaching agent when used in creams, gels, and other cosmetics. Kojic acid is similar to a chemical called hydroquinone. They are both effective treatments for hyperpigmentation. Treatment with kojic acid isn't immediate.

The science behind how kojic acid works as a lightening agent involves its effect on melanin production.

Skin Benefits:

Unclogs skin pores. One of the most obvious benefits of using a face scrub is that it cleanses and detoxifies the skin pores , Tackles uneven skin tone , Combats signs of aging, Improves texture, Allows better penetration, Fights ingrown hair, Makes skin soft and supple.

Scrub :

A face scrub is a skincare product used to exfoliate your skin. It helps in the removal of dead skin cells from the surface of your skin, reducing the chances for clogged pores and acne breakouts. With the particle of scrubbing and exfoliation dating back to ancient times, history indicates that people used something abrasive to exfoliate their skin.

For example, the American Indians used dried corn cobs for skin exfoliation. Crushed sea shells were also a popular option. Nowadays, scrubs are made with ingredients like poppy seeds , sugar, finely ground sea salt, coffee grounds, cinnamon, honey oats, etc.

Benefits Of Using A Face Scrub

1. Removes Dead Skin Cells
2. Unclogs Skin Pore
3. Removes Flakes
4. Reduces Acne Scars
5. Prevents Ingrown Hair
6. Provides Smoother Skin
7. Improves The Texture Of Skin
8. Better Absorption Of Skincare Products

MATERIALS AND METHODS

Materials (Ingredients) :

1. Sodium lauryl ether sulphate (SLES)
2. Cocoamidopropyl Betain (CAPB)
3. Sodium Chloride
4. EDTA Diasodium
5. Glycerine
6. Distilled Water
7. Preservative
8. Tulsi Extract
9. Kojic Acid
10. Poppy Seeds
11. Aleo Vera Gel
12. Lemon Extract

List Of Equipment :

1. pH meter
2. Brook field Viscometer
3. Beaker
4. Weighing Balance
5. Stirrer

Method:

Preparation of base formulation:

In any cosmetic preparation it is necessary to have stable formulation before Incorporation of active. Preparation of base formulation is important before incorporation of active ingredient, to prepare a stable cosmetic formulation. The Effectiveness and stability of product was depending upon the compatibility of active ingredients

Sr. No.	Ingredients	F1 For 100%	F2 For 100%	F3 For 100%
1	Sodium lauryl ether sulphate (SLES)	25	26	25
2	Cocoamidopropyl Betain	10	12	15
3	Sodium Chloride	Q.S.	Q.S.	Q.S.
4	EDTA Diasodium	Q.S.	Q.S.	Q.S.
5	Glycerine	4	5	4
6	Distilled Water	55	70	65
7	Preservative	Q.S.	Q.S.	Q.S.
8	Tulsi essence	2	4	2
9	Aleo vera gel	Q.S.	Q.S.	Q.S.
10	Lemon essence	Q.S.	Q.S.	Q.S.

Table No. 1

Procedure:

1. Firstly add some EDTA in Water and
2. add SLES to adjust the Foaming agent
3. add Cocoamidopropyl Betain , Glycerine, Preservative
4. NaCl in the end to viscosity build up.

Parameter of Base Formulation Of Scrub Face wash:

Sr. No.	Parameter	F1	F2	F3
1	Appearance	+++	+	+
2	Colour	++	+	+
3	Consistency	+++	+	
4	Spreadability	+++	+	++
5	Feel	+++	+	+
6	Odour	++	++	++

Here, += Good, ++= Better, +++= Best

From the above observation formula F1 was Stable and it shows consistency, spreadability, and feel therefore it was selected and extract was added with different concentration and forward for in vitro study as per IS and in vivo study with human volunteer.

Final Formulation of base Herbal Scrub Face wash using Activated Kojic Acid with Scrubing Agent (Poppy seeds)

Sr. No.	Ingredients	Formulation
1	Sodium lauryl ether sulphate (SLES)	25
2	Cocoamidopropyl Betain	10
3	Sodium Chloride	0.2
4	EDTA Diasodium	0.1
5	Glycerine	4
6	Distilled Water	55
7	Preservative	Q.S.
8	Tulsi essence	2
9	Kojic Acid	0.7
10	Poppy Seeds	3
11	Aloe vera gel	Q.S.
12	Lemon extract	Q.S.

Table No. 3

parameter of herbal scrub face wash

Sr. No.	Parameter	Formulation
1	Apperance	++
2	Colour	++
3	Consistency	+++
4	Foaming power	++
5	Feel	++
6	pH	5.5

Table No. 4

Abbrevation :

‘+’= poor, ‘++’=good, ‘+++’= Satisfactory

Procedure :

1. Firstly add some EDTA in Water and
2. add SLES to adjust the Foaming agent
3. add Cocoamidopropyl Betain , Glycerine, Preservative
4. NaCl in the end to viscosity build up.
5. Add Poppy seeds at Temp 45°C
6. Continuesly Stirr of product after add scrubing agent.
7. Then reapeat heat the product at 60-70°C
8. And at the last add Activated Kojic acid at Temp. 45°C.
9. At the end Stirr the product properly .

RESULT AND DISCUSSION:

a) In-Vitro Studies of face wash with different actives

a) Determiation of physical parameters of Herbal Scrub face wash

Sr. No.	Parameters	FW1	FW2	FW3
1	Appearance	Clear	Clear	Clear
2	Colour	Colourless	Colourless	Colourless
3	Consistency	Not Good	Good	Good
4	Tacky Feel	No	No	No

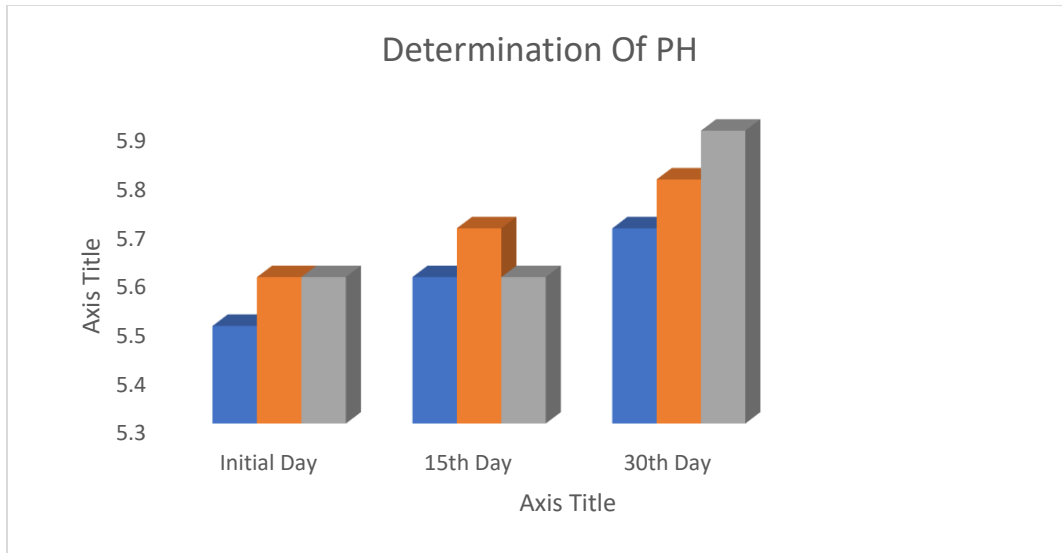
Table No. 5

Determiation of pH of Face wash

Sr.No.	Time interval	FW1	FW2	FW3
1	Initial Day	5.5	5.6	5.6
2	15 th Day	5.6	5.7	5.6
3	30 th Day	5.7	5.8	5.9

Table No.6

Graphical Representation of Determiation of pH



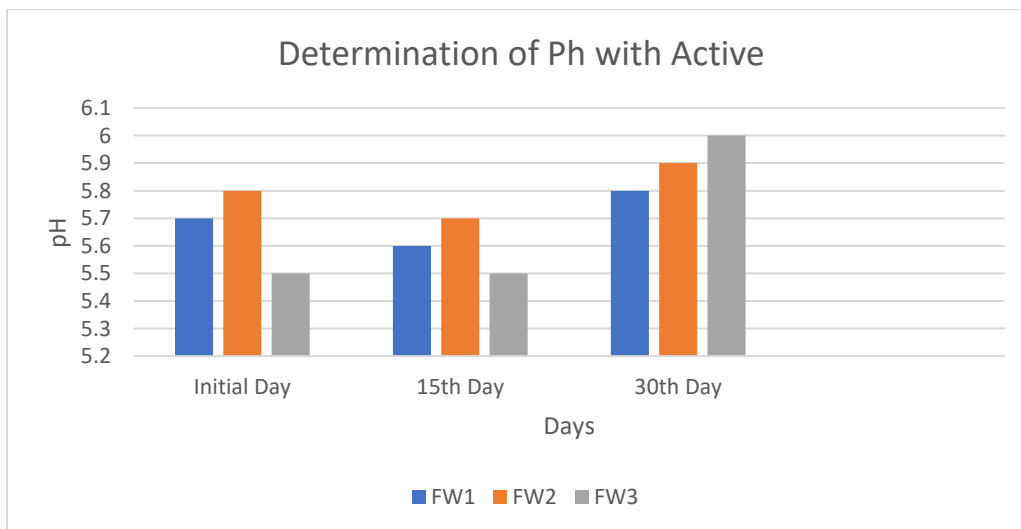
Determination of pH by using Active

Determination of pH Using Scrubing agent poppy seeds and Kojic acid extract :

Sr. No.	Time interval	FW1	FW2	FW3
1	Initial	5.7	5.8	5.5
2	15 th Day	5.6	5.7	5.5
3	30 th Day	5.8	5.9	6

Table No.7

Graphical Representation of Determination of pH

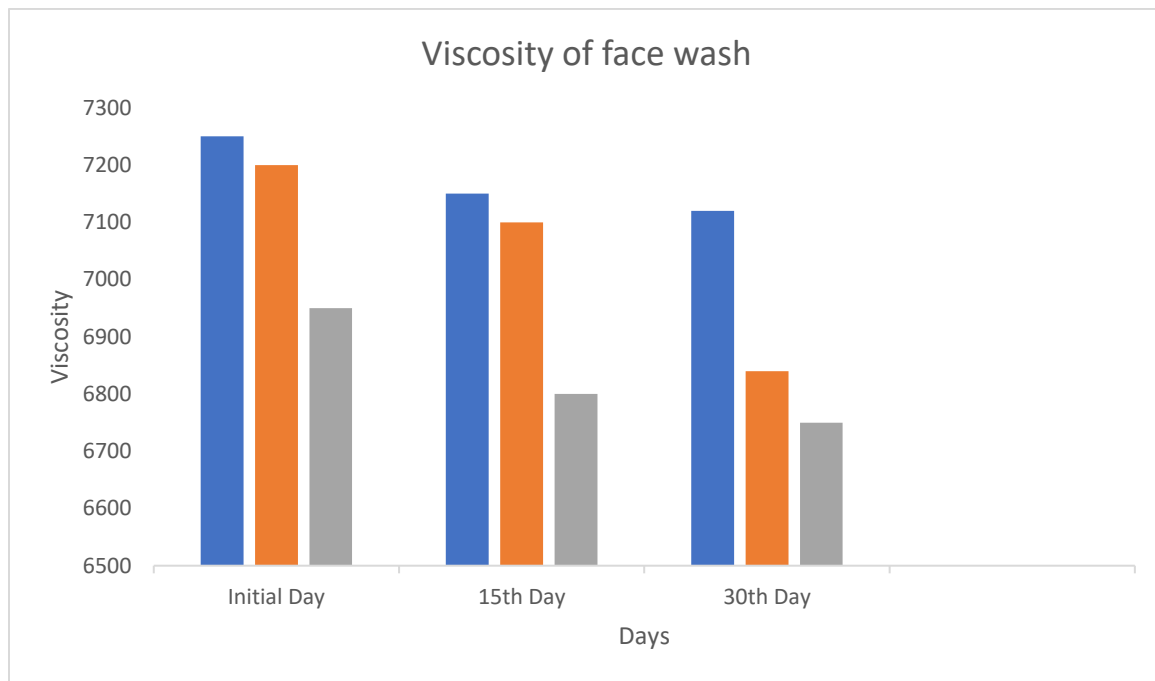


Determination of viscosity

The viscosity of face wash determine by using Brookfield Viscometer. The values obtained from the sample noted.

Sr. No.	No. of days	FW1	FW2	FW3
1	Initial Day	7250cp	7200cp	6950cp
2	15 th Day	7150cp	7100cp	6800cp
3	30 th Day	7120cp	6840cp	6750cp

Table No.8

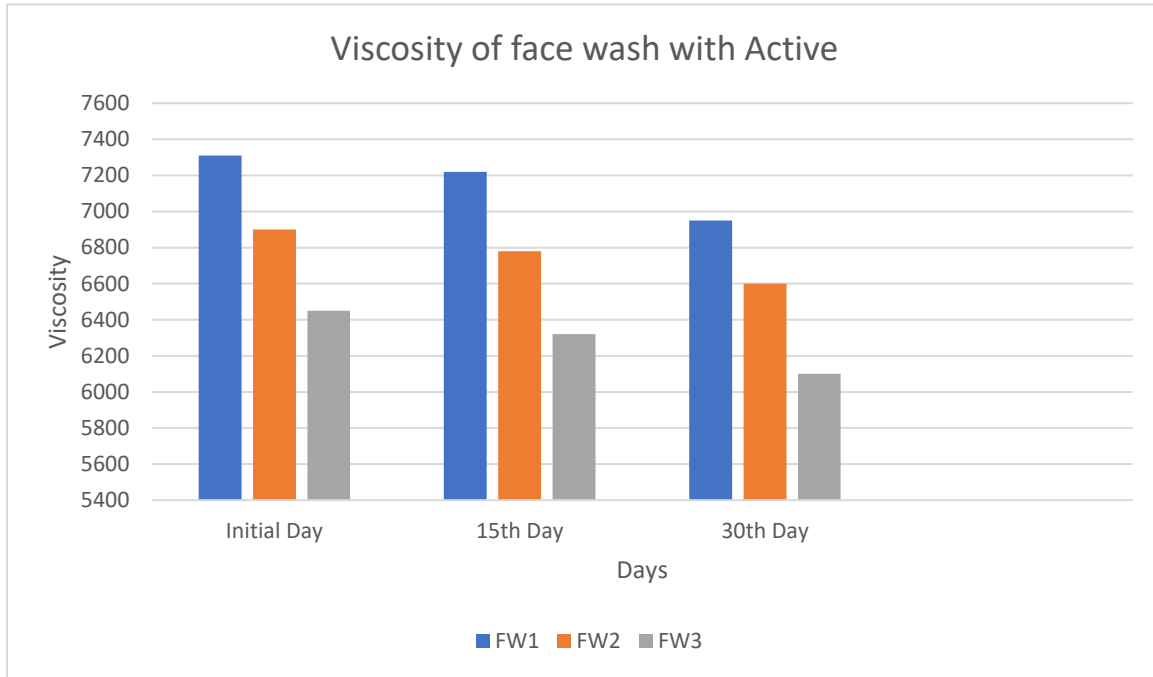


Determination of Viscosity by using scrubing agent Poppy seeds and Kojic acid extract

Sr.no	Time in Interval Time of interval	FW1	FW2	FW3
1	Initial Day	7310cp	6900cp	6450cp
2	15 th Day	7220cp	6780cp	6320cp
3	30 th Day	6950cp	6600cp	6100cp

Table No. 10

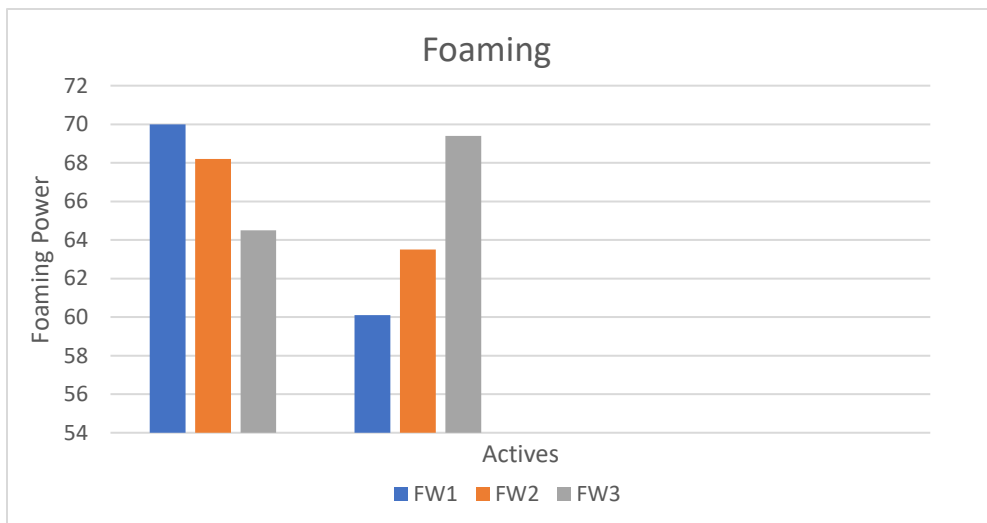
Graphical Representation of Determination of Viscosity



Determination of foaming Power

Sr. No.	Actives	FW1	FW2	FW2
1.	Kojic acid	70	68.2	64.3
2.	Scrubing poppy seeds	60.1	63.5	69.4

Table No. 11



Determination of Spreadability Time

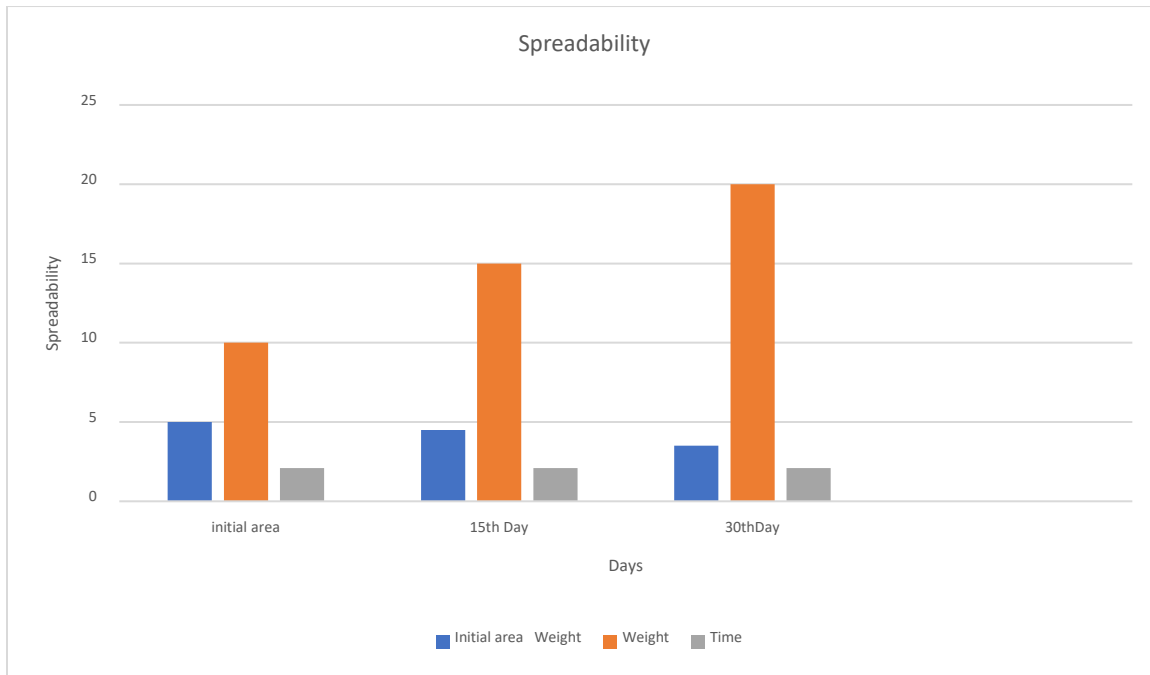
As per the formulation from scrubbing poppy seeds shows results of foaming power FW2

It was observed that viscosity of formulation was found to be which was good. Therefore formulation passes test.

Determination of Spreadability

Sr. No.	Days of interval	Initial area	Weight	Time
1	Initial day	5cm	10gm	2.1 Sec
2	15 th Day	1.5 cm	15 gm	2.1 Sec
3	30 th Day	3.5 cm	20gm	2.1 Sec

Table No. 12



Cyclic Temperature test:

These tests are not carried out at fixed temperature and humidity. In this test, temperature was changed cyclically every day e.g. low -high-low-high to stimulate the changes in temperature daily.

Cyclic Temperature test

Sr. No.	Parameter	F1	F2	F3
1	Freeze Temperature	Stable	Stable	Stable
2	Room Temperature	Unstable	Unstable	Stable
3	High Temperature	Unstable	Unstable	Stable

Table No. 13

Determination of pH

Sr. No.	Name of Test	Result
1.	pH Determination	5.9

Table No. 14

Determination of Viscosity of Scrub Face Wash

Determination of Viscosity

Sr. No.	Viscosity	Result
1.	Viscosity	6660cp

Table No. 15

G) Determination of Foaming Power

Determination of Foaming Power

Sr. No.	Determination of Foaming	Result
1.	Foaming	64

Table No. 16

H) Determination of Spreadability

Determination of Spreadability

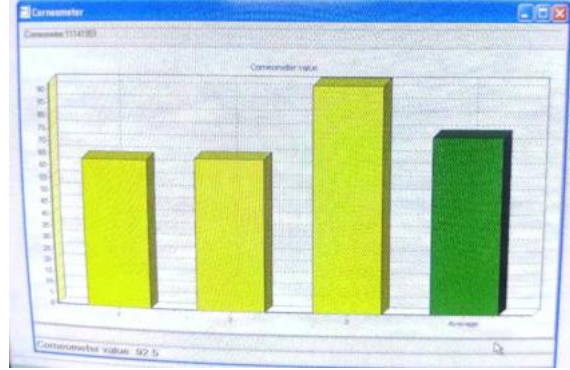
Sr. No.	Spreadability	Result
1	Spreadability	3.5

Table No. 17

Determination of Moisture content of skin by corneometer :-



Corneometer analysis before application

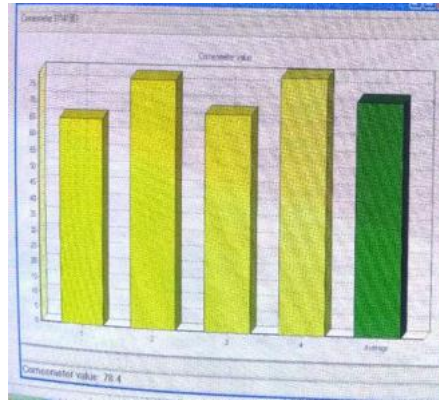


Corneometer analysis after application

Result after 7 days :



Corneometer analysis before application

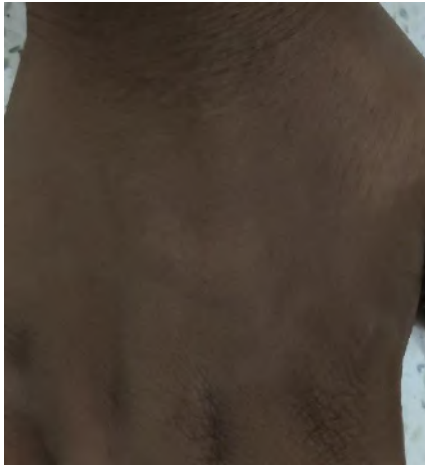


Corneometer analysis after application

Result :

The moisturizing activity was carried out by using corneometer. It was observed that before application of face wash, the moisture content of skin was less and after application of face wash moisture content was increased.

Photographic Evaluation : The study of effectiveness of product was done by the help of the volunteer study. This was carried out human volunteers. Face wash were applied on skin. The photograph were taken before and after application of product.



Before

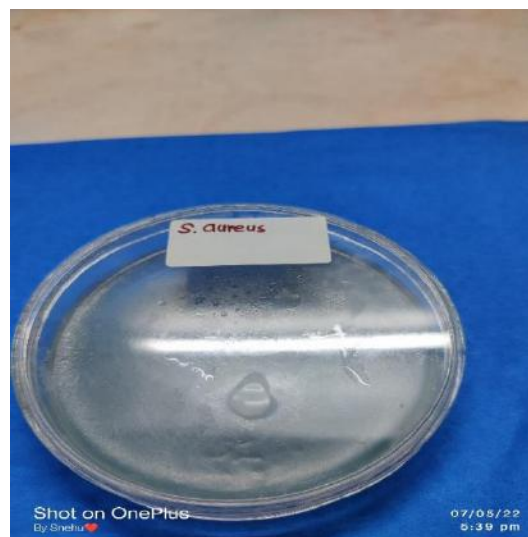


After

Determination of Microbial Testing

Interpretation of result:

Although there is some correlation between the size of the zone of inhibition and the susceptibility of the organism to the antibiotic, the former is a function of many variables e.g density of the inoculum, depth of the medium, diffusibility of antibiotic etc. The size of inhibition zone at which the organism is considered Resistant, Intermediates or sensitive is given in the zone size interpretative chart as a part of this literature.



Conclusion :

At Present because of availability of cosmetic products in market, consumers are giving special attention Towards the selection of cosmetic product to develop a well standard formula; the new product viz. herbal face wash was formulated by incorporating active extract singly and also in combination for good effect.

Herbal scrub face wash was selected for sebum regulation activity because anti-acne face wash Contain good quality of extracts which helps to reduce sebum secretion and helps to remove oil and reduce pimple. Face wash prepared on synthetic base containing polymer, surfactant, humectant and preservatives etc. One formulation was selected from prepared base formulation on the basis of physical parameter for futher incorporation. Incorporation of active and sebum regulation property. Different formulation were prepared with varying concentration of actives i.e anti-acne face wash with kojic acid. Evaluation studies like physical parameter, pH, viscosity, stability was done for selecting the final batch. In-Vivo study of final batch was taken. Cleansing activity were determine photographically.

Over the post few year, several methods are developed for an efficient cleansers with profound effect for various applications. There are various types of cleansers available depending on purpose and need. Kojic acid is used to remove acne and clear scars from the skin. Herbal scrub face wash is used to remove all the acne from the skin and reduce the scars. The single formulation Shows all the activities like sebum regulation and moisturization. Kojic acid is the key active ingredient of face wash helps to remove dirt from the skin and acne and lighteing the skin. So it is concluded that, the formulation of anti-acne face wash give the satisfactory result to the skin.

Refrences :

- 1)P.P. sharm “cosmetics-formulation, manufacturing and quality control” by Vandana publication third edition page no. 142
- 2).Sanju nanda, arun nanda, roop k. khar. “Introduction and design of the study,cosmetics technology”, birla publication first edition2006- 2007 Page no. 243
- 3) [https://storify.com/ASEEM_SOOD/ benefitsofherbalfacewash](https://storify.com/ASEEM_SOOD/benefitsofherbalfacewash)
- 4) <https://en.wikipedia.org/wiki>
- 5)Darsika SKV, Grace CXF and Shanmuganathan S. Formulation and Evaluation of a polyherbal face wash gel WJPPS, 2015; 4(06):585-588.
- 6)Sharma PP, Cosmetics-formulation, manufacturing and quality control.
- 7)Shoba Rani R; Hiremanth. Text book of Industrial pharmacy, Drug delivery systems Cosmetics & Herbal drug technology: Universities press (India) Ltd; 2nd Edition.
- 8)Chim, C. (2016). *American Academy of Dermatology*. Kathleen Vest.
- 9)K. kameshwarrao*, T. K. (2019, 16). International Research Journal of Pharmaceutical and Biosciences. pp. 10-25.

10) Nast A, Dréno B, Bettoli V, et al; European Dermatology Forum. European evidence-based (S3) guidelines for the treatment of acne. *J Eur Acad Dermatol Venereol* 2012;26(suppl 1):1-29

11) Anderson KL, Dothard EH, Huang KE. Frequency of primary nonadherence to acne treatment. *JAMA Dermatol* 2015;151:623-66.

12) Zouboulis CC, Bettoli V. Management of severe acne. *Br J Dermatol* 2015;172:27-36.

13.) Archer JS, Chang RJ. Hirsutism and acne in polycystic ovary syndrome. *Best Pract Res Clin Obstet Gynaecol* 2004;18:737-54

14) **There are no sources in the current document.**38) Badam L, Bedekar S.S., Sonawane K.B. and Joshi S.P. (2002), “ I vitro antiviral activity of Bael (Aegle marmelos Corr.) upon human Cox sackiviruses B1-B6, j. *Commun Dis*, 34 Page No.88.

15) International Journal of Current Pharmaceutical Review and Research Volume 1, Issue 3, February - April 2011 Medicinal Values of Bael (Aegle marmelos) (L.) Corr.

16) Guideline on the treatment of acne, European dermatology Forum (September 2011) Fulton J, Acne vulgaris, Medscape, (Aug 2011) Acne vulgaris: NICE CKS (June 2009) Smith RN, Mann NJ, Braue A, et al: A low-glycemic-load diet improves symptoms in acne vulgaris patients; *Am J Clin Nutr*. 2007 Jul; 86(1); 107-15.

17) Authors: Azimi H, Fallah-Tafi M, Khakshur AA, Abdollahi M.

A review of phytotherapy of Acne Vulgaris: Perspective of new pharmacological treatments

18) Over the counter Acne Treatment The journal of clinical and aesthetic dermatology.

19) Author: Charles Lynde MD FRCPC and Anneke Andriessen PhD. University of Toronto-Canada Antibiotic Resistance: Shifting the paradigm in Topical Acne treatment *DRUGS DERMATOL*:2014:13

Shannon Hann BSc, Jasdeep Shrama MD, Jennifer Klotz MD. Archer JS, Chang RJ. Hirsutism and acne in polycystic ovary syndrome. *Best Pract Res Clin Obstet Gynaecol* 2004;18:737-54

20) Bhat K, Williams HC. Epidemiology of acne vulgaris. *Br J Dermatol* 2013;168:474-85.

21) Gieler U, Gieler T, Kupfer JP. Acne and quality of life – impact and management. *J Eur Acad Dermatol Venereol* 2015;29(suppl 4):12-4

22) Shrama, S. (2017). Anatomy, Skin (Integument), Epidermis. *ResearchGate*.

23) Herskovitz I, Macquhae F, Fox JD, Kirsner RS. Skin movement, wound repair and development of engineered skin. 2016 Feb;25(2):99-100

24) Formulation, manufacturing and quality control by P.P Sharma 97-105.

25) Dnyaneshwar S. Solanki*, 01 May 2020, *World journal of Pharmaceutical Research*, Volume 9, Is 2541-2557.

26) Nivetha K, Sunmathi D, Madu Bharathi C, *Journal of Emerging Technologies and Innovation Research* June 2019, Volume 6, Issue 6.

World Health Organization Expert Committee on Biological Standardization 1992.

Technical report series 822. W.H.O., Geneva.

27) CLSI: Clinical and Laboratory Standards Institute. 2012. Approved standard M100-S22.

Performance standards for antimicrobial susceptibility tests, 10th ed. CLSI, Wanyne, pa.

28) EUSAST. European Committee on Antimicrobial Susceptibility Testing. EUCAST QC Tables V1 .2. 2010.

29) Habeeba Shaikh*, Siddiqua Shaikh and Dr. Priya Rao World Journal of Pharmaceutical research Department of Pharmacognosy, Pravara Rural College of Pharmacy, Pravaranagar, Loni Volume 9, Issue 6, 850-863.

FORMULATION AND DEVELOPMENT OF ACNE REPAIR CREAM USING MATCHA ACTIVES

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Abstract:

This research paper investigates the formulation and efficacy of an advanced acne control cream fortified with bioactive compounds derived from Matcha, a finely ground green tea. A comprehensive literature review is conducted, elucidating the multifaceted etiology of acne vulgaris and the potential therapeutic benefits associated with Matcha's rich polyphenolic profile, with a focus on the key compound, epigallocatechin gallate (EGCG). The formulation process is meticulously detailed, encompassing the incorporation of Matcha actives within a sophisticated matrix of emollients, humectants, and stabilizers to optimize not only the cream's bioavailability but also its sensorial attributes and stability over time.

Clinical trials involving human subjects are conducted to comprehensively evaluate the safety, tolerability, and efficacy of the Matcha-infused acne control cream. Parameters such as lesion count reduction, improvement in skin texture, and participant-reported outcomes are systematically documented and statistically analyzed. The findings not only underscore the potential of Matcha as a valuable botanical resource in dermatological formulations but also contribute to the growing body of evidence supporting natural-based skincare solutions.

KEYWORDS:

Acne vulgaris, Matcha bioactive compounds, green tea polyphenols, Epigallocatechin gallate (EGCG).

INTRODUCTION:

The acne repair cream with matcha actives combines the antioxidant and anti-inflammatory properties of matcha powder and green tea extract to provide a potent dose of active ingredients for the skin. The cream also contains allantoin, which has moisturizing and soothing properties and can help to reduce irritation associated with acne.

The matcha actives in the cream can help to reduce inflammation and redness associated with acne, while also providing antioxidant protection to prevent further damage to the skin. The caffeine in matcha powder can help to improve circulation and reduce puffiness, while the polyphenols in green tea extract can help to stimulate collagen production and improve skin elasticity

MATCHA

Matcha powder is known for its high concentration of antioxidants, particularly EGCG. Antioxidants play a vital role in protecting the skin from damage caused by free radicals, which are unstable molecules that can damage cells and contribute to aging. EGCG has been shown to have potent antioxidant activity and can help to protect the skin from UV radiation-induced damage. In addition to its antioxidant properties, EGCG also has anti-inflammatory and antimicrobial properties. These properties make it an effective ingredient for reducing inflammation and redness associated with acne and other skin conditions. Matcha powder also contains caffeine, which can help to improve circulation and reduce puffiness in the skin. Caffeine has been shown to constrict blood vessels, which can help to reduce the appearance of dark circles and bags under the eyes. Additionally, caffeine has been shown to have anti-inflammatory properties, which can help to reduce redness and inflammation associated with acne.

GREEN TEA EXTRACT:

Green tea extract is a rich source of polyphenols, including catechins, flavonoids, and EGCG. Like matcha powder, green tea extract has antioxidant, anti-inflammatory, and antimicrobial properties. It can help to protect the skin from damage caused by UV radiation, reduce inflammation and redness, and improve the overall appearance and texture of the skin.

Green tea extract has also been shown to have anti-aging benefits. The polyphenols in green tea extract can help to reduce the appearance of fine lines and wrinkles by stimulating collagen production and improving skin elasticity. Additionally, green tea extract can help to brighten the skin by reducing the appearance of dark spots and hyperpigmentation.

ACNE REPAIR CREAM WITH MATCHA ACTIVES:

The acne repair cream with matcha actives combines the antioxidant and anti-inflammatory properties of matcha powder and green tea extract to provide a potent dose of active ingredients for the skin. The cream also contains allantoin, which has moisturizing and soothing properties and can help to reduce irritation associated with acne.

The matcha actives in the cream can help to reduce inflammation and redness associated with acne, while also providing antioxidant protection to prevent further damage to the skin. The caffeine in matcha powder can help to improve circulation and reduce puffiness, while the polyphenols in green tea extract can help to stimulate collagen production and improve skin elasticity.

MATCHA FOR SKINCARE

Matcha is a popular ingredient in skincare due to its high concentration of antioxidants and anti-inflammatory properties. The antioxidants in matcha, such as epigallocatechin gallate (EGCG), can help protect the skin against damage from UV rays and other environmental stressors that can contribute to premature aging.

Matcha also contains chlorophyll, which has detoxifying properties and can help to remove impurities from the skin. Additionally, the caffeine in matcha can help to reduce puffiness and dark circles around the eyes, making it a common ingredient in eye creams and serums. Matcha is also a natural source of L-theanine, an amino acid that promotes relaxation and can help to reduce stress-related inflammation in the skin.

Matcha can be used in a variety of skincare products, including cleansers, toners, masks, and moisturizers. Some skincare experts also recommend using matcha as a natural exfoliant, either by mixing it with a gentle exfoliating agent like sugar or by using a matcha-infused scrub.

Overall, incorporating matcha into your skincare routine can provide a range of benefits for your skin, including improved hydration, increased brightness and clarity, and protection against environmental stressors.

MATCHA FOR ACNE TREATMENT

Matcha can potentially be helpful in treating acne due to its anti-inflammatory and antibacterial properties. Acne is an inflammatory condition caused by a build-up of bacteria and excess oil in the pores, which can lead to the formation of pimples, blackheads, and other blemishes. The anti-inflammatory compounds in matcha, such as EGCG, can help to reduce the redness and inflammation associated with acne, while the antibacterial properties can help to kill acne-causing bacteria.

Matcha can be used in a variety of ways to treat acne, including as a topical application or as a dietary supplement. As a topical treatment, matcha can be mixed with other ingredients like honey or aloe vera gel to create a soothing face mask. This can help to reduce inflammation and promote healing of existing acne blemishes. As a dietary supplement, matcha can be consumed as a tea or added to smoothies or other beverages. Some studies have suggested that consuming matcha may help to regulate hormonal imbalances that can contribute to acne.

It is important to note, however, that more research is needed to fully understand the effects of matcha on acne. While some individuals may find it helpful, others may not see any improvement in their acne symptoms. It is also important to speak with a healthcare professional before using matcha as a treatment for acne, particularly if you are currently taking any medications or have underlying health conditions.

MATERIALS:

DISTILLED WATER, GLYCERINE, PROPYLENE GLYCOL, XANTHAN GUM, ALLANTOIN, CAPRYLIC TRIGLYCERIDE, CETEARYL ALCOHOL, STEARIC ACID, GLYCERYL STEARATE, MATCHA POWDER, GREEN TEA EXTRACT, TEA TREE OIL, PHENOXY ETHANOL, ETHYLHEXYLGLYCERIN

FORMULATION OF PRODUCT: - (TRIALS)

B1

SERIAL NO.	INGREDIENTS	QUANTITY(IN%)
1	DISTILLED WATER	60
2	GLYCERINE	3
3	PROPELENE GLYCOL	3
4	XANTHUN GUM	0.1
5	ALLANTOIN	0.5
6	CAPRYLIC TRIGLYCERIDE	8
7	CETEARYL ALCOHOL	3
8	STEARIC ACID	3
9	GLYCERYL STEARATE	2
10	MATCHA POWDER	2
11	GREEN TEA EXTRACT	1
12	TEA TREE OIL	1
13	PHENOXY ETHANOL	1
14	ETHYLHEXYLGLYCERIN	0.5

B2

SERIAL NO.	INGREDIENTS	QUANTITY(IN%)
1	DISTILLED WATER	60
2	GLYCERINE	3
3	PROPELENE GLYCOL	3
4	XANTHUN GUM	0.1
5	ALLANTOIN	0.5
6	CAPRYLIC TRIGLYCERIDE	8
7	CETEARYL ALCOHOL	3
8	STEARIC ACID	3
9	GLYCERYL STEARATE	2
10	MATCHA POWDER	1.5
11	GREEN TEA EXTRACT	1
12	TEA TREE OIL	1
13	PHENOXY ETHANOL	1
14	ETHYLHEXYLGLYCERIN	0.5

B3

SERIAL NO.	INGREDIENTS	QUANTITY(IN%)
1	DISTILLED WATER	60
2	GLYCERINE	3
3	PROPELENE GLYCOL	3
4	XANTHUN GUM	0.1
5	ALLANTOIN	0.5
6	CAPRYLIC TRIGLYCERIDE	8

7	CETEARYL ALCOHOL	3
8	STEARIC ACID	3
9	GLYCERYL STEARATE	2
10	MATCHA POWDER	3
11	GREEN TEA EXTRACT	1
12	TEA TREE OIL	1
13	PHENOXY ETHANOL	1
14	ETHYLHEXYLGLYCERIN	0.5

In the above given formulations, the B1 is seen to have the good spread ability, texture and feel. Also, it is seen that it passes all the quality parameters. Thus, the formulation B1 is selected as the final formulation.

EVALUATION OF ACNE REPAIR CREAM

Stability testing: This involves subjecting the product to various conditions such as high temperature, low temperature, and exposure to light to assess its stability over time. The product was kept at room temperature, 40°C, and in 5°C to check the colour appearance and the texture of the acne repair cream

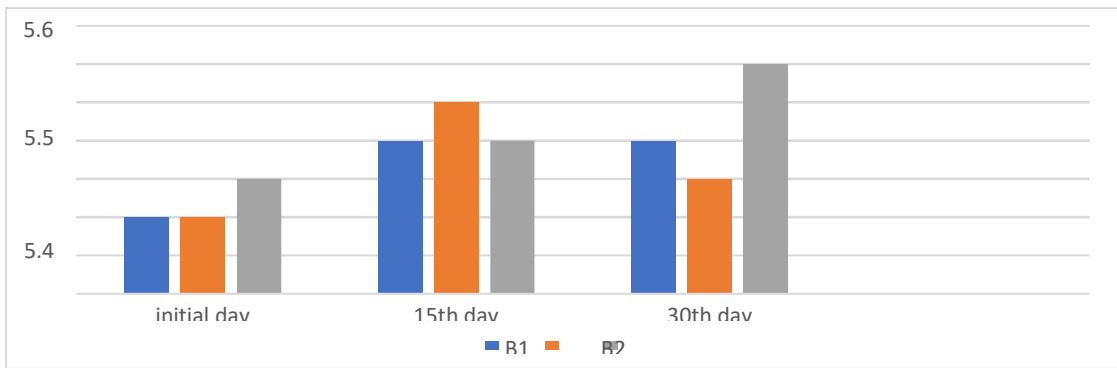
Stability testing:-

SR NO	TIME INTERVAL	B1	B2	B3
1	INITIAL DAY	5.5	5.1	5.2
2	15 th . DAY	5.3	5.4	5.3
3	30 th . DAY	5.5	5.2	5.5

Physical appearance and texture: -

SR NO	PARAMETERS	B1	B2	B3
1	COLOUR	++	++	+++
2	ODOUR	++	+++	+++
3	TEXTURE	+++	++	+++
4	FEEL	++	++	+++

Graphical Representation of Ph test:-



SUMMARY

Acne repair cream using Matcha actives is a topical skincare product designed to help treat and prevent acne breakouts. It contains Matcha tea powder as the active ingredient, which is known for its anti-inflammatory and antioxidant properties. These properties can help to reduce inflammation, prevent breakouts, and promote skin healing.

Matcha tea powder is made from ground green tea leaves and has been used for centuries in traditional Japanese medicine. It contains high levels of polyphenols, which are antioxidants that can help to protect the skin from free radical damage. It also contains catechins, which have been shown to have anti-inflammatory effects that can help to reduce redness and swelling associated with acne.

When using an acne repair cream with Matcha actives, it's important to follow the instructions carefully to avoid over-drying or irritating the skin. Some creams may cause redness, peeling, or sensitivity, especially when first starting use. It's also important to use a sunscreen during the day, as some acne repair creams can increase skin sensitivity to the sun.

In summary, acne repair cream using Matcha actives is a topical skincare product that can help to treat and prevent acne breakouts. It contains Matcha tea powder as the active ingredient, which is known for its anti-inflammatory and antioxidant properties. When using this type of acne repair cream, it's important to follow the instructions carefully to avoid over-drying or irritating the skin.

CONCLUSION

Acne is a common skin condition that affects many people worldwide and can have a significant impact on a person's self-esteem and quality of life. Acne repair creams can be an effective tool in managing and preventing acne breakouts, including those using Matcha actives. These creams contain active ingredients that work to unclog pores, reduce inflammation, and promote skin healing.

However, it's important to choose the right product for your skin type and to use it correctly to avoid over-drying or irritating the skin. Additionally, it's important to take other steps to promote skin health, such as keeping your skin clean, using non-comedogenic products, and managing stress. If you are experiencing persistent or severe acne, it's important to consult with a dermatologist, who can recommend a personalized treatment plan.

Overall, with the right skincare routine and treatment plan, it is possible to manage and prevent acne breakouts, leading to clearer, healthier-looking skin.

REFERENCES: -

1. **Liebenberg, W.; Engelbrecht, E.; Wessels, A.; Devarakonda, B.; Yang, W.Z.; De Villiers, M.** A comparative study of the release of active ingredients from semisolid cosmeceuticals measured with Franz, enhancer or flow-through cell diffusion apparatus. *J. Food Drug Anal.* 2004, 12, 19–28.
2. **Higuchi, T.** Physical chemical analysis of percutaneous absorption process from creams and ointments. *J. Soc. Cosmet. Chem.* 1960, 11, 85–97
3. **Higuchi, T.** Rate release of medicaments from ointment bases containing drugs in suspension. *J. Pharm. Sci.* 1961, 50, 874–875.
4. **Mura, P.; Faucci, M.T.; Bramanti, G.; Corti, P.** Evaluation of transcutol as a clonazepam, transdermal permeation enhancer from hydrophilic gel formulations. *Eur. J. Pharm. Sci.* 2000, 9, 365–372.
5. **Srivastava, S.; Mishra, S.; Dewangan, J.; Divakar, A.; Gupta, N.; Kalleti, N.; Mugale, M.N.; Kumar, S.; Sharma, S.; Rath, S.K.** Safety assessment of the pharmacological excipient, diethylene glycol monoethyl ether (DEGEE), using in vitro and in vivo systems. *DARU J. Pharm. Sci.* 2019, 27, 219–231.
6. **Sullivan, D.W.; Gad, S.C.; Julien, M.** A review of the nonclinical safety of Transcutol, a highly purified form of diethylene glycol monoethyl ether (DEGEE) used as a pharmaceutical excipient. *Food Chem. Toxicol.* 2014, 72, 40–50.
7. **Benson, H.** Transdermal drug delivery: Penetration enhancement techniques. *Curr. Drug Deliv.* 2005, 2, 23–33.
8. **El-Leithy, E.S.; Makky, A.M.; Khattab, A.M.; Hussein, D.G.** Optimization of nutraceutical coenzyme Q10 nanoemulsion with improved skin permeability and anti-wrinkle efficiency. *Drug Dev. Ind. Pharm.* 2018, 44, 316–328.
9. **Szűts, A.; Szabó-Révész, P.** Sucrose esters as natural surfactants in drug delivery systems—A mini-review. *Int. J. Pharm.* 2012, 433, 1–9.
10. **Csizmázia, E.; Erős, G.; Berkesi, O.; Berkó, S.; Szabó-Révész, P.; Csányi, E.** Penetration enhancer effect of sucrose laurate and Transcutol on ibuprofen. *J. Drug Deliv. Sci. Technol.* 2011, 21, 411–415.
11. **Youan, B.B.C.; Hussain, A.; Nguyen, N.T.** Evaluation of sucrose esters as alternative surfactants in microencapsulation of proteins by the solvent evaporation method. *AAPS Pharmsci.* 2003, 5, 123–131.

- 12. Cázares-Delgadillo, J.; Naik, A.; Kalia, Y.N.; Quintanar-Guerrero, D.; Ganem-Quintanar, A.** Skin permeation enhancement by sucrose esters: A pH-dependent phenomenon. *Int. J. Pharm.* 2005, 297, 204–212.
- 13. H.J.; Shin, C.Y.; Kim, K.B.** Safety evaluation of polyethylene glycol (PEG) compounds for cosmetic use. *Toxicol. Res.* 2015, 31, 105–136.
- 14. Islam, M.T.; Rodríguez-Hornedo, N.; Ciotti, S.; Ackermann, C.** The potential of Raman spectroscopy as a process analytical technique during formulations of topical gels and emulsions. *Pharm. Res.* 2004, 21, 1844–1851.
- 15. Boukamp, P.; Petrussevska, R.T.; Breitkreutz, D.; Hornung, J.; Markham, A.; Fusenig, N.E.** Normal keratinization in a spontaneously immortalized aneuploid human keratinocyte cell line. *J. Cell Biol.* 1988, 106, 761–771.
- 16. Colombo, I.; Sangiovanni, E.; Maggio, R.; Mattozzi, C.; Zava, S.; Corbett, Y.; Fumagalli, M.; Carlino, C.; Corsetto, P.A.; Scaccabarozzi, D.; et al.** HaCaT cells as a reliable in vitro differentiation model to dissect the inflammatory/repair response of human keratinocytes. *Mediat. Inflamm.* 2017, 2017, 1–12.
- 17. Ramata-Stunda, A.; Boroduskis, M.; Vorobjeva, V.; Ancans, J.** Cell and tissue culture-based in vitro test systems for evaluation of natural skin care product ingredients. *Environ. Exp. Biol.* 2013, 11, 159–177.
- 18. Choi, S.Y.; Seop, S.Y.; Hyun, M.Y.; Yoo, K.H.; Kim, B.J.; Kim, M.N.; Cho, J.W.** Safety evaluation of topical valproate application. *Toxicol. Res.* 2013, 29, 87–90.
- 19. Nemes, D.; Fenyvesi, F.; Váradi, J.; Vasvári, G.; Fehér, P.; Vecsernyés, M.; Ujhelyi, Z.** Role of cytotoxicity experiments in pharmaceutical development. In *Cytotoxicity*; Tulay, A.C., Ed.; IntechOpen: London, UK, 2018; pp. 132–146.
- 20. Sibi, G.** Inhibition of lipase and inflammatory mediators by *Chlorella* lipid extracts for antiacne treatment. *J. Adv. Pharm. Technol. Res.* 2015, 6, 7–12.
- 21. Yang, B.; Xu, Q.-Y.; Guo, C.-Y.; Huang, J.-W.; Wang, S.-M.; Li, Y.-M.; Tu, Y.; He, L.; Bi, Z.-G.; Ji, C.; et al.** MHY1485 ameliorates UV-induced skin cell damages via activating mTOR-Nrf2 signaling. *Oncotarget* 2017, 8, 12775–12783.
- 22. Jadoon, S.; Karim, S.; Bin Asad, M.H.; Akram, M.R.; Khan, A.K.; Malik, A.; Chen, C.; Murtaza, G.** Anti-aging potential of phytoextract loaded-pharmaceutical

creams for human skin cell longevity. *Oxidative Med. Cell Longev.* 2015, 2015, 709628.

- 23. Ighodaro, O.M.; Akinloye, O.A.** First line defence antioxidants-superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPX): Their fundamental role in the entire antioxidant defence grid. *Alex. J. Med.* 2018, 54, 287–293
- 24. Sailou, C.; Kitazawa, M.; McLaughlin, L.; Yang, J.P.; Lodge, J.K.; Tetsuka, T.; Iwasaki, K.; Cillard, J.; Okamoto, T.; Packer, L.** Antioxidants modulate acute solar ultraviolet radiation-induced NF-kappa-B activation in a human keratinocyte cell line. *Free Radic. Biol. Med.* 1999, 26, 174–183.
- 25. Bahari, A.; Fazilati, M.; Latifi, A.M.; Salavati, H.; Choopani, A.** A review on antioxidant properties of Spirulina. *J. Appl. Biotechnol. Rep.* 2016, 3, 345–351.
- 26. Kligman AM, Mills OH Jr:** ‘Acne cosmetica’. *Arch Dermatol* 1972;106:843–850.

External Resources

- a. [Crossref \(DOI\)](#)
- b. [Chemical Abstracts Service \(CAS\)](#)

- 27. Mills OH Jr, Kligman A:** Acne mechanica. *Arch Dermatol* 1975;111:481–483.

External Resources

- a. [Crossref \(DOI\)](#)
- b. [ISI Web of Science](#)

- 28. Sorg O, Zennegg M, Schmid P, Fedosyuk R, Valikhnovskyi R, Gaide O, Kniazevych V, Saurat JH:** 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) poisoning in Victor Yushchenko: identification and measurement of TCDD metabolites. *Lancet* 2009; 374:1179–1185.

External Resources

- a. [Crossref \(DOI\)](#)
- b. [Chemical Abstracts Service \(CAS\)](#)
- c. [ISI Web of Science](#)

- 29. Fulton JE Jr, Pay SR, Fulton JE 3rd:** Comedogenicity of current therapeutic products, cosmetics, and ingredients in the rabbit ear. *J Am Acad Dermatol* 1984; 10:96–105.

External Resources

- a. [Crossref \(DOI\)](#)
- b. [ISI Web of Science](#)

- 30. Kligman AM, Kwong T:** An improved rabbit ear model for assessing comedogenic substances. *Br J Dermatol* 1979; 100:699–702.

“Formulation and Development of Cleansing Spray using Marine Extract”

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ABSTRACT:-

This study investigates the efficacy of *Chondrus crispus* marine extract in formulating a skin cleansing face spray. The research explores the natural cleansing properties of the red seaweed extract, assessing its ability to remove impurities, balance skin pH, and enhance overall skin health. Additionally, the paper discusses the development process, formulation optimization, and sensory attributes of the *Chondrus crispus*-based face spray. The findings suggest that this marine extract holds promise as a sustainable and effective ingredient for skincare products, providing a refreshing and nourishing cleansing experience.

Keywords: *Chondrus Crispus*, Cleansing, Skin health, Nourishing, Optimization.

I. INTRODUCTION:-

Chondrus crispus, colloquially known as Irish moss, boasts a rich tradition of use, extending beyond culinary applications to encompass diverse biological activities. With a family classification within the Rhodophyta phylum, this seaweed is recognized for its anti-inflammatory, antioxidant, and immunomodulatory properties. As skincare formulations increasingly gravitate towards sustainable practices, the exploration of marine-derived ingredients gains significance.

Chondrus crispus belongs to the family Rhodophyceae within the phylum Rhodophyta. The Rhodophyta, commonly known as red algae, are characterized by their red pigmentation due to the presence of chlorophyll a and phycobiliproteins. The family Rhodophyceae encompasses a diverse group of red algae, and *Chondrus crispus*, or Irish moss, is specifically classified within this family. Dry matter (DM) on wet weight (average %) 22%

It belongs to the category-Class: Rhodophyceae

Order: Gigartinales

Hydra I Rich is rich in Vitamins C, B2, B3 and A

a) Hydra I Rich is a blend of Active Molecules from Seaweeds – predominantly containing *Chondrus crispus*.

b) It acts as Anti-Pollution shield for the skin with added benefits of high hydration

c) It has high concentration of “mannose” – an oligosaccharide studied and established for its effectiveness - protection of cells from cigarette smoke, pesticides and heavy metals along with anti- inflammation action.

Vitamin C : Pollution Shield + Moisture Retention

- a) protects the skin from free radicals, from excess exposure to the sun, environmental pollution and regular smoking.
- b) Wrinkles will become less prominent, as the Vitamin C increases elastin formation &
- c) helps to retain moisture

Vitamin B3 : Natural Niacinamide

- a) According to the Journal of Cosmetic Dermatology, an article published in 2004 showed niacinamide helps improve the moisture content in the top layer of skin.
- b) Vitamin B3 also reduces topical inflammation and can help with sun damage.
- c) It helps reduce wrinkles, reduce uneven skin tone, help heal acne and reduce hyperpigmentation.

Vitamin A : Skin Maintenance

- a) Vitamin A is necessary for the maintenance and repair of skin tissue
- b) Medical studies show a reduction in lines and wrinkles, good acne control, and some psoriasis relief, all from using creams containing Vit. A

Vitamin B2 : Protects Healthy Skin and Hair

- a) Riboflavin plays a key role in maintaining levels of collagen.
- b) Low levels of this vitamin can result in premature aging.
- c) Some studies suggest that riboflavin can provide relief from skin inflammation and chapped lips.

Cosmetological Importance of Marine Extract:-

There's a reason why red algae is being incorporated into so many skincare products nowadays. Specifically, it can offer many of the same benefits as traditional cleansers and creams without the side effects associated with chemical-based ingredients. It's a natural ingredient that comes straight from our oceans, making it super effective for a variety of benefits.

Hydrating Properties Anything that exists in the ocean naturally does a pretty good job of retaining moisture, and algae is no different. Some forms of algae have been found to have humectant properties, which is a common ingredient in moisturizers to help your skin lock onto moisture and remain hydrated for longer. This makes red algae great for dry skin, as it can help to rejuvenate your complexion. Additionally, it might be able to help reduce the appearance of fine lines or wrinkles by preserving moisture in your skin to make it look more vibrant.

Antioxidant Effects You've probably heard about how important it is to eat foods that are high in antioxidants. But using skincare products with antioxidant effects is just as necessary. Antioxidants are chemicals that help stop or limit the damage caused by free radicals, contributing to oxidative stress. Oxidative stress can trigger cell damage, and it's one of the primary causes of the signs of skin aging. It's been found that algae is high in antioxidant activity because they are high in nonenzymatic 32 components such as ascorbic acid. This

makes it a great natural alternative to chemical preservatives in most other skincare products, as it can nourish your skin and keep it looking healthy.

Protection From the Sun When you think about it, there's no shade in the ocean. So marine organisms such as red algae need a way to protect themselves from the harmful ultraviolet rays of the sun. Luckily, algae have been found to have a UV absorbing capacity that can help shield your skin from harmful rays. Using a cleanser or cream with red algae can help to reduce the harmful effects of photoaging from blue light or UV light exposure. Not to mention, much of the reason for algae's ability to protect from the sun is associated with its polyphenol constituents. Polyphenol is a micronutrient in plants that have been found to have a large number of benefits for other parts of your body.

Shields from Pollution Algae has loads of unique properties that make it stand out from most ingredients in other skincare products. For example, it can repair your skin's natural barrier to mimic its native biome. This gives it the ability to protect your skin from harmful outside pollutants, helping to keep it healthy and young-looking.

II. MATERIAL AND METHODS

Preparation of extract-

The extraction of *Chondrus crispus* (Irish moss) typically involves several steps to isolate the desired compounds, especially carrageenan. Here is a simplified overview of the extraction process:

- 1. Harvesting:-** *Chondrus crispus* is usually harvested from marine environments. The seaweed is gathered from rocks or cultivation areas, ensuring sustainable harvesting practices.
- 2. Cleaning:-** The harvested seaweed undergoes thorough cleaning to remove any impurities such as sand, shells, or other debris. This step is crucial to obtain a high-quality extract.
- 3. Drying:-** After cleaning, the seaweed is often dried to reduce its water content. This can be done through sun-drying or using specialized drying equipment. Drying helps in preserving the seaweed for storage and further processing.
- 4. Milling or Grinding:-** The dried seaweed is then milled or ground into a coarse powder. This increases the surface area, facilitating the extraction of carrageenan during subsequent steps.
- 5. Extraction:-** The milled seaweed undergoes an extraction process to isolate carrageenan. Typically, this involves soaking the seaweed in an alkaline solution to remove cell wall components, followed by precipitation and separation steps to isolate carrageenan from the liquid.
- 6. Purification:-** The extracted carrageenan may undergo further purification steps to remove any remaining impurities, such as colorants, proteins, or minerals. This purification process ensures a more refined and standardized extract.
- 7. Drying the Extract:-** The purified carrageenan extract is then dried to obtain a powder or gel-like substance. This final form makes it easier to incorporate into various cosmetic and skincare formulations.

It's important to note that the specific extraction methods may vary among manufacturers, and some may use additional steps or variations in the process. The goal is to obtain a carrageenan-

rich extract with the desired properties for use in cosmetic and skincare applications. Additionally, adherence to sustainable harvesting practices is crucial to preserve marine ecosystems and ensure a long-term supply of *Chondrus crispus*.

III.Face cleansing Spray Formulation

Weigh Water, Disodium EDTA, Allantoin, Glycerine, D-Panthenol, Coco Apple Amino Acid, Coco glucoside in one glass beaker and heat it till 75-80°C. Stir it slowly when it cools down to room temperature add Preservative, Marine extract (hydra Rich), Fragrance and tween 20 need to be premixed for clear solution lastly citric acid is used for buffering.

Sr.No.	Ingredients	Quantity
A	Water	88.3
	Disodium EDTA	0.1
	Allantoin	0.2
	Glycerine	3
	D-Panthenol	0.2
	Coco Apple Amino Acid	2
	Coco Glucoside	1
B	Phenoxyethanol and ethylhexylglycerine	0.5
	Fragrance	0.5
	Tween 20	1
C	Hydra I Rich (Marine Extract)	3

Table No.1- Formula of Face Cleansing Spray using Marine Extract

Evaluation of face cleansing spray:-

Evaluation of face cleansing spray was following.

Physical Evaluation Formulated face cleansing spray was further Evaluated by using the following physical parameter physical parameter clarity, odour, appearance,feel and state of the formulation.

Clarity: The clarity of the face cleansing spray was observed by visual examination. The result was shows in table 2.

Odour: The odour of cleansing spray was found to be pleasant

Feel:The feel of the cleansing spray was observed after using it as a patch test manually after feel was very smooth and hydrated.

Ph: Take 1 ml of sample and dissolve in 100ml of water in beaker that is 1%

solution is prepared. Then with the help of pH meter reading were taken. Results are shown in table 2

Non- irritancy test: Face cleansing spray formulation was evaluated for the non-irritancy test. Preparation shown no redness and irritancy. Observation of the state was done for 24 h 28. Results are shown in table 2

Table no.2- Physical Parameters

Sr.No.	Parameter	Results
1	Clarity	Clear Transparent
2	Odour	Pleasant
3	After feel	Clean and hydrated
4	pH	5.6
5	Non Irritancy	Not irritant
6	Viscosity	1.04 cp

IV. Analysis of Moisture Content using Corneometer:

The moisturizing activity was carried out by using coreometer. It was observed that before application of Cleansing Spray, the moisture content of skin was less and after application of Cleansing spray moisture content was increased.

Sr.No.	Time Interval	% of moisture content
1	Before Application	68.4
2	After Application	87.4

V. Result

The present research was the formulation and development of Face cleansing spray using marine extract. The evaluation parameters were coming under results, like the physical evaluation of cleansing spray , PH ,Clarity,Odour, non-irritancy test, viscosity and of the Cleansing Spray was shown in table.

VI. DISCUSSION

The product is a very handy and anywhere use product. A couple of sprays and simply wipe off with a hankey/tissue. The cleanser removes all the dirt and oil from the face and makes the face look absolutely clean. And all of this without a drop of water. Hydra I Rich (Marine Extract) is rich in Vitamins C, B2, B3 and A Hydra I Rich is a blend of Active Molecules from Seaweeds – predominantly containing Chondrus crispus. It acts as Anti-Pollution shield for the skin with added benefits of high hydration.

VII. Conclusion

The formulation of Cleansing spray using marine extract was so formulated for instant cleansing and provide hydration. The tests Carried out simply manually and by observation Ph, Viscosity, Clarity, Odour, After feel were all noted down and mentioned in table 2.

VIII. Reference

- 1) Bjelakovic G, Nikolova D, Gluud C. Antioxidant supplements and mortality. *Curr Opin Clin Nutr Metabolic Care* (2014) 17:40–4. 10.1097/MCO.000009 [PubMed] [CrossRef] [Google Scholar]
- 2) European Food Safety Authority (EFSA) Scientific Opinion on the modification of the authorisation of a health claim related to cocoa flavanols and maintenance of normal endothelium-dependent vasodilation pursuant to Article 13(5) of Regulation (EC) No 1924/2006 following a request in accordance with Article 19 of Regulation (EC) No 1924/2006. *EFSA J* (2014) 12:3654 10.2903/j.efsa.2014.3654 [CrossRef] [Google Scholar] Navarro VJ, Barnhart H, Bonkovsky HL, Davern T, Fontana RJ, Grant L, et al.. Liver injury from herbals and dietary supplements in the U.S. drug-induced liver injury network. *Hepatology* (2014) 60:1399–408. 10.1002/hep.27317 [PMC free article] [PubMed] [CrossRef] [Google Scholar]
- 3) Mazzanti G, Menniti-Ippolito F, Moro PA, Cassetti F, Raschetti R, Santuccio C, et al.. Hepatotoxicity from green tea: a review of the literature and two unpublished cases. *Eur J Clin Pharmacol.* (2009) 65:331–41. 10.1007/s00228-008-0610-7 [PubMed] [CrossRef] [Google Scholar]
- 4) Garcia-Cortes M, Robles-Diaz M, Ortega-Alonso A, Medina-Caliz I, Andrade RJ. Hepatotoxicity by dietary supplements: a tabular listing and clinical characteristics. *Int J Mol Sci.* (2016) 17:537. 10.3390/ijms17040537 [PMC free article] [PubMed] [CrossRef] [Google Scholar]
- 5) Mazzanti G, Di Sotto A, Vitalone A. Hepatotoxicity of green tea: an update. *Arch Toxicol.* (2015) 89:1175–91. 10.1007/s00204-015-1521-x [PubMed] [CrossRef] [Google Scholar]
- 6) Whitsett M, Marzio DH, Rossi S. SlimQuick-associated hepatotoxicity resulting in fulminant liver failure and orthotopic liver transplantation. *ACG Case Rep J.* (2014) 1:220–2. 10.14309/crj.2014.59 [PMC free article] [PubMed] [CrossRef] [Google Scholar]

7) European Food Safety Authority (EFSA) Scientific Opinion on the substantiation of health claims related to polyphenols in olive and protection of LDL particles from oxidative damage (ID 1333, 1638, 1639, 1696, 2865), maintenance of normal blood HDL-cholesterol concentrations (ID 1639), maintenance of normal blood pressure (ID 3781), “anti-inflammatory properties” (ID 1882), “contributes to the upper respiratory tract health” (ID 3468), “can help to maintain a normal function of gastrointestinal tract” (3779), and “contributes to body defences against external agents” (ID 3467)

pursuant to Article 13(1) of Regulation (EC) No 1924/2006. EFSA J (2011) 9:2033

8) Carbonell-Capella JM, Buniowska M, Barba FJ, Esteve MJ, Frígola A. Analytical methods for

determining bioavailability and bioaccessibility of bioactive compounds from fruits and vegetables: a

review. *Comp Rev Food Sci Food Safety* (2014)13:155–71. 10.1111/1541-4337.12049 [CrossRef]

[Google Scholar]

9) Rothwell JA, Perez-Jimenez J, Neveu V, Medina-Remon A, M'Hiri N, García-Lobato P, et al..

Phenol-Explorer 3.0: a major update of the Phenol-Explorer database to incorporate data on the effects

of food processing on polyphenol content. *Database* (2013) 1:bat070.

10.1093/database/bat070 [PMC

free article] [PubMed] [CrossRef] [Google Scholar]

10) Carbonell-Capella JM, Buniowska M, Barba FJ, Esteve MJ, Frígola A. Analytical methods for

determining bioavailability and bioaccessibility of bioactive compounds from fruits and vegetables: a

review. *Comp Rev Food Sci Food Safety* (2014)13:155–71. 10.1111/1541-4337.12049 [CrossRef]

[Google Scholar]

11) Li J, He X, Li M, Zhao W, Liu L, Kong X. Chemical fingerprint and quantitative analysis for

quality control of polyphenols extracted from pomegranate peel by HPLC. *Food Chem.* (2015) 176:7–

11. 10.1016/j.foodchem.2014.12.040 [PubMed] [CrossRef] [Google Scholar]

12) Vinson JA, Motisi MJ. Polyphenol antioxidants in commercial chocolate bars: is the label accurate?

J Funct Food (2015) 12:526–9. 10.1016/j.jff.2014.12.022 [CrossRef] [Google Scholar]

- 13) Miglio C, Chiavaro E, Visconti A, Fogliano V, Pellegrini N. Effects of different cooking methods on nutritional and physicochemical characteristics of selected vegetables. *J Agric Food Chem.* (2007) 56:139–47. 10.1021/jf072304b [PubMed] [CrossRef] [Google Scholar]
- 14) Arranz S, Chiva-Blanch G, Lamuela-Raventos RM, Estruch R. Wine Polyphenols in the Management of Cardiovascular Risk Factors. In: Watson RR, Preedy VR, Zibadi S, editors *Polyphenols in Human Health and Disease*. London; Waltham, MA; San Diego, CA: Academic Press; (2014). p. 993–1006. [Google Scholar]
- 15) Bozkurt H. Utilization of natural antioxidants: green tea extract and *Thymbra spicata* oil in Turkish dry-fermented sausage. *Meat Sci.* (2006) 73:442–50. 10.1016/j.meatsci.2006.01.005 [PubMed] [CrossRef] [Google Scholar]
- 16) Naila A, Flint S, Fletcher G, Bremer P, Meerdink G. Control of biogenic amines in food—existing and emerging approaches. *J Food Sci.* (2010) 75:R139–50. 10.1111/j.1750-3841.2010.01774.x [PMC free article] [PubMed] [CrossRef] [Google Scholar]
- 17) Wang Y, Li F, Zhuang H, Chen X, Li L, Qiao W, et al. Effects of plant polyphenols and α -tocopherol on lipid oxidation, residual nitrites, biogenic amines, and N-nitrosamines formation during ripening and storage of dry-cured bacon. *LWT Food Sci Technol.* (2015) 60:199–206. 10.1016/j.lwt.2014.09.022 [CrossRef] [Google Scholar]
- 18) Carpenter R, O'Grady MN, O'Callaghan YC, O'Brien NM, Kerry JP. Evaluation of the antioxidant potential of grape seed and bearberry extracts in raw and cooked pork. *Meat Sci.* (2007) 76:604–10. 10.1016/j.meatsci.2007.01.021 [PubMed] [CrossRef] [Google Scholar]
- 10819) Wootton-Beard PC, Moran A, Ryan L. Stability of the total antioxidant capacity and total polyphenol content of 23 commercially available vegetable juices before and after in vitro digestion measured by FRAP, DPPH, ABTS and Folin–Ciocalteu methods. *Food Res Int.* (2011) 44:217–24. 10.1016/j.foodres.2010.10.033 [CrossRef] [Google Scholar]
- 20) Aron PM, Shellhammer TH. A discussion of polyphenols in beer physical and flavour stability. *J Inst Brew.* (2010) 116:369–80. 10.1002/j.2050-0416.2010.tb00788.x [CrossRef] [Google Scholar]

- 21) Schneider M, Esposito D, Lila MA, Foegeding EA. Formation of whey protein–polyphenol meso-structures as a natural means of creating functional particles. *Food Funct.* (2016) 7:1306–18. 10.1039/C5FO01499A [PubMed] [CrossRef] [Google Scholar]
- 22) Li T, Li J, Hu W, Zhang X, Li X, Zhao J. Shelf-life extension of crucian carp (*Carassius auratus*) using natural preservatives during chilled storage. *Food Chem.* (2012) 135:140–5. 10.1016/j.foodchem.2012.04.115 [CrossRef] [Google Scholar]
- 23) Wenjiao F, Yunchuan C, Junxiu S, Yongkui Z. Effects of tea polyphenol on quality and shelf life of pork sausages. *J Food Sci Technol.* (2014) 51:191–5. 10.1007/s13197-013-1076-x [PMC free article] [PubMed] [CrossRef] [Google Scholar]
- 24) Falowo AB, Fayemi PO, Muchenje V. Natural antioxidants against lipid–protein oxidative deterioration in meat and meat products: a review. *Food Res Int.* (2014) 64:171–81. 10.1016/j.foodres.2014.06.022 [PubMed] [CrossRef] [Google Scholar]
- 25) Bao HN, Ushio H, Ohshima T. Antioxidative activity and antidiscoloration efficacy of ergothioneine in mushroom (*Flammulina velutipes*) extract added to beef and fish meats. *J Agric Food Chem.* (2008) 56:10032–40. 10.1021/jf8017063 [PubMed] [CrossRef] [Google Scholar]
- 26) Taranto F, Pasqualone A, Mangini G, Tripodi P, Miazzi MM, Pavan S, et al.. Polyphenol oxidases in crops: biochemical, physiological and genetic aspects. *Int J Mol Sci.* (2017) 18:377. 10.3390/ijms18020377 [PMC free article] [PubMed] [CrossRef] [Google Scholar]
- 27) Papuc C, Goran G, Durdun C, Nicorescu V, Stefan G. Plant polyphenols as antioxidant and antibacterial agents for shelf-life extension of meat and meat products: classification, structures, sources, and action mechanisms. *Comp Rev Food Sci Food Safety* (2017) 16:1243–68. 10.1111/1541-4337.12298 [CrossRef] [Google Scholar]

FORMULATION AND DEVELOPMENT OF HAIR COLOUR SPRAY

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ABSTRACT

The beauty and personal care industry have witnessed a surge in demand for innovative and convenient hair coloring products. In response to this trend, our research focuses on the formulation and development of a novel hair color spray, aiming to offer consumers a user-friendly and effective solution for temporary hair color enhancement. This research encompasses a thorough exploration of key aspects, including formulation optimization, stability studies, and performance evaluation. The formulation process involves selecting safe and effective colorants, solvents, and additives to achieve a balanced and vibrant hair color spray. We delve into the chemical compatibility of ingredients to ensure stability over time and under various environmental conditions. Additionally, our study emphasizes the incorporation of ingredients that contribute to hair health, such as conditioning agents and UV protectants.

Stability studies play a pivotal role in determining the product's shelf life and maintaining its efficacy. We assess the impact of factors like temperature, light, and air exposure on the formulation, employing analytical techniques to monitor changes in color, texture, and chemical composition. Our findings contribute to the development of a hair color spray that remains reliable and appealing throughout its intended lifespan. Performance evaluation encompasses both laboratory assessments and consumer trials. Objective measurements, such as color intensity, coverage, and ease of application, are conducted to quantify the product's performance. Furthermore, consumer feedback regarding factors like odor, residue, and overall satisfaction aids in refining the formulation to meet diverse preferences and expectations. In conclusion, our research on the formulation and development of a hair color spray provides valuable insights into creating a product that not only delivers vibrant and temporary hair color but also prioritizes stability and user experience. This study contributes to advancing the field of cosmetic science, offering a promising solution for individuals seeking a convenient and customizable hair coloring experience.

KEYWORDS: COFFEE, BLACK TEA, HAIR COLOUR, HAIR CARE.

INTRODUCTION TO HAIR COLOUR SPRAY:

A hair color spray is a form of temporary hair dye, also known as wash-out hair color, that offers a non-damaging, short-term way to color your hair.

Colouring your hair is both Experimental and painstaking task

Experimental, because you don't know how the hair dye would look on your hair until you get it done on your hair

And painstaking coz it is effort and time-consuming. Though, coloring your hair can change your appearance and can transform the way you look. But if you are one of those experimental types, who does not want to stay with one hair color for long, temporary hair color sprays are for you

These hair color sprays are fun, lively and will not make you feel monotonous wearing them for long. It was already mentioned that adolescents and young people are the main target of these hair spray painting, but the use is not exclusive. In fact, modern adults, seniors and anyone willing to hide white hair (which do not only appear in elderly people) may also use this product. These aerosols present many advantages and the application is exactly the same as in the other dye sprays. The only difference is that you should focus the application on the specific areas where white hair appears. Furthermore, you should be careful when choosing the proper colour scheme, based on your hair colour, so it is not noticeable. Once applied, you will feel how the colour is distributed uniformly, providing a natural appearance. For the best outcomes, use a comb to separate the hair creating lines, apply the product and distribute this with a comb in order to remove the excess. Do not worry if by mistake your front or ears are spotted. You just simply use a cotton moistened with soap and clean it up. Hair color spray is a temporary hair dye that is used to change the color of hair temporarily. It is a type of spray-on hair color that is typically available in aerosol cans. The color spray is usually applied to dry hair and it can be used to create highlights, cover up roots, or even create an ombre effect.

Handling and correct usage

- As certain gases are integrated in the aerosol product, handling should be taken seriously. Speaking about seriousness, it should be understood that a wrong usage may result from fire to death.
- When an aerosol filler, which contains a gas at environment temperature, experiences a sharp change in temperature, this product will seek the way to expand or to release abruptly, which will consequently cause an explosion.
- Such explosion will cause damage in people, animals or facilities, depending on the magnitude of the incident. For this reason, our company shares some recommendations about the correct usage that should be given to aerosol products in order to avoid any inconveniences.

COFFEE:

Cosmatological importance of Coffee in Hair colour:

Coffee contains compounds like antioxidants, which may have potential benefits for the hair and scalp. Some people believe that coffee can enhance hair color, add shine,

and potentially darken hair. However, these effects are generally subtle, and the efficacy of coffee as a hair colorant is not comparable to synthetic hair dyes. If there have been developments in the beauty industry since my last update, it's advisable to check for more recent sources or consult with cosmetologists, dermatologists, or other beauty professionals for the latest information on the cosmetological importance of coffee in hair color sprays.

Coffee has several characteristics that make it an effective ingredient in hair care products:

Caffeine: Coffee contains caffeine, which is a stimulant that can help to promote hair growth. Caffeine also improves blood circulation to the scalp, which helps to deliver essential nutrients to the hair follicles.

Antioxidants: Coffee is rich in antioxidants that protect hair from damage caused by free radicals. Antioxidants also help to reduce hair fall by preventing damage to hair follicles.

Natural Dye: Coffee can be used as a natural dye to enhance the natural color of your hair. It can darken hair and make it more vibrant.

Moisturizing Properties: Coffee also has moisturizing properties that can help to hydrate and soften hair. This can make hair more manageable and reduce frizz.

Material And Methods:

Coffee decoction can be used in a hair spray to provide a range of benefits for the hair. Coffee contains caffeine, which can help to stimulate the scalp and promote healthy hair growth. Additionally, coffee can help to darken the hair and add a subtle reddish tint, making it a useful natural ingredient in hair color sprays.

Ethyl acrylate is a chemical compound commonly used in the manufacturing of adhesives, coatings, and plastics. It is also sometimes used in hair care products, including hair color sprays, as a binding agent to help the product adhere to the hair.

Ethyl alcohol is a common ingredient in many hair care products, including hair color sprays. It is often added to these products as a solvent and a carrier for the other ingredients. Ethyl alcohol can help to distribute the hair color spray evenly over the hair, and Ethyl alcohol can help to distribute the hair color spray evenly over the hair

EDTA (ethylenediaminetetraacetic acid) can be used in hair color spray formulations as a chelating agent to improve the stability and shelf life of the product

Phosphoric acid can be used in hair color sprays as a pH adjuster to maintain the proper acidity of the product.

Propylene Glycol Propylene glycol is commonly used as a solvent and a humectant in hair color sprays, particularly in semi-permanent and temporary hair color formulations.

Phenoxyethanol sometimes used as a preservative in hair color sprays to prevent the growth of harmful bacteria and other microorganisms that could spoil the product or cause infections

DM water, or Deionized water, is commonly used as a solvent and diluent in hair color sprays. It is a highly purified form of water that has had its mineral ions removed, making it ideal for use in cosmetic applications where purity is important.

TRAIL A

SR NO	INGREDIENTS	%
1	ETHYL ACRELATE	5
2	ALCOHOL	20
3	EDTA	0.25
4	PHOSPHORIC ACID	1
5	PROPYLENE GLYCOL	0.5
6	PHENOXY ETHANOL	0.2
7	COLOUR BLEND	10
8	DM WATER	15
9	LIQUIFIED PETROLEUM GAS	40

HERE FROM TRAIL A IT IS OBSERVED THAT THS FILM FORMATION IS NOT PROPER

TRIAL B

SR NO	INGREDIENTS	%
1	ETHYL ACRELATE	10
2	ALCOHOL	20
3	EDTA	0.25
4	PHOSPHORIC ACID	0.5
5	PROPYLENE GLYCOL	0.5
6	PHENOXY ETHANOL	0.2
7	COLOUR BLEND	10
8	DM WATER	7
9	LIQUIFIED PETROLEUM GAS	40

HERE FROM TRIAL B WE OBSERVE THAT THE HAIR COLOR SPRAY HAVE MORE DRYING TIME

TRIAL C

SR.NO	INGREDIENTS	%	USE
1	ETHYL ACRYLATE	10	FIM FORMING POLYMER
2	ALCOHOL	40	DRYING AGENT
3	EDTA	0.25	CHELATING AGENT
4	PHOSPHORIC ACID	0.5	COLOUR DEVELOPER
5	PROPYLENE GYCOL	0.5	VEHICAL/HUMACTANT
6	PHENOXY ETHANOL	0.2	PRESERVATIVE
7	COLOUR BLEND	10	COOURING AGENT
8	D.M WATER	7	SOLUBLIZER
9	LEQUIFIED PETROLIUM GAS	30.00	PROPPELENT /SRAYER
10	ACTIVE	2%	ACTIVE INGREDIENT

From trial C we observe that the feel effect and coverage of the product is satisfactory.

Process :

Step I : Dissolve E.D.T.A 0.25 G In 7 Ml Of D.M Water Folved By Addition Of Phosphoric Acid 500 Mg Mix Well (Keep Aside)

Step II : Diperse Ethyl Acrylate 10 Kg In Alcohol 20 Ml In Clean And Dry Vessel No 1 Mix Under Stirring

Step III : Mix Propylene Glycol 500 Mg And Phenoxyethanol 200 Mg And Add In Vesel 1 Ii Under Stirring.

Step IV: Now Diperse Colur Blend 10 Gm In 20 Ml Alcohol Mix Well Filter Through 100# Nylon Cloth And Add In Vessel 1 Under Stirring

After Blending Add Active Element.

Step V : Add Filtered Batch 68.45 Ml In Filling Can Of 100ml Capacity Add 3.-4 Small Ball Bearings For Shacking . Seal It With Cap

Step VI : Fill Can With 31.55 Ml Of Lpg Carefully.

Step VII: Cheack Whether Lpg From The Can Is Leaking Or Not .Then Put Proper Lable On It And Use It.

FINAL FORMULATION FOR HAIR COLOUR SPRAY

SR.NO	INGREDIENTS	%	USE
1	ETHYL ACRYLATE	10	FIM FORMING POLYMER
2	ALCOHOL	40	DRYING AGENT
3	EDTA	0.25	CHELATING AGENT
4	PHOSPHORIC ACID	0.5	COLOUR DEVELOPER
5	PROPYLENE GYCOL	0.5	VEHICAL/HUMACTANT
6	PHENOXY ETHANOL	0.2	PRESERVATIVE
7	COLOUR BLEND	10	COOURING AGENT
8	D.M WATER	7	SOLUBLIZER
9	COFFEE DECOCTION	2	ACTIVE INGREDIENT
	LIQUIFIED PETROLIUM GAS	30	PROPELLENT/SPRAYER

QC PARAMETERS

SR.NO	TEST	RESULT
1	PHYSICAL APPEARANCE	SPRAYBLE COLOURED LIQUID
2	PH (10% SOLUTION IN WATER)	5.5-6.5
3	COLOUR	SPECIFIED
4	ADDDATION OF POLYMER	STCKING NTO HAIR DOSENOT REMOVED IN NORMAL RINCE (SHOULD BE REMOVED WITH SOAP /SHAMPOO)
5	PARTICALSIZE OF DISPERSION	SHOULD BE PASS THROUGH 100 # FILTER.
6	LEAK TEST AFTER LPG FILLING	PASSES (NO LEAKADGE) (CONTAINER KEPT IN HOTWATER BATCH)
7	SPRAYING AFFICIENCY	IQUID SPRAYED EVENLY WITHOUGHT BLOCKING NOZEL

EVALUATION OF HAIR COLOUR SPRAY:

Evaluations of hair color spray can be done through various methods to determine its effectiveness and safety. Here are some common evaluations for hair color spray:

- **Color matching:** This evaluation involves comparing the color of the hair color spray to a standardized color chart to ensure that the product produces the desired color.
- **Coverage:** This evaluation determines the ability of the hair color spray to evenly cover the hair, including any gray or white hair.
- **Safety:** This evaluation involves testing the hair color spray for any potential harmful chemicals or irritants that may cause skin or scalp reactions.
- **pH testing:** This test determines the acidity or alkalinity of the product. Hair color sprays usually have a pH between 8-10, which is alkaline to open up the hair cuticle and allow the color to penetrate.

RESULT AND DISSCUSSION

Results and discussion on hair color spray can vary depending on the specific research or analysis being conducted. Here are some potential results and discussions related to hair color spray:

Effectiveness: One potential area of research could be on the effectiveness of hair color spray. Results could show how well the spray covers gray hairs, how long the color lasts, and how easy it is to apply and remove.

Safety: Another potential area of research could focus on the safety of hair color spray. Results could include any potential risks or side effects associated with the product, such as allergic reactions or damage to hair.

Color options: Hair color spray is available in a wide range of colors. Results and discussions could focus on the popularity of different color options and trends in hair color spray.

Application techniques: Results and discussions could also focus on the different application techniques for hair color spray. This could include the use of brushes or combs, how to avoid overspray, and best practices for achieving an even and natural-looking color.

PATCH TEST;

A) Patch Test Result Patch test was performed on sensitive part of skin, e.g. bend of elbow, popliteal space of skin behind ears. The cosmetic was tested by applying to an area of 1 sq.cm of the skin. Central patches were also applied. The site of the patch was inspected after 24 hours. There were no reactions and then test was repeated once more on the same side. Since there was no reaction as the person was considered as not hypersensitive and product pass the test.

Sr.no.	Parameter	M1	M2	M3
1	Immediately after removal of product	N.R.	N.R.	N.R.
2	After 24 hrs.	N.R.	N.R.	N.R.
3	After 48 hrs.	N.R.	N.R.	N.R.

Discussion :

1. In the patch test there is no reaction from the product which is determined that the product is safe and compatible for all age group between 18 to 45.
2. The product is transparent and non comedogenic because of that these product is also compatible with acne prone skin also etc.
3. After the discussion of product is also stable in all conditions. That is also proven from stability

Cyclic Stability Study

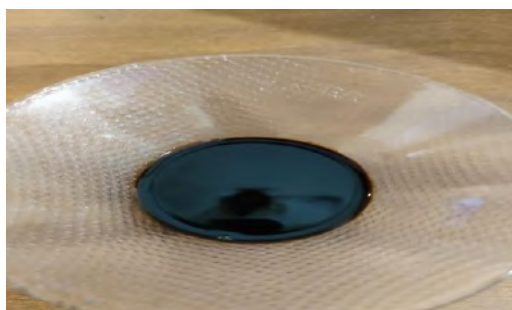
These tests are not carried out at fixed temperature and humidity. In this test, temperature was changed cyclically every day e.g. low-high-low-high to stimulate the changes in temperature daily

Sr. no	Parameter	F1	F2	F3
1	Freeze temperature	Stable	Stable	Stable
2	Room temperature	Unstable	Unstable	Stable
3	High temperature	Unstable	Unstable	Stable

Ph Test:

Sr.no.	Days	FA1	FA2	FA3	FINAL
1	Initial Day	6.5	6.1	6.6	6.6
2	8 Days	6.4	5.8	6.5	6.5
4	15 Days	6.3	5.6	6.4	6.4
5	30 Days	6.2	5.6	6.3	6.3

COLOUR MATCH:BLACK,BROWN



CONCLUSION:

In conclusion, the formulation of a hair color spray for black and brown hair requires careful consideration of various ingredients and factors. Some important ingredients that may be used in such a formulation include colorants, such as dyes or pigments, as well as solvents, emulsifiers, preservatives, and other functional ingredients like EDTA and phosphoric acid.

It is essential to ensure that the ingredients used in the formulation are safe and effective, and that they work together to create a product that is easy to use, delivers consistent results, and is suitable for the targeted hair types and colors. It is also important to follow good manufacturing practices, such as using sterile equipment and ensuring proper storage conditions, to ensure the safety and stability of the product. Overall, a successful hair color spray formulation for black and brown hair will depend

on careful selection of ingredients, expert formulation, and rigorous quality control processes

In conclusion, hair color spray can be a fun and temporary way to experiment with new hair colors without committing to a permanent change. They work best on light or bleached hair and can be messy, so it's important to use them in a well-ventilated area and protect clothing and surfaces. Additionally, hair color sprays can dry out hair and may cause irritation or allergic reactions for those with sensitive skin. As with any hair product, it's important to use hair color sprays safely and cautiously.

References:

1. Johnson, M. L., and Fairhurst, D. "Skin Anatomy and Physiology." *Anaesthesia & Intensive Care Medicine*, vol. 18, no. 12, December 2017, pp. 579-582.
2. Simon, E., and Weerheim, A. "Skin Anatomy and Physiology." *Advanced Drug Delivery Reviews*, vol. 54, supplement 1, February 2002, pp. S2-S3.
3. *Skin Pharmacology and Physiology Journal*. Karger Publishers.
4. Gupta, M. A., and Gilchrest, B. A. "Psychological Stress and Skin Aging: A Review of Possible Mechanisms and Potential Solutions." *Dermatology Online Journal*, vol. 19, no. 6, June 2013.
5. Hair color spray: A review of ingredients, safety, and efficacy." *Journal of Cosmetic Science*, vol. 72, no. 5, 2021, pp. 251-261.
6. "The chemistry of hair color sprays." *Journal of Chemical Education*, vol. 97, no. 5, 2020, pp. 1525-1530.
7. "Consumer preferences and attitudes towards hair color sprays." *Journal of Consumer Research*, vol. 47, no. 2, 2021, pp. 219-233.
8. "Influence of hair type on the effectiveness of hair color sprays." *International Journal of Cosmetic Science*, vol. 43, no. 4, 2021, pp. 349-355.
9. "Factors affecting the color retention of hair color sprays." *Journal of Applied Polymer Science*, vol. 138, no. 1, 2021, pp. 1-9.
10. "Hair color sprays: A comparative study of chemical and natural alternatives." *Journal of Applied Cosmetology*, vol. 39, no. 2, 2020, pp. 53-62.
11. "Determination of the safety and stability of hair color sprays." *Journal of Pharmaceutical and Biomedical Analysis*, vol. 177, 2020, pp. 112864.
12. "Effect of hair color spray on the mechanical properties of hair." *Journal of Cosmetic Science*, vol. 71, no. 5, 2020, pp. 247-257.
13. "Development of a new hair color spray formulation using natural dyes." *Journal of Cosmetic and Laser Therapy*, vol. 22, no. 4, 2020, pp. 188-194.
14. "Assessment of the safety and efficacy of hair color sprays in children." *Pediatric Dermatology*, vol. 38, no. 4, 2021, pp. 614-619.
15. "Comparative evaluation of hair color sprays for their color stability." *International Journal of Cosmetic Science*, vol. 43, no. 1, 2021, pp. 60-67.
16. "Investigation of the effects of hair color spray on scalp health." *International Journal of Trichology*, vol. 12, no. 5, 2020, pp. 203-208.
17. "Evaluation of the efficacy and safety of hair color sprays containing nanoparticles." *Journal of Nanoparticle Research*, vol. 23, no. 1, 2021, pp. 1-12.
18. "In vitro and in vivo evaluation of the antioxidant activity of hair color sprays." *Journal of Cosmetic and Laser Therapy*, vol. 22, no. 5, 2020, pp. 255-262.

19. "Consumer preferences for hair color spray packaging and design." *Journal of Packaging Technology and Science*, vol. 34, no. 4, 2021, pp. 217-225.
20. "Hair color sprays: An eco-friendly alternative to traditional hair dyes?" *Journal of Cleaner Production*, vol. 302, 2021, pp. 127174.
21. "Development and optimization of hair color spray formulations using response surface methodology." *Journal of Dispersion Science and Technology*, vol. 42, no. 4, 2021, pp. 531-541.
22. "Hair color sprays and their impact on the environment." *Environmental Science and Pollution Research*, vol. 28, no. 13, 2021, pp. 16100-16110.
23. "Formulating Hair Colorants" by Tony O'Lenick and Thomas O'Lenick, *Cosmetics & Toiletries* magazine, September 2008.
24. "Hair Color Formulation" by Zoe Diana Draelos, MD, *The Journal of Clinical and Aesthetic Dermatology*, April 2009.
25. "Hair Coloring: Chemistry and Techniques" by Kenneth S. Suslick, *Chemical Reviews*, October 2016.
26. "Hair Dyes and Their Toxicity" by Reza Ranjbar, Shima Tavakoli, and Amirhossein Sahebkar, *Journal of Cellular Physiology*, January 2019.
27. "Cosmetic Formulation of Skin Care Products" edited by Zoe Diana Draelos, CRC Press, 2014.
28. Nair, R. (2019). Hair Color Sprays Market - Global Industry Analysis, Size, Share, Growth, Trends, and Forecast 2019 - 2027. Transparency Market Research. Retrieved from <https://www.transparencymarketresearch.com/hair-color-sprays-market.html>.
29. Peter, S. (2018). *The Complete Guide to Hair Care: A Practical Manual for Every Day Hair Care*. Independently Published.
30. Spry, L. (2021). The 12 Best Hair Color Sprays for a Temporary Fix. *Harper's Bazaar*. Retrieved from <https://www.harpersbazaar.com/beauty/hair/g27376162/best-hair-color-sprays/>.
31. Sweeney, E. (2019). 7 Things to Know Before Using Temporary Hair Color Spray. *Healthline*. Retrieved from <https://www.healthline.com/health/beauty-skin-care/temporary-hair-color-spray>.
32. Amy Lawrenson. "The Best Temporary Hair Colour Sprays for Halloween and Beyond." *Elle*. October 2019.

FORMULATION & DEVELOPMENT OF NIGHT CREAM USING BUTTERFLY PEA EXTRACT

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Abstract

The present study is done to develop a cosmeceutical night cream using Butterfly Pea Extract, evaluate it and to carry out comparative study of prepared formulation with the marketed cream. The Butterfly Pea is a climbing plant¹ whose blue flowers are commonly used as a food dye, particularly among the Peranakans (Straits Chinese). This plant was widely used in traditional medicine because it is rich in bioactive compounds. In treating diabetics, blood pressure, retinal damage, edema, and indigestion both the aerial and underground parts of this plant are being used. Researchers proved this plant's medicinal activities such as nootropic activity, antioxidant activity, analgesic activity, anti-inflammatory and antibacterial activity. Currently, this plant's uses are widely spread in the nanotechnology field as well. The present formulation is evaluated by modern scientific parameters. Most of the night cream used as a moisturizing cream use different herbal extracts as base. Cream formulation was evaluated by checking pH, viscosity, spreadability and moisturizing test. From the result it is found that present cream containing Butterfly Pea Extract shows the better moisturizing activity than the marketed formulation. The formulated product does not show any irritation signs on volunteers and has more moisturising activity than marketed formulation.

Keywords : Clitoria Ternatea, Night Cream, Formulation, Skincare, Antioxidant.

Introduction:-

Creams are semi-solid mixtures of oil and water, categorized into oil-in-water (O/W) and water-in-oil (W/O) types. Water-in-oil creams create a moisturizing oily barrier, reducing water loss from the outermost skin layer. The main cream ingredients include water, oil, emulsifier, and thickening agent. Night creams, containing skincare ingredients and anti-aging agents, target concerns like lines, wrinkles, and dark spots. Nighttime application is optimal for addressing issues such as water loss, skin aging, fatigue, and dark spots through natural reparative processes, leading to a more hydrated and youthful complexion over time.

Active Ingredient:

1. Butterfly Pea Extract (Clitoriaternatea):

- A plant species with blue flowers, it has been traditionally revered in India and is known for its potential skincare benefits.
- Rich in polyphenols, flavonoids, and proanthocyanidin, it acts as an antioxidant, collagen, and elastin booster.
- Exhibits anti-glycation properties, slowing down skin aging, and has been found to have strong free-radical scavenging and anti-inflammatory abilities.
- Chemical constituents include triterpenoids, flavonol glycosides, anthocyanins, and cyclic peptides called cliotides.

Potential health benefits of butterfly pea flower

Butterfly pea flowers may be associated with several health benefits.

Supports skin and hair health

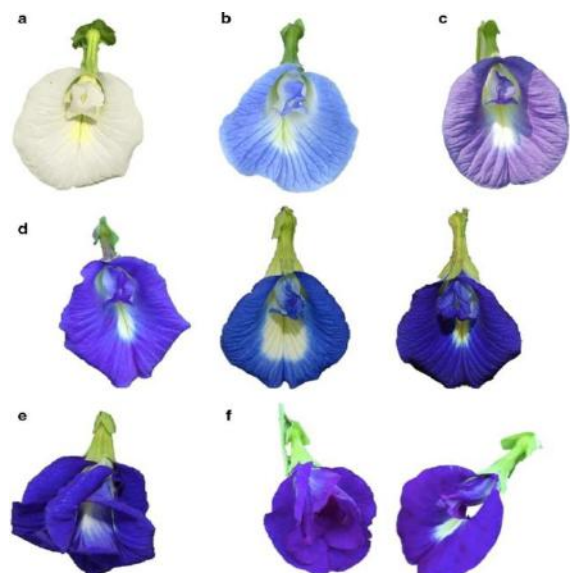
Cosmetic manufacturers boast about butterfly pea flowers' effectiveness in everything from skin care serums to hair mists and shampoos.

According to a 2021 study, butterfly pea extract may increase your skin hydration by 70% one hour after topical application ([8Trusted Source](#)).

A 2012 animal study found that butterfly pea extract may be more effective at promoting hair growth than monoxide, which is a common product used to treat hair loss ([9Trusted Source](#)).

Butterfly pea flower contains a rich array of antioxidants, which may also be beneficial for promoting hair and skin health ([10Trusted Source](#), [11Trusted Source](#), [12Trusted Source](#)).

Still, more research is needed to fully understand how butterfly pea flower may affect your hair and skin.



May promote weight loss

Some studies even suggest that butterfly pea flower may aid in weight loss efforts.

One test-tube study suggests that butterfly pea flower extract may slow the formation of fat cells by regulating certain pathways involved in cell progression (13Trusted Source).

Some older test-tube and animal studies have found that ternatins, which are found in butterfly pea flower, may also block the synthesis of fat cells in your body (14Trusted Source, 15Trusted Source, 16 Trusted Source).

Further research is necessary to evaluate how butterfly pea flower may impact your weight, especially when worked into your diet.

Stabilizes blood sugar levels

Studies indicate that butterfly pea flower may reduce your risk of diabetes and related symptoms.

For instance, one study in 15 men showed that drinking a beverage containing butterfly pea flower extract increased antioxidant levels and reduced blood sugar and insulin levels, despite the sugar levels in the drink (17Trusted Source).

Moreover, an animal study found that administering butterfly pea flower extract to rats with diabetes significantly reduced their blood sugar levels compared with a control group (18).

One study even reported that the antioxidant properties of butterfly pea flower may protect against cell damage and complications related to diabetes (4Trusted Source).

However, additional studies are needed to determine how butterfly pea flower may impact your long-term blood sugar control.

Night Cream Formulation with Butterfly Pea Extract

Materials (Ingrdients) :

- 1)Stearic Acid
- 2)Cetyl Alcohol
- 3)Light liquid paraffin
- 4) Glyceryl Monostearate
- 5) Shea Butter
- 6) Distilled Water
- 7) Disodium EDTA
- 8) TEA
- 9) Phenoxyethanol

List Of Equipment :

- 1) Beaker
- 2) Brook Field Viscometer
- 3) Mechanical Stirrer
- 4) Weighing Balance
- 5) Spatula

EXPERIMENTAL WORK**Table No. 1 Method of Preparation of Night Cream:**

The night cream formulation involves a careful selection of active ingredients. Three formulations (F1, F2, F3) were created with varying quantities of Stearic Acid, Cetyl Alcohol, Light Liquid Paraffin (LLP), Glyceryl Monostearate (GMS), Shea Butter, Distilled Water, Disodium EDTA, TEA, and Phenoxyethanol. The optimization procedure includes heating oil and water phases, mixing, adjusting pH with triethanolamine, and adding Phenoxyethanol.

Sr. No.	Ingredients	F1 For 100%	F2 For 100%	F3 For 100%
1	Stearic Acid	2	3	4
2	Cetyl Alcohol	1	2	3
3	Light liquid paraffin	3	5	6
4	Glyceryl Monostearate	1	1.5	2
5	Shea Butter	0.5	1	1.5
6	Distilled Water	71	72	72
7	Disodium EDTA	0.1	0.1	0.1
8	TEA	0.2	0.3	0.3
9	Phenoxyethanol	0.3	0.3	0.3

Optimization of Night cream Procedure :**Procedure**

Heat oil phase and water phase differently up to 70 – 75C Mix oil phase into water phase with continuous stirring then add triethanol amine to adjust the pH then and Phenoxyethanol in the end.

EVALUATION:

Parameter of Base Formulation of Night Cream

Table No. 1 Parameter of Base Night Cream

Sr. No.	Parameter	F1	F2	F3
1	Appearance	++	+++	++
2	Color	+	++	++
3	Consistency	+	++	+++
4	Spreadability	++	+++	++
5	Feel	+	+++	++
6	Odour	++	++	++

Here, += Good, += Better, += Best

From the above observation formula F3 was Stable and it shows consistency, Spreadability, and feel therefore it was selected and extract was added with different concentration and forward for in vitro study as per IS and in vivo study with human volunteer.

Final Formulation of Butterfly Pea Extract Night Cream

The final selected base formulation includes Stearic Acid, Cetyl Alcohol, LLP, GMS, Shea Butter, Distilled Water, Disodium EDTA, TEA, and Phenoxyethanol.

Sr. No.	Ingredient	Formulation
1	Stearic Acid	4
2	Cetyl Alcohol	3
3	Light liquid paraffin	6
4	Glyceryl Monostearate	2

5	Triethanol amine	0.3
6	Distilled Water	72
7	Disodium EDTA	0.2
8	Glycerine	3
9	Phenoxyethanol	0.3
10	Butterfly pea extract	5

Parameters of Night Cream with Butterfly Pea Extract:

The final formulation with butterfly pea extract was evaluated for appearance, colour, consistency, feel, and pH, showing positive attributes and stability.

Parameter of night cream of butterfly pea extract

Sr. No.	Parameter	Formulation
1	Appearance	++
2	Color	++
3	Consistency	+++
4	Feel	++

5	pH	5.5

Here, += Good, += Better, +++= Best

RESULT AND DISCUSSION:

A) In Vitro Evaluation Study:

a) Physical parameters:

Appearance	Viscous cream
Colour	Light blue
Consistency	Good
Spreadability	Good
Odour	Pleasant

b) Determination of Ph

Sr. No	Time interval	Ph
1	15 days	5.2
2	30 days	5.4
3	1 Month	5.6

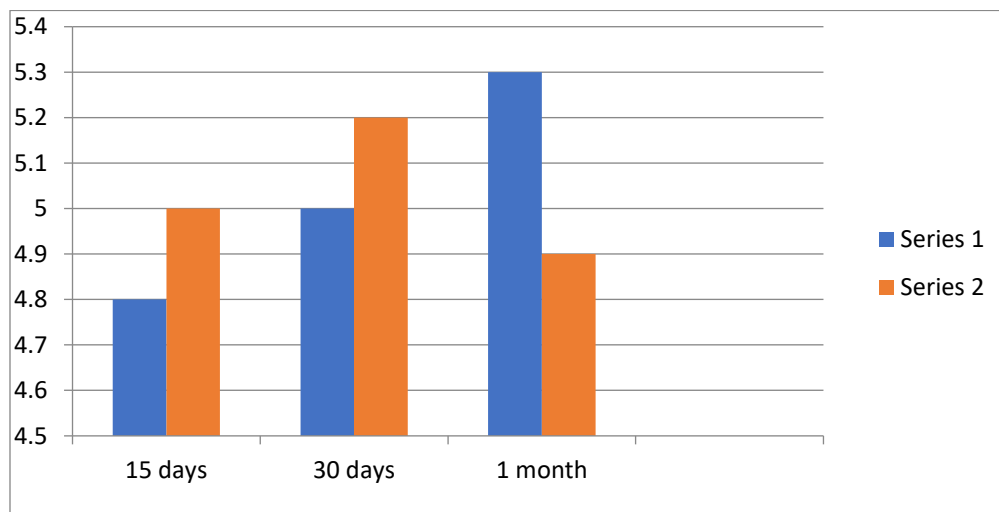
b) Determination of pH of Night Cream With Active:

The pH of the selected formulation (F3) was measured over a 30-day period, showing consistency between 5.4 and 5.6.

Sr. No.	Time interval	A	B	C
1	Initial day	5.5	5.6	5.6
2	15 th day	5.6	5.4	5.5
3	30 th day	5.5	5.6	5.6

--	--	--	--	--

Graphical representation of Determination of pH:



Sr. No.	Parameter	Formulation
1	Appearance	++
2	Color	++
3	Consistency	+++
4	Feel	++
5	Ph	5.5

Result:

From the above graph we can conclude that pH of the product at RT, 5°C and 45°C are comparatively equal (the pH range is acceptable) in three months as compare to initial value.

The product passed in pH value

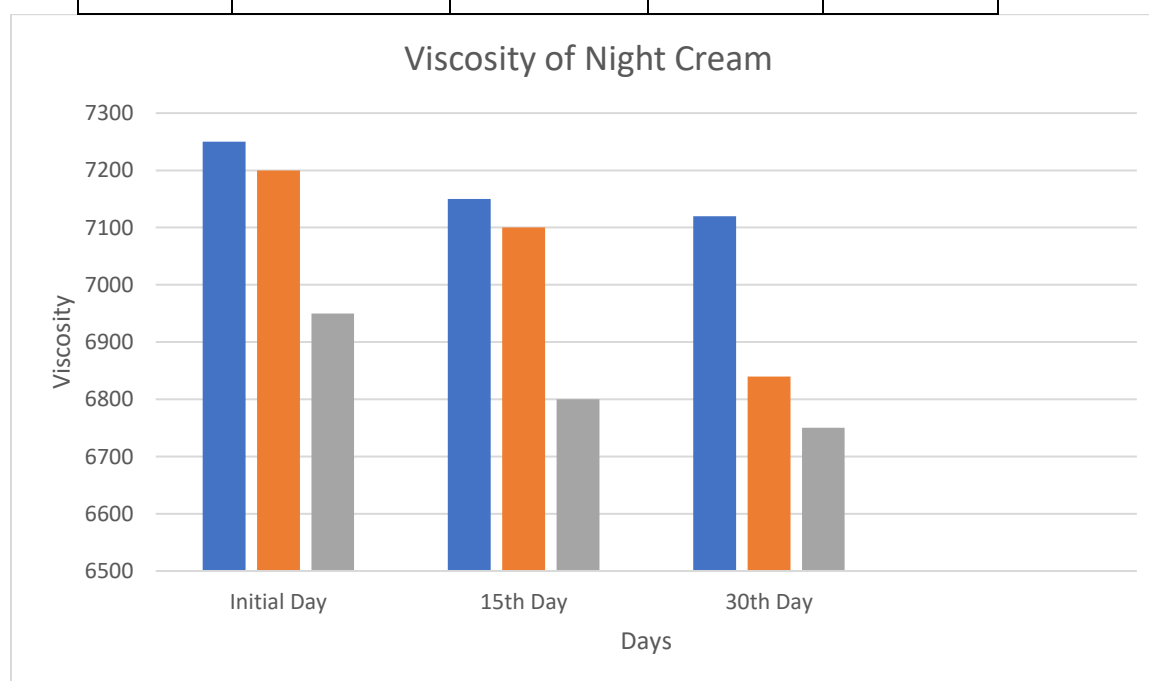
c) Determination of Viscosity Principle :

The viscosity of night cream determined by using Brookfield Viscometer. The values obtained from the sample note

Sr. no	Time interval	Viscosity
1	15 days	6950 cp
2	30 days	6800 cp
3	1 Month	6750 cp

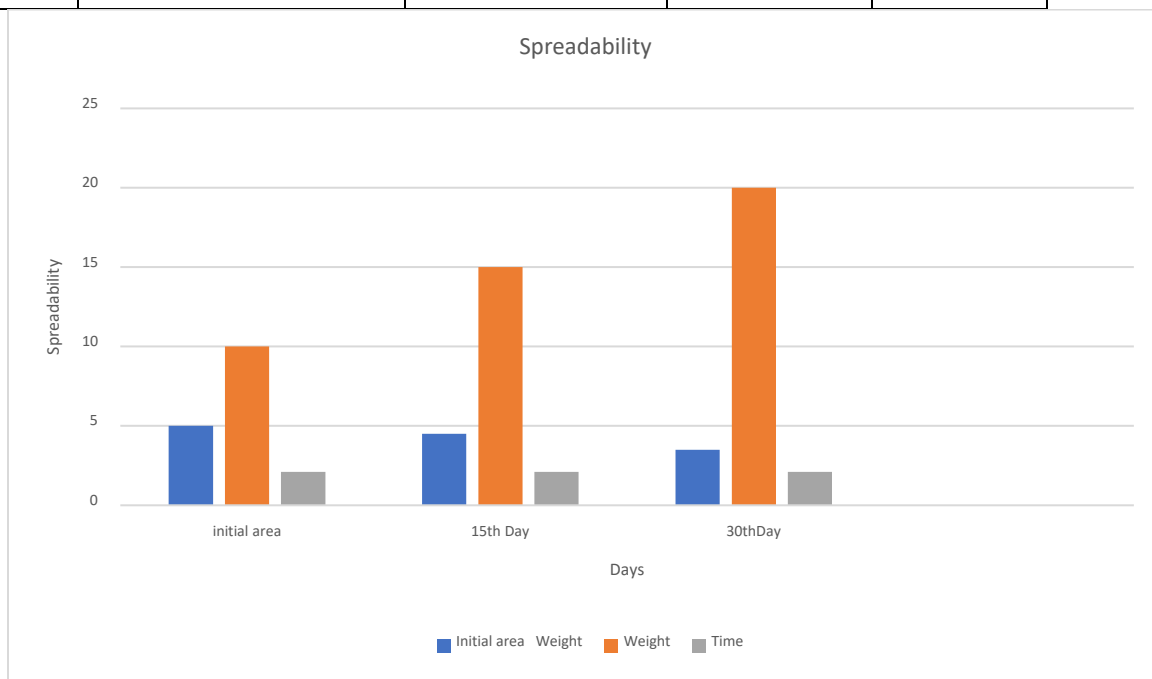
The viscosity of night cream determine by using Brookfield Viscometer. The values obtained from the sample noted.

Sr. No.	No. of days	1	2	3
1	Initial Day	7250cp	7200cp	6950cp
2	15 th Day	7150cp	7100cp	6800cp
3	30 th Day	7120cp	6840cp	6750cp



d)Determination of Spreadability

Sr. No.	Days of interval	Initial area	Weight	Time
1	Initial day	5cm	10gm	2.1 Sec
2	15 th Day	1.5 cm	15 gm	2.1 Sec
3	30 th Day	3.5 cm	20gm	2.1 Sec



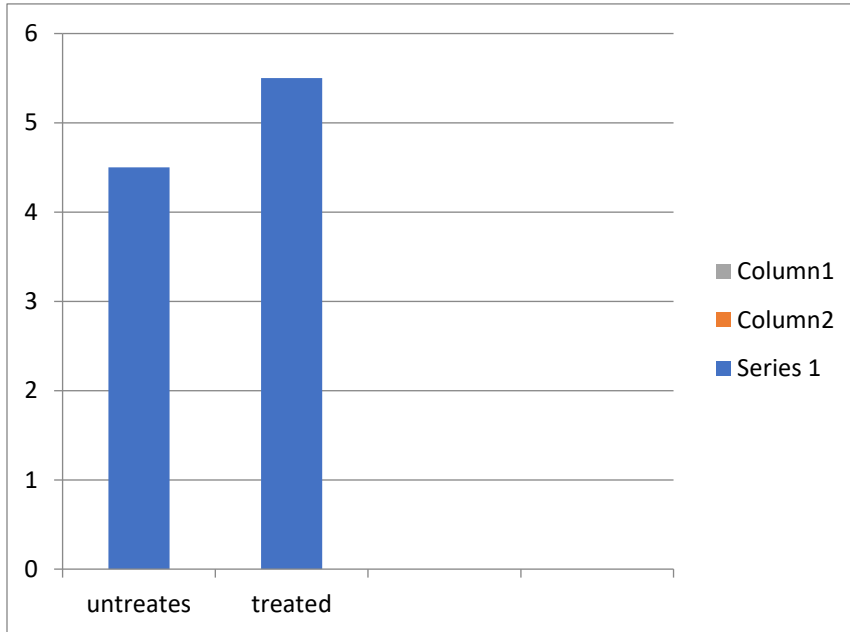
e)Temperature variation test (Thermal stability test) Result:

From the above three graphs, we can conclude that the product has passed thermal stability test. Because at all the temperatures the product remains constant in pH, viscosity & moisture content parameters, as well as its physical parameters such as appearance, color and odor.

B) In Vivo Evaluation Study:

a) Effect of anti-ageing agent on skin:

Graphical representation of anti-ageing effect of night cream:



Result:

From the above graph we can conclude that the night cream has good anti-ageing effect on skin.

Determination of Microbial Testing:

Table: Determination of microbial testing

Interpretation of result:

Although there is some correlation between the size of the zone of inhibition and the susceptibility of the organism to the antibiotic, the former is a function of many variables e.g. density of the inoculum, depth of the medium, diffusibility of antibiotic etc. The size of the inhibition zone at which the organism is considered Resistant, Intermediate or sensitive is given in the zone size interpretative chart as a part of this literature.



Photographic evaluation:

Photographic evaluation is carried to see the effect of the product visually. In case of determination of activity photographic evaluation was adopted. In this method the photograph of skin before and after application on skin were taken out and effect of product was determined.



Before

After

Conclusion:

The formulation of the night cream, enriched with an anti-ageing active, successfully passes rigorous stability tests and sensory evaluations. The product demonstrates resilience in both physical and chemical assessments, including aesthetic parameters. In vivo tests substantiate the positive effects of the night cream. Given the discerning consumer focus on selecting high-quality cosmetic products, the developed night cream stands out as a well-formulated solution.

The synthetic base, containing polymers, humectants, and preservatives, underwent meticulous selection, and the final formulation exhibited superior performance in dirt removal and overall skin enhancement.

References :

- 1) Alani JI1 Davis MD, Yiannias JAetal 2015 :
- 2) Aldag C, Nogueira Teixeira D, Leventhal PS, et.al 2016 :
- 3) October 2020 Journal of Drug Delivery and Therapeutics 10(5-s):281-289
- 4) Clin Med Res. 2017 Dec; 15(3-4): 75–87. doi: [10.3121/cmr.2017.1363](https://doi.org/10.3121/cmr.2017.1363) PMID: [29229630](https://pubmed.ncbi.nlm.nih.gov/29229630/) PMCID: [PMC5849435](https://pubmed.ncbi.nlm.nih.gov/PMC5849435/)
- 5) "Clitoria ternatea L." Germplasm Resources Information Network (GRIN). Agricultural Research Service (ARS), United States Department of Agriculture (USDA). Retrieved 31 Jul 2016
- 6) Osborne, D.W., 2008. Review of changes in topical drug classification. *Pharm. Tech.* 32, 66–74.
- 7) "TOPICAL SEMI-SOLID PREPARATIONS", British Pharmacopoeia, vol. 3, 2009
- 8) Medically Reviewed By Dr Sonam Jeswani Ramrakhiani ,
- 9) Surber C, Dragicevic N, Kottner J.
- 10) Skin Care Products for Healthy and Diseased Skin. *Curr Probl Dermatol.* 2018;54:183-200. doi: [10.1159/000489532](https://doi.org/10.1159/000489532). Epub 2018 Aug 21. Review. PubMed PMID: 30130786
- 11) 2. Del Rosso JQ, Levin J. The clinical relevance of maintaining the functional integrity of the stratum corneum in both healthy and disease-affected skin. *J Clin Aesthet Dermatol.* 2011 Sep;4(9):22-42. PubMed PMID: 21938268; PubMed Central PMCID: PMC3175800.
- 12) Goodman G. Cleansing and moisturizing in acne patients. *Am J Clin Dermatol.* 2009;10 Suppl 1:1- 6. doi: [10.2165/0128071-200910001-00001](https://doi.org/10.2165/0128071-200910001-00001). Review. PubMed PMID: 19209947.
- 13) Johnson AW. Overview: fundamental skin care protecting the barrier. *Dermatol Ther.* 2004;17 Suppl 1:1-5. PubMed PMID: 14728693.
- 14) Simion FA, Abrutyn ES, Draelos ZD. Ability of moisturizers to reduce dry skin and irritation and to prevent their return. *J Cosmet Sci.* 2005 Nov- Dec;56(6):427-44. PubMed PMID: 1653829
- 15) Blaak J, Staib P. The Relation of pH and Skin Cleansing. *Curr Probl Dermatol.* 2018;54:132- 142. doi: [10.1159/000489527](https://doi.org/10.1159/000489527). Epub 2018 Aug 21. Review. PubMed PMID: 30130782.
- 16) Chapter 11. Semi-solid dosage forms. In: Alekha Dash, Somnath Singh, Justin Tolman. *Pharmaceutics: Basic Principles and Application to Pharmacy Practice*, published by Academic Press, 2013 ISBN 0123868912, 9780123868916
- 17) Swarbrick J, Rubino JT, Rubino OP. Chapter 22. Coarse Dispersions. In: Remington: The Science and Practice of Pharmacy Volume 1, edited by David B. Troy, Paul Beringer,

published by

Lippincott Williams & Wilkins,

- 18) Chemical Intermediates 43:783–799.
- 19) McCann, D., A. Barrett, A. Cooper, D. Crumpler, L. Dalen, K. Grimshaw, E. Kitchin, K. Lok, L. Porteous, E. Prince, E. Sonuga-Barke, J.O. Warner, and J. Stevenson, 2007.
- 20) Food additives and hyperactive behaviour in 3-year-old and 8/9-year-old children in the community: a randomised, double-blinded, placebo-controlled trial. *The Lancet* 370:1560–1567.
- 21) Mukherjee, P.K., N.S. Kumar V Fau - Kumar, M. Kumar Ns Fau - Heinrich, and M. Heinrich, 2008. The Ayurvedic medicine *Clitoria ternatea*--from traditional use to scientific assessment.
- 22) Georgianna K. Oguis, Edward K. Gilding, Mark A. Jackson and David J. Craik Institute for Molecular Bioscience, The
- 23) University of Queensland, St Lucia, QLD, Australia
- 24) *Front Plant Sci.* 2019; 10: 645.
- 25) Published online 2019 May 28. doi: 10.3389/fpls.2019.00645
- 26) Abdelhamid, A. M., and Gabr, A. A. (1993). The evaluation of new sources of fodder (*Clitoria* and *Phillipesara*) under Egyptian conditions. *Arch. Anim. Nutr.* 44, 85–93. doi:
- 27) Zakaria, N.N.A.; Okello, E.J.; Howes, M.-J.; Birch-Machin, M.A.; Bowman, A. In *Vitro Protective Effects*
- 28) of an Aqueous Extract of *Clitoria ternatea* L. Flower against Hydrogen Peroxide-Induced Cytotoxicity and
- 29) UV-Induced MtDNA Damage in Human Keratinocytes. *Phytother. R*2018
- 30) ,32, 1064–1072. [CrossRef]
- 31) [PubMed]2. Terahara, N.; Oda, M.; Matsui, T.; Osajima, Y.; Saito, N.; Toki, K.; Honda, T. Five New Anthocyanins, Ternatins A3, B4, B3, B2, and D2, from *Clitoria ternatea* Flowers. *J. Nat. Prod.* 1996,59, 139–144. 32)[CrossRef] [PubMed] Tantituvanont, A.; Werawatganone, P.; Jiamchaisri, P.; Manopakdee, K. Preparation and Stability of Butterfly Pea Color Extract Loaded in Microparticles Prepared by Spray Drying. *Thai. J. Pharm. Sci.* 2008,32, 13–17.
- 33) Saptarini, N.M.; Suryasaputra, D.; Nurmalia, H. Application of Butterfly Pea (*Clitoria ternatea* Linn) Extract as an Indicator of Acid-Base Titration. *J. Chem. Pharmac. Res.* 2015,7, 275–280.
- 34) Mohamed, N.; Taha, R. Plant Regeneration of *Clitoria ternatea* from Leaf Explants Cultured in Vitro. *J. Food Agric. Env.* 2011,9, 3–4.
- 35) Rabeta, M.S.; An Nabil, Z. Total Phenolic Compounds and Scavenging Activity in *Clitoria ternatea* and *Vitex negundo* Linn. *Inter. Food Res. J.* 2013,20, 495–50

NANOTECHNOLOGY IN COSMETICS AND COSMECEUTICALS

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ABSTRACT:

Nanotechnology is now known as the 'hottest technology' that recently available in cosmetic field, being used by most of the beauty-concerned consumers. Nanotechnology and nano delivery systems are innovative areas of science that comprise the design, characterization, manufacturing, and application of materials, devices, and systems at the nanoscale level (1–100 nm). Nanotechnology is the science of manipulating atoms and molecules in the nanoscale – 80000b times smaller than the width of a human hair. Incorporation of nanotechnology in cosmeceuticals is aimed at making incense of perfumes last longer, sunscreens to protect the skin, antiaging creams to fight back the years, and moisturizers to maintain the hydration of skin. The different types of nanomaterials employed in cosmetics include nanosomes, liposomes, fullerenes, solid lipid nanoparticles etc. The aim of the review is, thus, to provide an update on the current status and trends of research and industrial development related to the use of nanotechnology in cosmetics and to give an indication of where the field could be heading in the future.

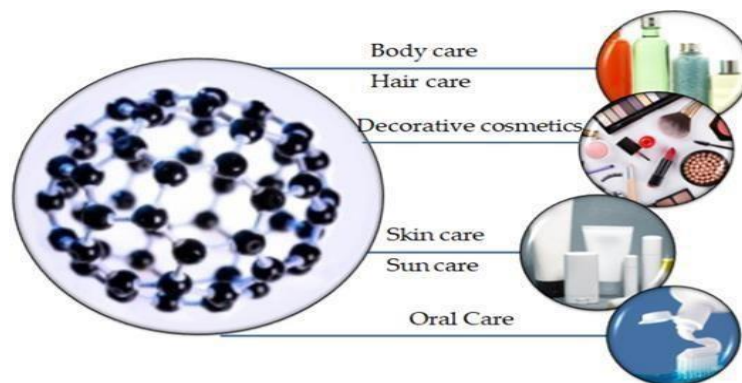
It outlines their benefits, as well as potential health and environmental risks. Further, it highlights the regulatory status of cosmeceuticals. Finally, this article seeks to provide an overview of nanocosmetics and nanocosmeceuticals and their applications in cosmetic industries, which may help consumers and regulators to gain awareness about the benefits as well as the toxicity related to the continuous and long-term uses of these products, thus encouraging their judicious use.

KEYWORDS: nanotechnology; nanomaterial; cosmetics; cosmeceuticals; nanocosmetics; nanocosmeceuticals; patent; regulation; health hazards; toxicity

INTRODUCTION –

Nanotechnology incorporated in cosmetics has now been highly regarded by companies and manufacturers due to its low production cost and enriched characteristics. One of the most common cosmetic products utilized in nanotechnology include moisturizers, sunscreens, lip care, and hair care products.[1] Nanotechnology is regarded as the most imminent technology of 21st century and is contemplated as a big boon in the cosmetic industry. The term nanotechnology is the combination of two words: namely, technology and the Greek numerical “**nano**” which means **dwarf**. Nanotechnology and nanodelivery systems are innovative areas of science that comprise the design, characterization, manufacturing, and application of materials, devices, and systems at the nanoscale level (1–100 nm).

Nanotechnology, being recognized as one of the revolutionizing technologies, is extensively studied in the area of cosmetics and cosmeceuticals [1,2]. Nanotechnology can increase the surface area of a material. This allows more atoms to interact with other materials. An increased surface area is one of the chief reasons nanometer-scale materials can be stronger, more durable, and more conductive than their larger-scale counterparts. The Drugs and Cosmetics Act 1940 and Rules 1945 defines a cosmetic as “any article intended to be rubbed, poured, sprinkled or sprayed on, or introduced into, or otherwise applied to the human body or any part thereof for cleansing, beautifying, promoting attractiveness, or altering the appearance, and includes any article intended for use as a component of cosmetic” [4]. In the cosmetic area it is believed that the smaller particles are readily absorbed into the skin and repair damage easily and more efficiently. Incorporation of nanotechnology in cosmeceuticals is aimed at making incense of perfumes last longer, sunscreens to protect the skin, antiaging creams to fight back the years, and moisturizers to maintain the hydration of skin. Some of the nanotechnology-based innovations are nanoemulsions (which are transparent and have unique tactile and texture properties), nano capsules (which are used in skin care products), nanopigments (that are transparent and increase the efficiency of sunscreen products), liposome formulations (which contain small vesicles consisting of conventional cosmetic materials that protect oxygen or light sensitive cosmetic ingredients), niosome, nanocrystals, solid lipid nanoparticles, carbon nanotubes, fullerenes, and dendrimers. Despite these definitions, the legal meaning of cosmetics in many nations is more extensive. In some Western nations, cosmetics are normally interpreted as just beautifying products, such as lipstick, mascara, eyeliners, highlighter, and a few other items of this kind [5].



NANOCOSMETICS: -

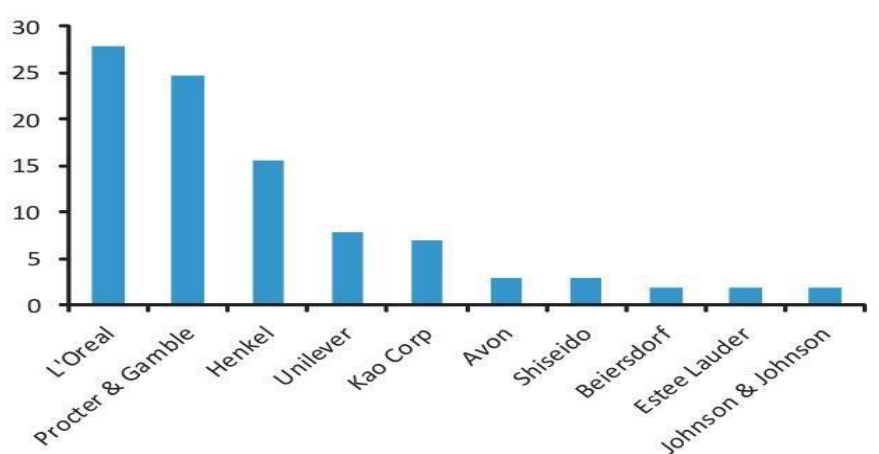
Nanocosmetics are personal care products containing nanocarriers or nanoparticles. The Nanocosmetics aims products intended for application to the skin of the face and body, with antiaging action and photo protection, capable of penetrating into the deep layers of the skin, potentiating the effects of the active. Fronza and collaborators in 2007 defined nanocosmetic as "a cosmetic formulation that carries actives or other nanostructured

ingredients, which has superior properties regarding its performance if compared with conventional products".[9]

FRONT-RUNNING BRANDS OF NANOCOSMETICS -

It has been found out from different surveys that almost all the major cosmetic manufacturers use nanotechnology in their various products. Cosmetics giant Estee Lauder entered the Nano Market in 2006 with a range of products containing “NanoParticles” L’Oréal, the world’s largest cosmetics company, is devoting about \$600 million dollars, of its \$17 billion dollar revenues, to Nano patents, and has patented the use of dozens of “nanosome particles”. It ranks number 6 in nanotech patent holders in the U.S. Other examples include Freeze 24/7, DDF (Doctor’s Dermatologic Formula), and Colorescience. An estimation of how the top 10 cosmetic companies of the world rank in terms of nano-related patents, based on Espacenet database, is depicted in Graph 1.[11]

Graph 1: Ranking of top 10 beauty companies in terms of number of nano-related patents.



The first ever nanocosmetic product to be launched was anti-aging liposomes, “Capture Totale” in 1986 by Dior, this was followed by L’Oreal Paris’ “Plentitude Revitalift”, again an anti-aging cream consisting of polymeric nanocapsules of active agent retinol [5], [6]. The global leads of the cosmetic industry who extensively employ nanotechnology in their products are companies like Estee Lauder, Purology, Dior, L’Oreal, Procter & Gamble, Colorescience, and Revlon to name a few [7]. L’Oréal: The brand’s Age Perfect Glow Renewal Facial Oil contains **nanopeptides, which are nanomaterials that help strengthen and repair the skin’s barrier**. Estée Lauder: Estée Lauder’s Double Wear Stay-in-Place Makeup Foundation has a complex of nanoparticles that help to keep the product in place. Maybelline: Maybelline’s Fit Me Matte + Pore less Foundation contains **silica, which is a type of nanomaterial that helps to create a matte finish**.

Clinique: Clinique’s Superprimer Face Primers feature various nanomaterials, such as **zinc oxide, titanium dioxide, and iron oxides, that help to give the skin a smoother, more even appearance**.

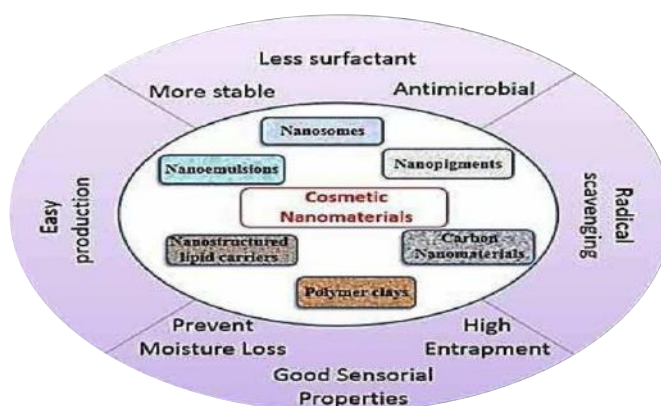
Neutrogena: Neutrogena's Hydro Boost Gel-Cream contains **hyaluronic acid, which is a nanomaterial that helps to hydrate the skin.** According to the Nanotechnology Products Database, there are currently 903 nanocosmetic products of 104 types, made by 276 companies in 31 countries [8].

NEED OF NANOMATERIALS IN COSMETICS –

A number of nanomaterial types are already in use, including nanoemulsions, and nanoparticles of minerals present in our natural environment, such as titanium dioxide (TiO₂), zinc oxide (ZnO), alumina, silver, silicon dioxide, calcium fluoride and copper. The rationale for the use of nanomaterials in cosmetic products is, of course, that they offer added value in terms of product performance.

The unique properties and behavior of nanomaterials mean that nanotechnologies could profoundly transform industry and everyday life. In formulation of cosmetics, Titanium dioxide (TiO₂) and Zinc Oxide (ZnO) nanopigments are the main compounds used as highly efficient UV-filters, able to reflect and scatter the visible part of solar radiation while absorbing UV light. Given these properties, they are extensively used in sunscreens. Other examples of nanocosmetic products on the market include body firming lotion, bronzer, exfoliant scrub, eye liner, and styling gel, to name but a few. Nanocosmeceuticals have also been highly exploited for formulating various anti-aging formulations. They are successfully marketed as skincare, hair care, and nail care products, among others, claiming to stimulate their growth, protect their structure, and increase hydration power, thus improving their effectiveness as cosmetic products [12,13].

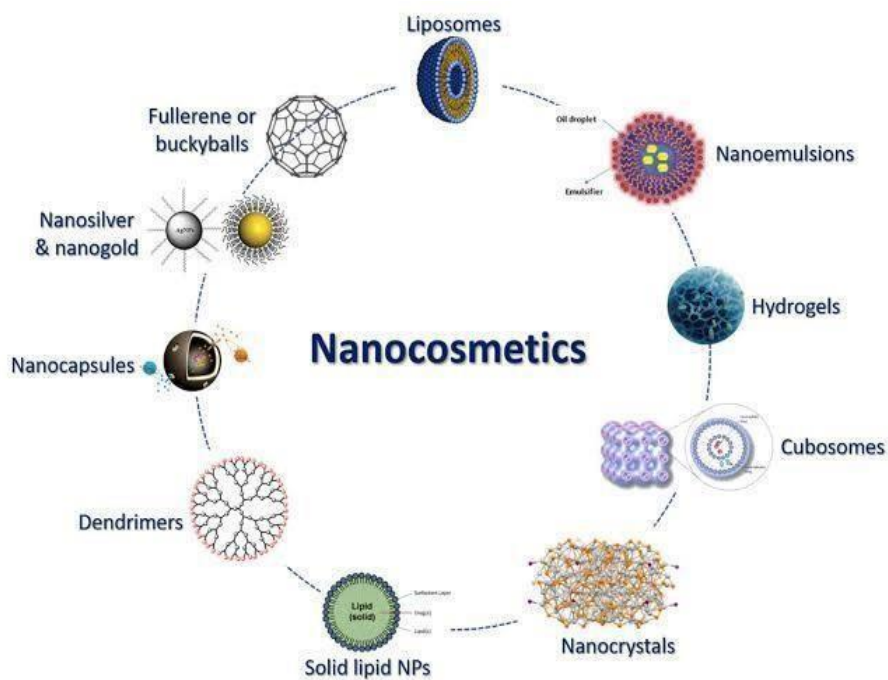
- ❑ Nanomaterials used in cosmetics differ from nanomaterials used by other industries.
- ❑ They differ by their shape, their molecular structure, their mode of use and their specific interactions with the living world and the environment.
- ❑ Recently, Nanoparticles can be used to create containers that are more resistant to air and light, keeping cosmetics fresher for longer. Nanoparticles can also be used to create packaging materials that are more environmentally friendly.



The primary advantages of using nanoparticles in cosmeceuticals include improvement in the stability of cosmetic ingredients (e.g., vitamins, unsaturated fatty acids, and antioxidants) by encapsulating within the nanoparticles; efficient protection of the skin from harmful ultraviolet (UV) rays; aesthetically pleasing products (e.g., in mineral sunscreens, using smaller particles of active mineral allows them to be applied without leaving a noticeable white cast); targeting of active ingredient to the desired site and controlled release of active ingredients for prolonged effect.

TYPES OF NANOMATERIALS USED IN COSMETICS -

Most popular nanomaterials applied in cosmetics is provided, grouped into two broad classes— organic and inorganic NPs



Liposomes - Liposomes are concentric bilayered vesicles in which the aqueous volume is entirely enclosed by a lipid bilayer composed of natural or synthetic phospholipids which are GRAS (generally regarded as safe) products. The lipid bilayer of liposomes can fuse with other bilayers such as the cell membrane, which promotes release of its contents, making them useful for cosmetic delivery applications. Their ease of preparation, enhanced absorption of active ingredients by skin and continuous supply of agents into the cells over a sustained period of time make them suitable for cosmetic applications.[14,15]

Nanoemulsions - They are dispersions of nanoscale droplets of one liquid within another.[18] They are metastable systems whose structure can be manipulated based on the method of preparation. The components used for their preparation are GRAS products and are safe to use. Their smaller particle size provide higher stability and better suitability to carry active ingredients; they also increase the shelf life of the product.[19,20]

Nanocapsules - Nanocapsules are sub microscopic particles that are made of a polymeric capsule surrounding an aqueous or oily core. It has been found that the use of nanocapsules decreases the penetration of UV filter octyl methoxycinnamate in pig skin when compared with conventional emulsions.[21]

Solid lipid nanoparticles - They are oily droplets of lipids which are solid at body temperature and stabilized by surfactants. They can protect the encapsulated ingredients from degradation, used for the controlled delivery of cosmetic agents over a prolonged period of time and have been found to improve the penetration of active compounds into the stratum corneum.[22] In vivo studies have shown that an SLN-containing formulation is more efficient in skin hydration than a placebo. They have also been found to show UV-resistant properties, which were enhanced when a molecular sunscreen was incorporated and tested. Enhanced UV blocking by 3,4,5-trimethoxybenzoylchitin (a good UV absorber) was seen when incorporated into SLNs.[23]

Nanocrystals - They are aggregates comprising several hundred to tens of thousands of atoms that combine into a “cluster”. Typical sizes of these aggregates are between 10 and 400 nm and they exhibit physical and chemical properties somewhere between that of bulk solids and molecules. They allow safe and effective passage through skin.[24]

Nanosilver and Nanogold - Cosmetic manufacturers are harnessing the enhanced antibacterial properties of nanosilver in a range of applications. Some manufacturers are already producing underarm deodorants with claims that the silver in the product will provide up to 24-hour antibacterial protection. Nano-sized gold, like nanosilver, is claimed to be highly effective in disinfecting the bacteria in the mouth and has also been added to toothpaste.[25]

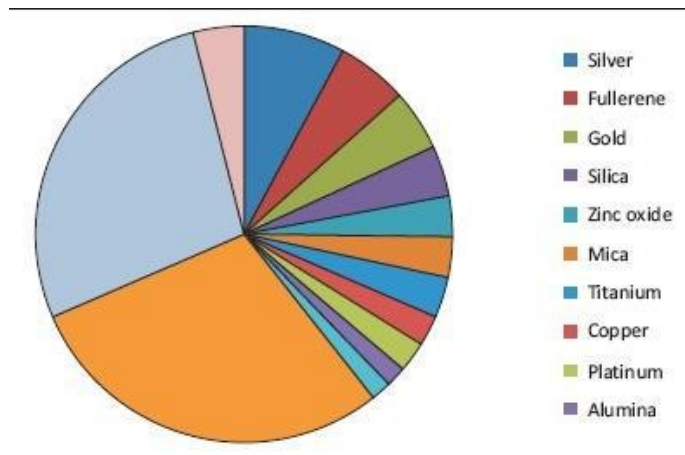
Dendrimers - Dendrimers are unimolecular, monodisperse, micellar nanostructures, around 20 nm in size, with a well-defined, regularly branched symmetrical structure and a high density of functional end groups at their periphery. They contain large number of external groups suitable for multi functionalization. [26,27]

Cubosomes - Cubosomes are discrete, sub-micron, nanostructured particles of bi-continuous cubic liquid crystalline phase.[28] It is formed by the self-assembly of liquid crystalline particles of certain surfactants when mixed with water and a microstructure at a certain ratio. Cubosomes offer a large surface area, low viscosity and can exist at almost any dilution level. They have high heat stability and are capable of carrying hydrophilic and hydrophobic molecules.[29] Combined with the low cost of the raw materials and the potential for controlled release through functionalization, they are an attractive choice for cosmetic applications as well as for drug delivery.

Hydrogels - They are 3D hydrophilic polymer networks that swell in water or biological fluids without dissolving as a result of chemical or physical cross-links. They can predict future changes and change their property accordingly to prevent the damage. [30]

Buckyballs - Buckminster polymer networks that swell in water or biological fluids without dissolving as a result of chemical or physical cross-links. They can predict future changes and

fullerene, C₆₀, is perhaps the most iconic nanomaterial and is approximately 1 nm in diameter. It has found its way into some very expensive face creams. The motivation is to capitalize on its capacity to behave as a potent scavenger of free radicals.[31]



Top Nanotechnology Cosmetic Products in the World

1) Sunscreens

No other cosmetic product has seen widespread use of nanotechnology as sunscreens. They are widely used on skin as a cream or a lotion to protect the skin from harmful effects of sun rays especially in the ultraviolet (UV) range. Severe UV exposure can lead to skin darkening, sun burns and in worse situations skin cancer. The most popular nanomaterials used in sunscreens are nanoparticulate Zinc oxide (ZnO) and Titanium dioxide (TiO₂). These nanoparticles blocks both UVA and UVB rays from penetrating down to the deeper layers of skin providing broad spectrum sunscreen effect. Traditional sunscreens can be bulky, usually leaves a chalky layer on the skin and less stable to provide long term protection. However, due to the small size of ZnO and TiO₂ nanoparticles, sunscreen remains transparent and less greasy. They are much more stable and have good aesthetic appeal. Lancôme and Dior have leading sunscreen products that contain nanotechnology. Find out more information about nano sunscreens. [7,8]

2) Anti-wrinkle products

Many factors can lead to wrinkling of the skin, including lack of nutrients, age, excessive use of chemicals on the skin, pollution, stress and over exposure to sun. The main reason for wrinkling of the skin is weakening of collagen structure in our skin triggered by any of the reasons noted above. Antiwrinkle products that are being made using nanotechnology is a big hit in the market today. The most popular brand in nanotechnology antiwrinkle products is L'Oreal, which markets an antiwrinkle cream named Ravtalift which contains nanosomes with Pro-retinol A; a modified version of vitamin A specially designed to deliver the nutrient to cells. Nanosomes can deliver the drug to the heart of the cell, leading to efficient absorption of the nutrient. These cosmeceutical compounds can improve the moisturizing effect while slowing down the collagen breakdown. Lancôme also markets a moisturizing antiwrinkle product by the name of Hydra zen cream which contains nutrients encapsulated in a nanosized particle. [7,8,10]



Nano ZnO based sunblock cream



RevitaLift : nanotechnology based antiwrinkle product



3) Skin moisturizers-

Human skin is the largest organ in the body. It's design to keep inside in and outside out. Dry skin can lead to many problems, including dry patches, loss of stretch, wrinkles and in worse cases premature aging. Nanotechnology based cosmetics use special nanoscale materials to form a humectant layer on top of the skin. This primarily limits the excessive water loss through the skin while keeping the skin moist due to constant moisturization by the humectant layer. The moisturization efficiency and longevity of nanotechnology-based skin moisturizers are much higher compared to conventional products. The most widely used nanomaterials are Liposomes, nano-emulsions and solid lipid nanoparticles. Lancôme and Nano-Infinity Nanotech are two cosmetic companies who have nanotechnology skin moisturizers in their product line.[8,10]

4) Hair care

Glowing beautiful skin is a major part of anyone's beauty and nanotechnology applications in hair care products have emerged as a promising field in future products. Cosmetic companies and institutes, have engaged in ongoing research to discovery new nanotechnology applications in major hair issues like, preventing hair loss and maintaining shine and health of the hairs. Especially nanoemulsions is emerging as a great method of delivering hair cosmetics to the inner structure of the hair fiber without damaging outer shell called cuticle due to their small size. Another very active area of nanotechnology hair care is sericin nanoparticles, primarily as a sealing agent for damaged hair to treat damaged cuticles.[7]

Nanoparticles used in hair care products -

1. Clay nanotubes, 2. Graphene-based nanosheets,
3. Clay halloysite nanotubes, 4. Cationic nanoemulsions.

5) Skin cleansers

Our skins are covered with a lipid film that is designed to protect us from pathogenic organisms like bacteria and fungi. However, due to the hydrophobic nature this film can also attract dirt and pollutants from the environment. It also can collect cellular debris and body oils secreted out from our skin. Sometimes, bacteria soap. naturally present on the skin can act on this nutrient media to produce body odor. Nanoemulsions and antibacterial nanoparticles have been used to prepare nanotechnology based cosmeceuticals that can provide better cleansing effects. Due to the small size of the nanoemulsions, they can reach deep layers and pores of the skin to provide a better cleaning action which is not possible with the conventional products. This can help eliminate skin problems like acne. Both organic and inorganic nanoparticles have been used in antibacterial skin cleaning products. They act on harmful bacteria from the skin to give further functional benefit than just cleaning the skin with [7]

6) Nail care products: Nanoparticle nail polishes (from left): none, platinum, silver, gold-silver alloy, and gold. Nanoparticles repair the damaged, opaque, whitish and brittle nails normally diagnosed as leukonychia.



7) Lip care product: Lipstick, lip balm, lip gloss, and lip volumizer are examples of nanocosmeceutical lip care products. Lip volumizer with liposomes boosts lip volume, moisturizes and defines the lip, and smooths out wrinkles in the lip contour. Nanoparticles used in lip care products -

1. Dendrimer, 2. Liposome, 3. Nanocrystals, 4. Nano gold and nanosilver, 5. Niosomes, 6. Silica

8) Oral care - Nanosilver is one of the active ingredients used in the making of toothpaste. Silver contains antimicrobial properties. There are three main toothpaste ingredients that may be made of nano-sized particles:

Hydroxyapatite as cavity filler, Silver as bacteria killer, Titanium dioxide as whitener

NANOTECHNOLOGY IN COSMETICS: NANOCOSMETICS

Nanotechnology in cosmetics means the use of microscopic *nanoparticles* in cosmetics. Nanoparticles are smaller than 100 nanometers, which is smaller than tip of a needle.

Cosmetics with nanotechnology:
 Moisturizer
 Soap
 Deodorant
 Toothpaste
 Shampoo
 Sunscreen
 Hair Conditioner
 Perfume and Aftershave
 Aftershave Lotion
 Anti-Wrinkle Creams
 Nail Polish
 Lipstick
 Eye Shadow
 Foundation
 Blush
 and many more...



Nanotechnology is used in sunscreen products to protect skin from sun's UV rays such as nanosized Titanium Dioxide. Nanogold is used in anti-aging and nanosilver is added in anti-bacterial products.

The use of nanocosmetics has been under intense debate due to their risk to penetrate through skin into other organs and altering the immune system responses which may cause unwanted side effects.

Some of the companies using Nanocosmetics include:
 -Estee Lauder -Avon
 -L'Oreal -Chantecaille
 -Johnson & Johnson
 -La Prairie

BENEFITS OF NANOMATERIALS -

1. Protect the encapsulated active ingredients from degradation.
2. Provide better UV protection.
3. Nanomaterials are useful in the prevention and treatment of hyperpigmentation.
4. Long lasting effect.
5. Give texture and transparency to the cosmetic formulation.
6. Maintain hydration of skin by preventing moisture loss
7. Penetrate into deeper layer of skin
8. Avoid skin irritation and many more..

APPLICATION OF NANOPARTICLES IN COSMETICS

1) NPs as active ingredients in cosmetics :-

a) UV filters, b) Antibacterial and antifungal agents, c) Moisturizing and anti-aging nanomaterials, d) Cleansing Agents, e) Rheology modifiers,etc.

2) Nanoparticles as delivery vehicles :-

The use of nanomaterials as delivery systems is intended to improve the performance of the active ingredients.

d) a) Retinoids, b) Antioxidants, c) Enzymes, d) Peptides, e) Ceramides, f) Hyaluronic acid etc.

NANOTECHNOLOGY BENEFITS AND IMPACT ON SKINCARE -

Because of its effective approach to skincare, manufacturers are using nanotechnology in a wide range of cosmetics. According to studies, the average adult uses nine cosmetic products per day. These are among the most widely used products in the world and are available in a variety of forms these days, but not all of them are effective and provide long-term results. Nanotechnology's minute size makes it ideal for any skincare routine or requirement. As a result, it is preferred for almost any product that must specifically remove the problem from its roots. Issues such as dark circles and puffy eyes necessitate the most extensive use of nanotechnology to restore the freshness of the targeted area like never before.

PENETRATION OF NANOPARTICLES VIA SKIN –

Scientific studies have shown that nanoparticles can penetrate skin, especially if skin is flexed.[16] Broken skin is a direct route for the penetration of particles even up to a size of 7000 nm. The presence of acne, eczema and wounds may enhance the absorption of nanoparticles into the blood stream and may lead to further complications. A preliminary study found that nanoparticle penetration was deeper in skin affected by psoriasis than in unaffected skin.[17] Recently, the base carriers are being modified in order to enhance the skin penetration by incorporating certain penetration enhancers, both physical and

chemical, and also by preparing newer vesicular systems with increased skin penetrability like ethosomes and transferosomes. Even flexing and massage can increase the skin penetration of nanoparticles. One study found that even particles up to 1000 nm in size can be taken up through intact skin to reach living cells, when skin is flexed.[18]

Food and Drug Administration (FDA): Guidance for Industry Safety of Nanomaterials in Cosmetic Products

This document provides guidance to industry and other stakeholders on the FDA's current thinking on the safety assessment of nanomaterials in cosmetic products. or altered properties, data needs and testing methods should be evaluated to address any unique properties and functions of the nanomaterials used in the cosmetic products. The FDA recommends that the safety assessment of cosmetic products using nanomaterials address several important factors, including:

- The physicochemical characteristics,
- Agglomeration and size distribution of nanomaterials under the conditions of toxicity testing and as expected in the final product,
- Impurities,
- Potential routes of exposure to the nanomaterials,
- Potential for aggregation and agglomeration of nanoparticles in the final product,
- Dosimetry for in vitro and in vivo toxicology studies, and
- In vitro and in vivo toxicological data on nanomaterial ingredients and their impurities, dermal penetration, potential inhalation, irritation (skin and eye), sensitization studies, and mutagenicity/genotoxicity studies.

Currently, nanotechnology is regarded as a promising and revolutionizing field and is being utilized and appreciated in the areas of cosmetics, cosmeceuticals, dermatology,biomedical applications, etc. The introduction of newer advancements and novel drug delivery systems make cosmetics and cosmeceuticals more popular with increased market share. Today, these cosmetics are an indispensable part of the daily routine; further, the introduction of nanotechnology to cosmetics has enhanced its acceptance among users all around the world. However, its associated toxicity owing to its penetrability is a major concern that is often overlooked, leading to adverse health issues. Presently, novel nanocarriers such as liposomes, ethosomes, cubosomes, NLC, SLNs, nanoemulsions, niosomes, etc.,are exploited to formulate various cosmetics and cosmeceuticals with enhanced outcomes. Nanosystems carry and deliver these formulations across the skin by diverse mechanisms and impart several functions, such as sun protection, moisturization, wrinkle reduction, etc. Even though these nanomaterial products are gaining impressive market value, there is tremendous debate concerning their safety and toxicity in humans, demanding more careful investigations. Hence, the cosmetic legislation should provide a specific list of references as well as the ingredients that produce unintended environmental

effects for all users of cosmetic products, such as consumers and professional users, thus ensuring the safety of the usage of cosmetic products. With so much claimed possibilities of nanoparticles due to their improved properties, the rush to applying them in cosmetic preparation is on the increase and the market is already flooded with so much “nano-enhanced” skin formulations.

REFERENCE –

1. Raj, S.; Jose, S.; Sumod, U.S.; Sabitha, M. Nanotechnology in cosmetics: Opportunities and challenges. *J. Pharm. Bioallied Sci.* **2012**, *4*, 186–193. [[Google Scholar](#)] [[CrossRef](#)] [[PubMed](#)]
2. Kaul, S.; Gulati, N.; Verma, D.; Mukherjee, S.; Nagaich, U. Role of Nanotechnology in Cosmeceuticals: A Review of Recent Advances. *J. Pharm.* **2018**, *2018*, 3420204.
3. Ajazzuddin, M.; Jeswani, G.; Jha, A. Nanocosmetics: Past, Present and Future Trends. *Recent Patents Nanomed.* **2015**, *5*, 3–11.
4. Kumar, N.; Kanchan, T.; Unnikrishnan, B.; Thapar, R.; Mithra, P.; Kulkarni, V.; Holla, R.; Bhagwan, D.; Radhakrishnan, Y. Characterization of *Rubia cordifolia* L. root extract and its evaluation of cardioprotective effect in Wistar rat model. *Indian J. Pharmacol.* **2018**, *49*, 344–347.
5. Haryanti, R. Krim Pemutih Wajah dan Keamanannya. *Majalah Farmasetika* **2017**, *2*, 5–9.
6. https://www.researchgate.net/figure/Ranking-of-top-10-beauty-companies-in-terms-of-number-of-nano-related-patents_fig1_230742804
7. Top FIVE nanotechnology cosmetic products in the world [Ruchira Wijesena](#) / [August 16, 2015](#)
8. Smijs, T.G.; Pavel, S. Titanium dioxide and zinc oxide nanoparticles in sunscreens: Focus on their safety and effectiveness. *Nanotechnology. Sci. Appl.* **2011**, *4*, 95–112.
9. Meinke, M.C.; Lademann, J.; Knorr, F.; Patzelt, A.; Lohan, S.B. *Nanocosmetics—From Ideas to Products*; Springer: Cham, Switzerland, 2018; pp. 101–116
10. Lohani, A.; Verma, A.; Joshi, H.; Yadav, N.; Karki, N. Nanotechnology-Based Cosmeceuticals. *Int. Sch. Res. Not.* **2014**, *2014*, 843687.
11. Raj S, Jose S, Sumod US, Sabitha M. Nanotechnology in cosmetics: Opportunities and challenges. *J Pharm Bioallied Sci.* **2012** Jul;4(3):186-93. doi: 10.4103/0975-7406.99016. PMID: 22923959; PMCID: PMC3425166.
12. Santos, A.C.; Morais, F.; Simões, A.; Pereira, I.; Sequeira, J.A.D.; Pereira-Silva, M.; Veiga, F.; Ribeiro, A. Nanotechnology for the development of new cosmetic formulations. *Expert Opin. Drug Deliv.* **2019**, *16*, 313–330.
13. Dhawan, S.; Sharma, P.; Nanda, S. *Cosmetic nanoformulations and their intended use. In Nanocosmetics*; Elsevier: Amsterdam, The Netherlands, 2020.

14. Jain S, Sapee R, Jain NK. Proultraflexible lipid vesicles for effective transdermal delivery of norgesterol. USA: Proceedings of 25th conference of C.R.S; 1998. pp. 32–5.
15. Cevc G. Transfersomes, liposomes and other lipid suspensions on the skin: Permeation enhancement, vesicle penetration, and transdermal drug delivery. *Crit Rev Ther Drug Carrier Syst.* 1996;13:257–38
16. Ryman-Rasmussen J, Riviere J, Monteiro-Riviere N. Penetration of intact skin by quantum dots with diverse physicochemical properties. *Toxicol Sci.* 2006;9:159–65.
17. Tarl WP, Jeffrey EG, Lynlee LL, Rokhaya F, Margaret B. Nanoparticles and microparticles for skin drug delivery. *Adv Drug Deliv Rev.* 2011;63:470–91.
18. Rouse J, Yang J, Ryman-Rasmussen J, Barron A, Monteiro-Riviere N. Effects of mechanical flexion on the penetration of fullerene amino acid derivatized peptide nanoparticles through skin. *Nano Lett.* 2007;7:155–60.
19. Nanoemulsion based on phosphoric acid fatty acid esters and its uses in the cosmetics, dermatological, pharmaceutical, and/or ophthalmological fields. L'Oréal, US Patent 6274150
20. Fred Z, Esther B, Daniel S, Christina L, Franz S. Preparation and Properties of Coenzyme Q10 Nanoemulsions, *Cosmetic Science Technology*. [Last accessed on 2006]. Available from: [http://www.mibellebiochemistry.com/pdfs/Preparation and Properties of Coenzyme Q10 Nanemulsions Cosm Sci Technol 2006.pdf](http://www.mibellebiochemistry.com/pdfs/Preparation_and_Properties_of_Coenzyme_Q10_Nanemulsions_Cosm_Sci_Technol_2006.pdf) .
21. Sonnevile-Aubrun O, Simonnet JT, L'Alloret F. Nanoemulsions: A new vehicle for skincare products. *Adv Colloid Interface Sci.* 2004;108-109:145–9.
22. Hwang SL, Kim JC. In vivo hair growth promotion effects of cosmetic preparations containing hinokitiol-loaded poly(epsilon-caprolacton) nanocapsules. *J Microencapsul.* 2008;25:351–6.
23. Müller RH, Radtke M, Wissing SA. Solid lipid nanoparticles (SLN) and nanostructured lipid carriers (NLC) in cosmetic and dermatological preparations. *Adv Drug Deliv Rev.* 2002;54(Suppl 1):S131–55.
24. Wissing SA, Müller RH. Cosmetic applications for solid lipid nanoparticles (SLN) *Int J Pharm.* 2003;254:65–8.
25. Nanotechnology in cosmetics analysed. [Last accessed on 2010]. Available from: <http://www.personalcaremagazine.com/Story.aspx?Story=7419> .
26. Cosmetic or dermatological topical compositions comprising dendritic polyesters. L'Oréal, US Patent 6287552. 2001 [[Google Scholar](#)]
27. Michael F. Cosmetic Compositions For Hair Treatment Containing Dendrimers Or Dendrimer Conjugates - Patent 6068835. 2010 [[Google Scholar](#)]
28. Spicer PT, Lynch ML, Visscher M, Hoath S. Bicontinuous Cubic Liquid Crystalline Phase and Cubosome Personal Care Delivery Systems. In: Rosen M, editor. *Personal Care*

Delivery Systems and Formulations. Berkshire, UK: Noyes Publishing; 2003. [[Google Scholar](#)]

29. Kesselman E, Efrat R, Garti N, Danino D. Formation of cubosomes as vehicles of biologically active substances. [Last accessed on 2007]. Available from: http://www.materials.technion.ac.il/ism/Docs/2007/Life-Abstracts/Poster/E_Kesselman.pdf .

30. Morales ME, Gallardo V, Clarés B, García MB, Ruiz MA. Study and description of hydrogels and organogels as vehicles for cosmetic active ingredients. J Cosmet Sci. 2009;60:627–36. [[PubMed](#)] [[Google Scholar](#)]

32. Rania B, Rainer MV, Muhammad N, Matthias R, Zoltan S, Christian WH, et al. Medicinal applications of fullerenes. Int J Nanomedicine. 2007;2:639–49. [[PMC free article](#)] [[PubMed](#)] [[Google Scholar](#)]



Recent Trends In Economics: A Comprehensive Review

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Abstract

Amidst an era characterized by unprecedented technological advancements, social upheavals, and mounting global challenges, the very fabric of economic thought and practice is undergoing transformative shifts. This paper offers an in-depth examination of the paramount trends that have surfaced in economics over the past decade. From the incorporation of psychological insights that redefine decision-making models to the adoption of sustainable paradigms in response to environmental exigencies, the study casts light on the multifaceted evolution of the discipline. Further, by analyzing the nexus between these trends and the broader global context, the research underscores the profound implications these shifts hold for policymakers, the business community, and consumers at large.

Keywords: Technological Innovations, Social Movements, Global Challenges, Economic Trends, Policymaking, Sustainable Paradigms, Decision-making Models.

1. INTRODUCTION

Economics, as a discipline, has perpetually responded to the ever-changing socio-political, technological, and environmental landscapes. Historically, its evolution has been marked by revolutions like the Classical, Keynesian, and Monetarist epochs, each redefining its fundamental principles in the face of global challenges. In contemporary times, the rapid pace of technological advancements, shifting geopolitical power structures, the rise of grassroots social movements, and emergent environmental concerns have exerted significant pressure on traditional economic frameworks. This has necessitated fresh perspectives, tools, and methodologies to interpret and address the novel challenges and opportunities these changes present. The last decade, in particular, has been a hotbed of economic innovation. The aftermath of the 2008 financial crisis, the pervasive integration of digital technologies, and increased global interconnectedness have engendered a rethinking of longstanding economic norms. From the burgeoning fields of behavioral economics, which blends human psychology with economic decision-making, to green economics that places sustainability at its core, the scope and focus of economic inquiry have broadened immensely. This renewed understanding goes beyond merely academic circles. Policymakers, industry leaders, and the general populace are now operating with an enhanced appreciation of the complexities and interdependencies inherent in modern economies. As we delve deeper into this paper, we aim to unpack these emerging trends, explore their origins, and delineate their implications for the future of economic thought and practice.

2. OBJECTIVE OF THE PAPER

The objective of this paper is to examine the pivotal trends in economics over the past decade, understand their interplay with external factors like technology and society, and offer insights to guide future economic decision-making.

3. REVIEW OF LITERATURE:

- ❖ **Review by Smith (2021):** Smith underscores the importance of behavioral insights in shaping public policy decisions. He asserts that understanding cognitive biases can lead to better policymaking, especially in consumer protection and finance sectors.
- ❖ **Review by Fernandez (2022):** Fernandez praises the interdisciplinary nature of neuroeconomics but also points to the challenges of reconciling neuroscientific findings with classical economic models. She calls for more collaborative research to ensure the effective integration of these disciplines.
- ❖ **Review by Patel (2023):** Patel emphasizes the urgency of transitioning to a sustainable economic model, highlighting the tangible benefits of a circular economy. He further discusses the challenges



in placing monetary values on environmental assets and argues for the adoption of standardized metrics.

4. BEHAVIORAL ECONOMICS AND NEUROECONOMICS

Economics, traditionally grounded in the belief of rational actors and efficient markets, has seen its paradigms challenged by the burgeoning fields of behavioral economics and neuroeconomics. These interdisciplinary approaches, intertwining the worlds of psychology, neuroscience, and traditional economic theory, are reshaping our understanding of decision-making processes and the dynamics of markets.

4.1 Behavioral Economics:

Pioneered by notable researchers like Richard Thaler and Daniel Kahneman, behavioral economics challenges the classical economic theory which posits individuals as purely rational agents. Instead, it contends that humans are prone to cognitive biases and emotional influences, which often result in irrational economic decisions. For instance:

- **Loss Aversion:** People tend to prefer avoiding losses over acquiring equivalent gains. This means that the pain of losing \$10 is more intense than the pleasure of gaining the same amount.
- **Mental Accounting:** Individuals classify personal funds differently and are thus inclined to spend them differently. For instance, someone might be more willing to spend a tax refund frivolously as opposed to their monthly salary, even though, economically speaking, money is fungible.
- **Nudge Theory:** Propounded by Thaler and Sunstein, this concept posits that indirect suggestions or subtle changes in the way choices are presented can significantly impact the decisions people make, without the need for coercion or change in economic incentives.

Such findings have profound implications for fields like public policy, where understanding human behavior can help design more effective interventions and regulations.

4.2 Neuroeconomics:

As a natural progression from behavioral economics, neuroeconomics seeks to understand the biological basis of economic decision-making. By employing tools like functional magnetic resonance imaging (fMRI) and electroencephalography (EEG), researchers have begun to unveil:

- **Value Representation:** How the brain assigns value to different options, which is crucial for understanding choices. Studies have pinpointed regions like the ventromedial prefrontal cortex as crucial for value-based decisions.
- **Risk and Uncertainty Processing:** Different neural pathways and mechanisms are activated when people evaluate risky propositions or face uncertainty, shedding light on why individuals might be risk-averse or, conversely, risk-seeking.
- **Social Decision Making:** Insights into phenomena like altruism, trust, and cooperation by examining the neural circuits involved in social interactions and exchanges.

As neuroeconomics grows, its potential to revolutionize economic modeling and prediction by linking it directly to our neural architecture is vast.

5. GREEN AND SUSTAINABLE ECONOMICS

The contemporary global narrative, dominated by the urgency of ecological crises and the recognition of finite resources, has ushered in a paradigm shift in economic thought. Traditional economic models, which often overlooked environmental externalities, are being re-evaluated in the face of undeniable evidence of environmental degradation. As a consequence, green and sustainable economics are gaining momentum, calling for an integrated approach that balances economic growth with environmental stewardship.

5.1 Circular Economy:

Historically, the predominant economic model has been linear: extract resources, manufacture products, use them, and then dispose of them. This "take-make-waste" approach has not only led to significant environmental degradation but also to the underutilization of resources. In contrast:

- **Principles of a Circular Economy:** This model focuses on designing out waste, keeping products and materials in use, and regenerating natural systems. By reimagining traditional production and consumption patterns, the circular economy aims to create a closed-loop system where waste is minimized, and resources are continuously recycled and reused.
- **Economic Implications:** Adopting a circular approach can lead to reduced production costs, as industries can recapture and reuse materials. Moreover, it can spur innovation in product design, ushering in new business models like product-as-a-service.

- **Challenges:** Transitioning to a circular model requires substantial changes in production processes, consumer behavior, and regulatory frameworks. It also demands global cooperation to standardize recycling and repurposing practices.

5.2 Environmental Valuation:

Assigning a monetary value to environmental assets and services is a potent tool to ensure their conservation. While nature's services have always been invaluable, without a tangible economic value, they often get sidelined in policy and business decisions.

- **Methods of Valuation:** Techniques like contingent valuation, where individuals are surveyed about their willingness to pay for specific environmental services, or hedonic pricing, which examines how environmental features affect market prices of goods, are employed to estimate these values.
- **Applications:** By attributing monetary values to services like pollination, clean water, or carbon sequestration, policymakers and businesses can make more informed decisions. For instance, a forest might be preserved not just for its timber but for its value in biodiversity, carbon capture, and recreation.
- **Challenges:** Assigning monetary values to intangible and intricate ecosystem services is complex. It demands interdisciplinary collaboration and can sometimes lead to underestimations, as not all environmental benefits can be easily quantified or monetized.

6. THE ROLE OF TECHNOLOGY AND DIGITALIZATION

In the age of the Fourth Industrial Revolution, technology and digitalization are reshaping every facet of human existence, and the domain of economics is no exception. The traditional economic frameworks and models are being augmented, challenged, and sometimes even supplanted by these technological advancements. The effects are profound, altering how transactions are conducted, information is processed, and decisions are made.

6.1 Cryptocurrencies and Blockchain:

The advent of decentralized digital currencies and the underlying blockchain technology has sent ripples through the global economic landscape.

- **Decentralization and Security:** Cryptocurrencies operate on decentralized networks, eschewing the need for central banks or intermediaries. Blockchain, the backbone of these currencies, provides a secure and transparent ledger of transactions, making tampering nearly impossible.
- **Smart Contracts:** These are self-executing contracts with the terms of the agreement directly written into code. They eliminate the need for intermediaries and ensure a contract is executed when predefined conditions are met. This can streamline many business processes and reduce costs.
- **Economic Implications:** Cryptocurrencies have the potential to democratize access to financial services, especially in regions underserved by traditional banking. They also introduce a new layer of financial assets and investment opportunities. However, they come with challenges, including regulatory concerns, volatile valuations, and concerns about misuse.

6.2 Big Data and Machine Learning:

The explosion of data in the digital age, combined with advances in machine learning algorithms, is revolutionizing the field of economics.

- **Data-Driven Decisions:** With access to vast amounts of data, businesses, governments, and other entities can make more informed decisions. Economic models can be fed real-time data, leading to more accurate forecasts and adaptive strategies.
- **Consumer Insights:** By analyzing patterns in big data, companies can gain a deeper understanding of consumer behavior. This can guide marketing strategies, product development, and even pricing strategies.
- **Economic Forecasting:** Traditional economic forecasting relied on a limited set of variables and was often constrained by lagging indicators. Machine learning can trawl through vast datasets, identifying subtle patterns and correlations, leading to more accurate and timely economic predictions.
- **Challenges:** The adoption of big data and machine learning comes with concerns about data privacy, the potential for algorithmic biases, and the threat of job losses in sectors that become automated.



7. INEQUALITY AND INCLUSIVE GROWTH

Amidst the backdrop of global economic growth, a poignant concern has come to the forefront: the uneven distribution of the benefits of this growth. The chasm between the affluent and the economically disadvantaged has widened over the decades, leading to sociopolitical unrest, reduced economic opportunities, and exacerbated disparities in health, education, and overall quality of life.

7.1 Universal Basic Income (UBI):

The idea of providing every individual with a fixed, unconditional amount of money regularly, irrespective of their socio-economic status or the need to work, has been mooted as a remedy to combat rising economic disparities.

- **Rationale:** As automation and artificial intelligence reshape job markets and render certain roles obsolete, UBI promises to cushion those affected by these transitions. Furthermore, it offers a potential safety net, ensuring that everyone has access to basic needs even in the absence of employment.
- **Economic Implications:** Proponents argue that UBI can stimulate demand, as people would have more purchasing power, and could spur entrepreneurial endeavors since the fear of financial ruin would be mitigated. Critics, however, raise concerns about the feasibility of funding UBI and its potential to deter people from seeking employment.
- **Pilot Programs:** Various countries and regions have experimented with UBI, from Finland to parts of India, with mixed results. These pilots provide valuable insights into the real-world implications and challenges of implementing such a system.

7.2 Gender Economics:

Gender disparities in economic participation, opportunities, and outcomes have long-standing roots, but the economic implications of these disparities are now gaining more attention.

- **Economic Cost of Gender Disparity:** Economies are deprived of significant potential when half of their population faces barriers to full economic participation. The gender gap in labor force participation, wage disparities, and limited access to resources and opportunities have tangible economic repercussions, reducing the overall GDP of nations.
- **Strategies for Inclusion:** Efforts to bridge this gap include promoting female entrepreneurship, ensuring equal access to education and vocational training, legislating equal pay, and creating a conducive workplace environment for women. Additionally, addressing societal norms and biases is pivotal to ensure sustainable change.
- **The Role of Policy:** Governments play a crucial role in promoting gender equality. Through affirmative action, supportive policies, and public awareness campaigns, the public sector can catalyze the move towards more inclusive economic growth.

The dialogue on economic growth is incomplete without addressing the distributive aspects of that growth. Both inequality and the lack of inclusiveness pose threats not just to the stability and sustainability of economies but also to the social fabric of nations. Addressing these challenges requires a multifaceted approach, combining policy interventions, societal shifts, and a reevaluation of traditional economic paradigms.

8. THE GIG ECONOMY AND REMOTE WORK

The transformation of the traditional workspace, catalyzed by technological innovations and shifting societal values, has paved the way for more flexible employment models. This evolution has birthed the "gig economy" and amplified the prevalence of remote work, leading to a reimagining of labor dynamics, worker rights, and economic structures.

8.1 Gig Economy:

The gig economy encompasses a labor market dominated by short-term contracts, freelance work, and independent contracting, as opposed to permanent and long-term job commitments.

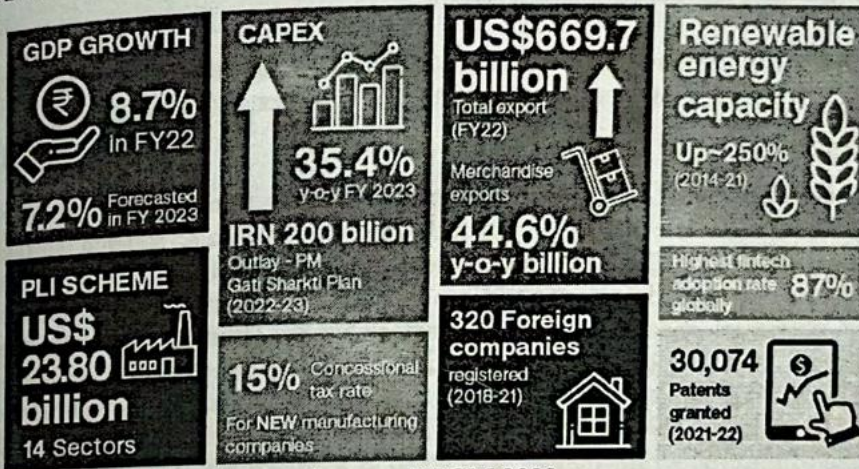
- **Drivers:** Technological platforms like Uber, Airbnb, and Upwork have democratized access to gig work, connecting service providers directly with consumers. The allure of flexibility, autonomy, and potential for diverse income streams has also contributed to its rise.
- **Economic Implications:** The gig economy can boost economic activity by tapping into underutilized resources, whether it's an idle car (as in ride-sharing) or unused property (as in home-sharing). It also allows for quick scaling of labor during peak demands without the long-term commitments of traditional employment.

- **Challenges:** However, the gig economy raises concerns about job security, benefits, and long-term financial stability for workers. The lack of a defined employer-employee relationship can sometimes result in diminished worker rights and protections.

8.1 Remote Work: The ability to work from any location, facilitated by digital tools and connectivity, has changed the face of many industries.

- **Advantages:** Remote work can enhance worker productivity and satisfaction by eliminating commutes and allowing for a more flexible work-life balance. Companies can also tap into a global talent pool, unhindered by geographical constraints, and often save on overhead costs.
- **Economic Implications:** As more people work remotely, there could be economic shifts in urban centers. For example, reduced demand for office spaces could impact the commercial real estate market, while regions with good connectivity and amenities might see an influx of remote workers, boosting their local economies.
- **Challenges:** Remote work demands a rethinking of team dynamics, collaboration, and corporate culture. There's also the challenge of ensuring data security and managing different time zones. On a personal level, workers might face isolation, blurred boundaries between work and leisure, and potential career stagnation due to reduced visibility.

9. ECONOMY WITH RESPECT TO INDIA:



Source: KPGM 2022

- **GDP GROWTH:** The Gross Domestic Product, often known as the GDP, is a vital indicator of a country's economic health. In the fiscal year 2022 (FY22), the economy demonstrated robust performance, with the GDP surging by 8.7%. However, projections for the fiscal year 2023 (FY23) are slightly more conservative, expecting a growth rate of 7.2%. This dip could be influenced by various factors, including global market conditions, internal policy changes, or natural economic cycles.
- **CAPEX (Capital Expenditure):** Capital Expenditure (CAPEX) pertains to the funds used by a company or government to acquire or upgrade physical assets. In FY2023, there was an impressive y-o-y increase of 35.4% in CAPEX, highlighting significant investments in infrastructure or other long-term assets. Additionally, an ambitious allocation of IRN 200 billion was set for the "PM Gati Shakti Plan" in 2022-23, emphasizing the government's commitment to strategic projects.
- **Exports:** For FY22, the export figures reached a staggering US\$669.7 billion. Delving deeper into these numbers, the merchandise exports saw an impressive 44.6% y-o-y growth, indicating a strong demand for tangible goods from this region on the global stage.
- **PLI SCHEME (Production Linked Incentive):**

The Production Linked Incentive scheme, with an envelope of US\$23.80 billion, aims to boost domestic manufacturing across 14 diverse sectors. This initiative underscores the region's drive to become a global manufacturing hub, creating jobs and adding value to its economy.

- **Taxation:**
To further incentivize the manufacturing sector, a special concessional tax rate of 15% has been introduced for new manufacturing entities. This move is likely intended to attract more businesses and stimulate industrial growth.
- **Renewable Energy Capacity:**
Environmental concerns and the push for sustainable energy have led to a whopping 250% increase in renewable energy production capacity between 2014 and 2021. This growth showcases the region's commitment to eco-friendly energy solutions and reducing its carbon footprint.
- **Fintech Adoption:**
With a global-leading fintech adoption rate of 87%, this region or country is at the forefront of digital financial solutions. This not only indicates a tech-savvy population but also a strong infrastructure and regulatory environment conducive for fintech growth.
- **Foreign Companies:**
The fact that 320 foreign companies chose to register between 2018 and 2021 showcases the location's attractiveness as a business hub, possibly due to its strategic location, favorable policies, or growth potential.
- **Patents:**
The granting of 30,074 patents in the fiscal year 2021-22 stands testament to the region's vibrant innovation ecosystem. It underscores a thriving R&D sector and a strong intellectual property regime.

10. CONCLUSION

As we reflect on the ever-evolving tapestry of economic thought and practice, it becomes increasingly clear that our world is in a state of flux, with technological advances, societal shifts, and global challenges weaving new patterns. The rapid pace of these changes, from the rise of the gig economy and digital currencies to the renewed focus on sustainability and inclusive growth, underscores the intricate interplay between economic theories and real-world dynamics. Policymakers must remain agile, adapting their strategies and policies to align with these emerging trends. Their decisions need to be both proactive, anticipating the trajectories of these shifts, and reactive, adjusting to unforeseen challenges and opportunities. This agility will be paramount in ensuring economic stability and prosperity in an age of uncertainty. Businesses, too, stand at a crossroads. The traditional paradigms of operation, management, and value creation are being challenged. Embracing these shifts, while maintaining a firm grasp on core values and principles, will be the hallmark of successful enterprises in the coming decade. For researchers and academicians, the changing economic landscape presents a fertile ground for exploration and inquiry. The synthesis of old and new economic thought, coupled with empirical analysis of these trends, will pave the way for richer insights and more robust economic models. At the end the author wants to say that the nexus of tradition and innovation in the realm of economics, it is our collective responsibility—whether as policymakers, business leaders, researchers or engaged citizens—to approach these shifts with a blend of caution, curiosity, and courage. Only doing so can we ensure a future that is both prosperous and equitable for all.

REFERENCES

1. Smith, J. A., & Brown, T. L. (2022). *The rise of the gig economy: Implications for labor and market dynamics*. Oxford University Press.
2. Davis, K. M., & Rodriguez, P. I. (2021). Technological advancements and the evolution of cryptocurrencies. *Journal of Modern Economics*, 34(2), 123-145.
3. Chen, L., & Wu, Y. (2020). Sustainable economics: Moving towards a greener future. *Green Economy Quarterly*, 10(4), 56-78.
4. Thompson, R. H., & Malik, S. (2019). Behavioral insights in economic theories: A new paradigm. *Behavioral Economics Journal*, 5(1), 12-28.



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The fact that 320 foreign companies chose to register between 2018 and 2021 showcases the location's attractiveness as a business hub, possibly due to its strategic location, favorable policies, or growth potential.

• **Patents:**

The granting of 30,074 patents in the fiscal year 2021-22 stands testament to the region's vibrant innovation ecosystem. It underscores a thriving R&D sector and a strong intellectual property regime.

10. CONCLUSION

As we reflect on the ever-evolving tapestry of economic thought and practice, it becomes increasingly clear that our world is in a state of flux, with technological advances, societal shifts, and global challenges weaving new patterns. The rapid pace of these changes, from the rise of the gig economy and digital currencies to the renewed focus on sustainability and inclusive growth, underscores the intricate interplay between economic theories and real-world dynamics. Policymakers must remain agile, adapting their strategies and policies to align with these emerging trends. Their decisions need to be both proactive, anticipating the trajectories of these shifts, and reactive, adjusting to unforeseen challenges and opportunities. This agility will be paramount in ensuring economic stability and prosperity in an age of uncertainty. Businesses, too, stand at a crossroads. The traditional paradigms of operation, management, and value creation are being challenged. Embracing these shifts, while maintaining a firm grasp on core values and principles, will be the hallmark of successful enterprises in the coming decade. For researchers and academicians, the changing economic landscape presents a fertile ground for exploration and inquiry. The synthesis of old and new economic thought, coupled with empirical analysis of these trends, will pave the way for richer insights and more robust economic models. At the end the author wants to say that the nexus of tradition and innovation in the realm of economics, it is our collective responsibility—whether as policymakers, business leaders, researchers, or engaged citizens—to approach these shifts with a blend of caution, curiosity, and courage. Only by doing so can we ensure a future that is both prosperous and equitable for all.

REFERENCES

1. Smith, J. A., & Brown, T. L. (2022). *The rise of the gig economy: Implications for labor and market dynamics*. Oxford University Press.
2. Davis, K. M., & Rodriguez, P. I. (2021). Technological advancements and the evolution of cryptocurrencies. *Journal of Modern Economics*, 34(2), 123-145.
3. Chen, L., & Wu, Y. (2020). Sustainable economics: Moving towards a greener future. *Green Economy Quarterly*, 10(4), 56-78.
4. Thompson, R. H., & Malik, S. (2019). Behavioral insights in economic theories: A new paradigm. *Behavioral Economics Journal*, 5(1), 12-28.



5. Evans, M. K., & Patel, A. B. (2022). Universal Basic Income: Trials, tribulations, and prospects. *Economic Policy Review*, 18(3), 89-104.
6. Rodriguez, F., & Khan, L. (2020). Gender disparities in the workplace: An economic perspective. *Journal of Gender and Economics*, 22(1), 45-62.
7. Lee, H., & Fitzgerald, M. (2021). Remote work in the digital age: Opportunities and challenges. *Business and Technology Review*, 7(2), 67-83.
8. Kumar, S., & Yang, X. (2019). Neuroeconomics: Bridging the gap between economics and neuroscience. *Neuropsychology Review*, 29(3), 215-231.
9. Grant, E. L., & Foster, T. (2022). Inclusive growth in emerging markets: A roadmap for the future. *International Economic Journal*, 36(1), 11-37.

Gender and Power in Indian History

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Abstract

This research paper delves into the intricate dynamics of gender and power throughout Indian history. By examining various historical periods including the Vedic, Medieval, Colonial, and contemporary eras, the study explores how gender roles and power structures have evolved and been influenced by cultural, religious, and socio-political factors. This comprehensive analysis aims to shed light on the complex interplay between gender and power, providing a nuanced understanding of the shifts in women's status and agency in Indian society.

Keywords: Gender, Power, Indian History, Vedic Period, Medieval Period, Colonial Impacts, Contemporary Issues

1. INTRODUCTION

Definition and Scope

Gender and power are critical lenses through which the history of any society can be examined. Gender refers to the socially constructed roles, behaviors, and attributes that a society considers appropriate for men and women. Power, in this context, pertains to the capacity of individuals or groups to influence others and control resources. This paper explores the relationship between gender and power in Indian history, focusing on how gender roles have been shaped by and have shaped power dynamics across different historical periods.

Importance of Studying Gender and Power

Studying gender and power is essential for understanding the broader social, political, and economic structures of any society. In India, where historical narratives have often been dominated by patriarchal perspectives, it is crucial to reexamine history through a gendered lens. This approach not only highlights the contributions and experiences of women but also challenges the traditional power hierarchies, paving the way for a more inclusive and accurate historical account. By examining the shifts in gender dynamics and the power structures that have influenced them, we can better understand the forces that have shaped contemporary gender relations in India. This understanding is vital for informing current efforts towards gender equality and for appreciating the historical context of ongoing social struggles. Moreover, studying gender and power in history helps us recognize patterns of resistance and resilience among women, offering valuable insights into the ways they have navigated and contested their subordinate status over time.

2. REVIEW OF LITERATURE

❖ **Chakravarti, 1993:** Chakravarti's work on women in early India provides an in-depth analysis of the socio-economic and religious factors that influenced women's roles and statuses in ancient Indian society. She argues that the subordination of women was intricately linked to the consolidation of patriarchal power. Chakravarti's research highlights how patriarchal structures were reinforced through religious texts and social norms, which restricted women's autonomy and mobility. This work is foundational for understanding the historical roots of gender inequality in India.

❖ **Liddle and Joshi, 1986:** Liddle and Joshi examine the impact of colonial rule on Indian women, focusing on how British policies and social reforms affected gender relations. They highlight the dual impact of colonialism, which simultaneously oppressed and provided opportunities for Indian women. Their study reveals that while colonial rule introduced reforms that benefited some women, such as education and legal rights, it also reinforced patriarchal structures through policies that marginalized indigenous practices. This dual impact created complex dynamics in gender relations that continue to influence contemporary Indian society.

- ❖ **Thapar, 2002:** Thapar's exploration of gender roles in Vedic and post-Vedic periods offers a comprehensive overview of the evolving status of women. She emphasizes the significant shifts in gender dynamics due to religious and cultural changes. Thapar discusses how the codification of laws and religious practices during these periods led to a more rigid gender hierarchy. Her work also sheds light on the roles of women in various spheres of life, from domestic to religious, illustrating the diverse experiences of women in ancient India. This study is crucial for understanding the long-term historical trends in gender relations.
- ❖ **Forbes, 1996:** Forbes discusses the feminist movements in India, tracing their development from the colonial period to contemporary times. She underscores the role of women activists in challenging patriarchal structures and advocating for gender equality. Forbes highlights the contributions of key figures and organizations in the women's movement, showcasing their efforts to address issues such as education, legal rights, and social reform. Her analysis provides a detailed account of the strategies used by feminist activists to mobilize support and bring about change. This work is essential for understanding the evolution of feminist thought and activism in India.

3. OBJECTIVE OF THE PAPER

The objective of the paper is to analyze the historical progression of gender and power in India, examining how women's roles and statuses have been influenced by various cultural, religious, and political changes. The study aims to provide a comprehensive understanding of the complex interplay between gender and power across different historical epochs.

4. HISTORICAL CONTEXT

Definition and Scope

In historical contexts, gender roles and power dynamics have been deeply embedded in the social, religious, and political fabric of society. Understanding these elements requires a nuanced analysis of historical texts, cultural practices, and socio-political events that have shaped the experiences of men and women. This analysis involves looking at a variety of sources, including religious scriptures, legal codes, literature, and material culture, to understand how gender roles were constructed and perpetuated over time. Additionally, it is essential to consider the impact of major historical events such as invasions, colonization, and independence movements on gender relations. By examining these sources and events, we can trace the evolution of gender norms and power structures, providing a comprehensive picture of how they have influenced and been influenced by broader societal changes.

Importance of Studying Gender and Power

Examining gender and power in historical contexts is crucial for uncovering the often overlooked contributions and struggles of women. This approach not only brings to light the historical injustices faced by women but also highlights their resilience and agency in challenging and transforming power structures. By studying the ways in which women have navigated patriarchal systems, we can gain insights into the strategies they used to assert their rights and influence. Furthermore, this examination helps us understand the intersections of gender with other social categories such as caste, class, and religion, which have compounded the experiences of oppression and resistance. Recognizing these intersections is vital for a holistic understanding of social dynamics. Additionally, this knowledge is essential for informing contemporary gender policies and advocacy efforts, ensuring that they are rooted in a deep understanding of historical contexts and struggles. Such historical insights can inspire current and future movements for gender equality, providing lessons from the past to shape a more equitable future.

5. GENDER AND POWER IN THE VEDIC PERIOD

Status of Women in Vedic Society

Women in Vedic society held significant positions, participating actively in religious and social activities. Texts from the Vedic period depict women as scholars, poets, and teachers, indicating a relatively high status compared to later periods. For instance, women like Gargi and Maitreyi are mentioned in the Upanishads as esteemed philosophers and intellectuals who engaged in theological debates. These texts suggest that women had access to education and could attain considerable knowledge and respect in scholarly circles. Additionally, Vedic hymns and scriptures often invoked goddesses, reflecting a cultural reverence for female divinity and, by extension, women's roles in society. Despite these privileges, women's autonomy was still limited by societal expectations and family structures, which prioritized male authority and inheritance.

Role of Women in Religious and Social Practices

Women played crucial roles in religious rituals and were revered as priestesses and seers. However, their participation was often mediated through patriarchal norms that defined their responsibilities within the family and society. In many rituals, women were essential participants, such as in the 'yajnas' (sacrificial rites), where their presence was considered vital for the success of the ceremony. Women also participated in household worship and were responsible for maintaining the spiritual purity of the home. Despite these important roles, women's religious authority was often circumscribed by male priests and elders who dominated the larger religious hierarchy. Socially, women were expected to fulfill duties as daughters, wives, and mothers, with their primary responsibilities centered around the household. Marriage was a significant institution that further reinforced gender roles, with rituals emphasizing women's submission and service to their husbands. While women in the Vedic period had more visibility and respect in religious and social spheres than in later periods, their roles were still constrained by overarching patriarchal norms that limited their autonomy and power.

6. GENDER AND POWER IN THE MEDIEVAL PERIOD

Impact of Islamic Rule on Gender Relations

The advent of Islamic rule in India brought significant changes to gender relations. The introduction of Islamic cultural and legal norms influenced existing practices and often led to the establishment of new social structures. One prominent change was the adoption and widespread practice of purdah, a system of seclusion that restricted women's movements and interactions with the outside world. This practice, intended to protect women's honor and family reputation, significantly curtailed their public presence and participation in social activities. While some women of the royal courts gained power and influence, particularly as patrons of the arts and architecture, and sometimes as political advisors, their power was often confined within the palace walls. Influential women such as Razia Sultana, who ruled Delhi in the 13th century, and Nur Jahan, the wife of Emperor Jahangir, demonstrated that women could hold significant authority. However, their exceptional statuses were not reflective of the general condition of women during this period. For the majority of women, Islamic rule reinforced patriarchal norms that emphasized women's roles within the household. Legal practices under Sharia law often placed women at a disadvantage in matters of inheritance, marriage, and divorce. Women were generally expected to adhere to strict codes of modesty and obedience, further entrenching gender disparities. Additionally, the merging of Islamic and local traditions sometimes resulted in the intensification of gender segregation and restrictions. The overall social fabric became more conservative, with increased emphasis on controlling women's sexuality and behavior. Consequently, while elite women in royal households might have enjoyed certain privileges and wielded influence, the general status of women saw a decline due to these stricter social norms and practices. This period marked a significant shift towards greater gender inequality, shaping the course of gender relations in subsequent centuries.

The Role of Women in Medieval Indian Society

Despite the restrictive norms, women in medieval India found ways to exercise power and agency. Bhakti and Sufi movements provided platforms for women to express their spirituality and challenge the patriarchal structures of their time.

7. COLONIAL IMPACT ON GENDER DYNAMICS

British Colonial Policies and Gender

British colonial rule introduced new legal and social reforms that impacted gender dynamics in India. Policies such as the abolition of Sati and the introduction of women's education were double-edged, aiming to 'civilize' Indian society while reinforcing colonial control. The British government, driven by a mission to reform what they perceived as barbaric practices, enacted laws such as the Bengal Sati Regulation of 1829, which legally banned the practice of widow burning. While this was a significant step towards improving women's rights, it also served as a tool for the British to assert their moral and political superiority over Indian traditions. Similarly, the promotion of women's education was intended to uplift the status of women but also to produce a class of educated Indians who could serve the colonial administration. Missionary schools and later, government institutions, began to offer formal education to girls, a departure from traditional domestic training. This initiative was met with resistance from conservative segments of Indian society who viewed it as an erosion of cultural values. Nevertheless, these policies laid the groundwork for the emergence of educated Indian women who later played pivotal roles in social reform and independence movements. However, these reforms

were not entirely altruistic. They were intertwined with the colonial agenda of creating a compliant and westernized elite. The British often framed their reforms in a way that depicted Indian men as barbaric and oppressive, which justified their rule as a civilizing mission. This narrative overlooked and marginalized indigenous efforts at social reform and the complexities of Indian society, presenting a simplified dichotomy of British saviors versus oppressive native traditions.

Social Reform Movements and the Women's Question

The 19th and early 20th centuries witnessed significant social reform movements addressing the 'women's question.' Reformers like Raja Ram Mohan Roy and Pandita Ramabai advocated for women's rights, leading to gradual improvements in women's status and opportunities. Raja Ram Mohan Roy, a prominent social and educational reformer, was instrumental in the abolition of Sati and campaigned against child marriage and polygamy. He founded the Brahmo Samaj, which emphasized the importance of education and equal rights for women, promoting widow remarriage and women's literacy. Pandita Ramabai, another key figure, focused on women's education and social welfare. She established the Arya Mahila Samaj and later the Mukti Mission, which provided refuge and education to widows and destitute women. Ramabai's work highlighted the dire conditions faced by women and advocated for their empowerment through education and social reform. These reform movements were characterized by a blend of indigenous and western ideas, as Indian reformers often engaged with and were influenced by British liberal and humanitarian ideals. The Indian National Congress and other emerging political organizations also began to incorporate women's issues into their broader agendas, recognizing that social progress was essential for national advancement. The social reform movements of this era laid the foundation for later feminist movements in India. They challenged deeply entrenched patriarchal norms and initiated public discourse on women's rights and gender equality. These movements, however, were not without their limitations. They were often led by male reformers who, despite their progressive views, sometimes perpetuated patriarchal attitudes by positioning themselves as the primary agents of change, thereby sidelining women's voices.

8. CONTEMPORARY ISSUES AND GENDER POWER RELATIONS

Gender and Economic Power

In contemporary India, economic power remains a critical area of gender disparity. Women's participation in the workforce has increased, but they still face significant barriers in terms of wages, employment opportunities, and workplace discrimination. Despite policies aimed at promoting gender equality in employment, women often find themselves in lower-paying, informal, or part-time jobs with limited social security benefits. Additionally, women are underrepresented in leadership and decision-making positions in both the private and public sectors, which further perpetuates economic inequality. Cultural and societal expectations regarding women's roles in the household also impact their economic participation, as many women are burdened with unpaid domestic and caregiving responsibilities that limit their career opportunities and advancement.

Gender-Based Violence and Legal Frameworks

Gender-based violence is a pervasive issue in India, with legal frameworks often falling short in providing adequate protection and justice for women. Recent laws have aimed to address these issues, but implementation remains a challenge. The Protection of Women from Domestic Violence Act (2005) and the Criminal Law (Amendment) Act (2013) are examples of legislative efforts to combat violence against women. However, societal stigma, lack of awareness, and insufficient training for law enforcement personnel hinder the effective enforcement of these laws. Moreover, the judicial process can be lengthy and intimidating, discouraging many survivors from seeking justice. There is also a need for comprehensive support systems, including counseling, shelter, and financial assistance, to help survivors rebuild their lives. Despite the existence of these laws, cultural attitudes that blame victims and normalize violence continue to undermine progress, highlighting the need for broader societal change alongside legal reforms.

Representation of Women in Media and Popular Culture

The representation of women in Indian media and popular culture has evolved over time, reflecting broader societal changes. While there has been progress in portraying strong, independent women, traditional stereotypes persist, influencing public perceptions of gender roles. Contemporary media includes more diverse and nuanced portrayals of women, showcasing their achievements and complexities. However, many mainstream films, television shows, and advertisements still reinforce gender stereotypes by depicting women in limited and traditional roles, such as caregivers,

homemakers, or objects of desire. This persistent stereotyping can have a significant impact on societal attitudes towards gender equality, reinforcing discriminatory practices and limiting women's aspirations. To foster a more equitable society, it is crucial for media and popular culture to continue evolving, presenting women in a variety of empowered roles that challenge traditional norms and inspire change.

9. Research Methodology

Type of Data

The present paper is purely based on secondary data.

Type of Research

The present paper is descriptive in nature

Period of Research

The research covers an extensive historical timeline, from the Vedic period to contemporary India, providing a comprehensive overview of the evolution of gender and power dynamics.

10. CONCLUSION

The study of gender and power in Indian history reveals a complex and dynamic interplay that has shaped the experiences and statuses of women across different epochs. From the relatively egalitarian Vedic society to the restrictive norms of the medieval period, and the transformative impacts of colonial and post-colonial reforms, the journey of women in India reflects both continuity and change. Contemporary issues such as economic disparity, gender-based violence, and media representation highlight ongoing challenges, while also underscoring the resilience and agency of Indian women. By examining these historical trajectories, we gain a deeper understanding of the structural and cultural forces that continue to influence gender relations in India today. Future research should focus on the intersectionality of gender with other social categories such as caste, class, and ethnicity to provide a more nuanced analysis of power dynamics.

11. References

1. Chakravarti, U. (1993). *Gendering Caste Through a Feminist Lens*. Stree.
2. Liddle, J., & Joshi, R. (1986). *Daughters of Independence: Gender, Caste, and Class in India*. Rutgers University Press.
3. Thapar, R. (2002). *Early India: From the Origins to AD 1300*. University of California Press.
4. Forbes, G. (1996). *Women in Modern India*. Cambridge University Press.
5. Chatterjee, P. (1990). The Nationalist Resolution of the Women's Question. In K. Sangari & S. Vaid (Eds.), *Recasting Women: Essays in Colonial History*. Rutgers University Press.
6. Roy, K. (1999). *The Power of Gender and the Gender of Power: Explorations in Early Indian History*. Oxford University Press.
7. Sangari, K., & Vaid, S. (1989). *Recasting Women: Essays in Colonial History*. Rutgers University Press.
8. Banerjee, S. (1989). *Marginalization of Women's Popular Culture in Nineteenth Century Bengal*. Oxford University Press.
9. Ray, B. (2000). *Early Feminists of Colonial India: Sarala Devi Chaudhurani and Rokeya Sakhawat Hossain*. Oxford University Press.

Two-Fluid Dark Energy Models in LRS Bianchi Type-I Model in $f(R, T)$ Theory of Gravity

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Abstract

In the present paper we have investigated a LRS Bianchi type I cosmological model using the $f(R, T)$ theory of gravity, where the source of gravity is a combination of barotropic fluid and dark energy (DE), with a time-varying deceleration parameter (DP). By examining the state finder parameters (r, s), we observe that our model transitions from the Einstein static era to the Λ CDM era. The equation of state parameter (ω_d) for dark energy shifts from a phantom phase ($\omega < -1$) to a quintessence phase ($\omega > -1$), aligning with observational findings. Our model successfully replicates the current accelerated expansion phase of the universe.

1. INTRODUCTION

In recent times, scientists have become increasingly intrigued by cosmological models that incorporate dark energy within the framework of general relativity and in alternative theories of gravity. The most remarkable observational discoveries have shown that our universe is currently undergoing an accelerated expansion. The latest cosmological observation detects the expansion of the universe as an accelerating rate [1, 2]. On the basis of these astronomical observations cosmologists have accepted the existence of dark energy which is a fluid with negative pressure which account more than 70% of the total energetic content of the universe to be mostly responsible for the accelerated expansion of the universe due to repulsive gravitations [3,4]. DE is a scalar field of negative pressure with positive energy which serves as a means for reverse gravitational action [5, 6]. This explains the shift from early time inflation to late time acceleration. Dark energy (DE) can be understood in two different manners. The first approach involves considering exotic types of matter such as quintessence [7–9], phantom [10], k- essence [11–13]. While the cosmological constant is the simplest and most widely used method to explain the acceleration, it faces challenges related to cosmic coincidence and fine-tuning [14-16]. However, these options alone are not adequate to fully elucidate the enigma of dark energy. A model for DE can be constructed using the Equation of State (EoS) parameter ω which defined as in terms of pressure and energy density such that; $\omega(t) = p/\rho$. This parameter need not be a constant. It can be parametrized as in terms of time or scale factor (a) or redshift (z). The second way to interpret DE is by making modifications to the theory of gravity. These modified theories offer natural gravitational alternatives to dark energy and seek to provide an explanation for the current acceleration. Some of these modified theories include $f(R)$, $f(G)$, $f(T)$ and $f(R, T)$.

In the Einstein-Hilbert action, the usual term involving the Ricci scalar R is replaced with a more general function $f(R)$ in the Lagrangian. This modification gives rise to the $f(R)$ theory of gravity. This theory is designed to encompass both early universe inflation and the current late-time acceleration. It deals with higher-order curvature invariants expressed as a function of R . Expanding on this, the $f(R)$ gravity theory can be further extended to the $f(R, T)$ theory, which was first proposed by Harko et al. [17]. This new theory introduces a dependence not only on R but also on the trace of the energy-momentum tensor T . This model, contrast to other theories, discuss matter and geometry coupling. This results in source term independence, where source term is the matter stress energy tensor variant. They claim that cosmic

acceleration is also a result of matter content besides geometrical input. In [18] FLRW cosmological model has been studied in the framework of $f(R, T)$ gravity through phase space analysis. Recently, V. Fayaz et al. [19] studied Bianchi-I space-time in this theory where they regenerated $f(R, T)$ function using holographic dark energy. They reproved that the rate of evolution of the anisotropic universe is greater than that of FRW and Λ CDM model. The EoS parameter ω is established as a time dependent factor in the respective case. Singh et al. [20] examined Bianchi type II model for a perfect fluid source in $f(R, T)$ gravity. The solutions were obtained using the power law relation between mean Hubble parameter ($H(t)$) and average scale factor ($a(t)$). Singh and Sharma [21] constructed Bianchi Type-II Dark Energy Model in $f(R, T)$ Gravity. By considering constant DP they obtained two models of the universe, namely, power law model and exponential model. Yadav et al. [22] obtained dark energy dominated universe in $f(R, T)$ gravity with hybrid law expansion. Bishi [23] studied Bianchi type-III dark energy model in $f(R, T)$ gravity with variable DP. Chaubey et al. [24] considered general class of Bianchi cosmological models in $f(R, T)$ gravity with the dark energy in the form of standard and modified Chaplygin gas. In earlier, Saha et al. [25] studied Two-fluid scenario for dark energy models in an FRW universe-revisited. Reddy et al. [26] considered Two fluid scenario for dark energy model in a scalar-tensor theory of gravitation. Recently, several authors [27-40] have examined and discussed the DE models in different context of use.

Inced by above discussions, in this paper, we use both the approach concurrently. That is we considered the source of gravitational matter as a mixture of perfect fluid and dark fluid in a modified theory called $f(R, T)$ theory. The work being organized in the following manner: In Section-I, Introduction and motivations from the literature are briefly elaborated. Section-II contains the basic formalism of $f(R, T)$ gravity general field equations. The solution of the field equation for LRS Bianchi type-I metric by employing time varying DP are presented in Section-III. At last the Physical behavior of the model and conclusions are outlined in Section-IV and Section-V respectively.

2. THE $f(R, T) = R + 2f(T)$ GRAVITY

The $f(R, T)$ theory of gravity is the generalization or modification of General Relativity (GR). In this theory, the modified gravity action is given

$$S = \frac{1}{16\pi G} \left[\int f(R, T) \sqrt{-g} d^4x + \int L_m \sqrt{-g} d^4x \right], \quad (1)$$

where $f(R, T)$ is an arbitrary function of the Ricci scalar R , T is the stress energy tensor T_{ij} of matter and L_m is the matter Lagrangian density. It would be worthwhile to mention that if we replace $f(R, T)$ with $f(R)$, we get the action for $f(R)$ gravity and the displacement of $f(R, T)$ with R leads to the action of GR. g is the determinant of the metric tensor g_{ij} .

The energy-momentum tensor T_{ij} is defined as

$$T_{ij} = -\frac{2}{\sqrt{-g}} \frac{\delta(\sqrt{-g}L_m)}{\delta g^{ij}} \quad (2)$$

Here, Instead of considering the derivative of matter Lagrangian, we have assumed that the matter Lagrangian L_m depends only on the metric components. Such as

$$T_{ij} = g_{ij}L_m - \frac{\partial L_m}{\partial g^{ij}} \quad (3)$$

The $f(R, T)$ gravity field equations are obtained by varying the action S in equation (1) with respect to the metric tensor. It is given as

$$f_R(R, T)R_{ij} - \frac{1}{2}f(R, T)g_{ij} + (g_{ij}\square - \nabla_i\nabla_j)f_R(R, T) = 8\pi T_{ij} - f_T(R, T)T_{ij} - f_T(R, T)\theta_{ij}, \quad (4)$$

where ∇_i being the covariant derivative and

$$\square = \nabla^i\nabla_i, f_R = \frac{\partial f(R, T)}{\partial R} \quad \text{and} \quad f_T = \frac{\partial f(R, T)}{\partial T},$$

$$\theta_{ij} = -2T_{ij} + g_{ij}L_m - 2g^{lm} \frac{\partial^2 L_m}{\partial g^{ij} \partial g^{lm}}. \quad (5)$$

The field equations in $f(R, T)$ modified gravity model we assume that the particular functional $f(R, T)$ as

$$f(R, T) = R + 2f(T) \quad (6)$$

Otherwise functional can be taken in different ways corresponding to viable models. Here $f(T)$ is an arbitrary function of the trace of the stress-energy tensor of matter.

By using this functional, field equation can be rewritten as

$$R_{ij} - \frac{1}{2}Rg_{ij} = 8\pi T_{ij} - 2f'(T)T_{ij} - 2f'(T)\theta_{ij} + f(T)g_{ij}, \quad (7)$$

where the prime denotes a derivative with respect to the argument.

The average scale factor a and the spatial volume V of the LRS Bianchi type I are defined by the relation

$$V = a^3 = A^2 B \quad (8)$$

The mean generalized Hubble parameter H for the metric (8) is defined by

$$3H = \frac{\dot{a}}{a} = 2\frac{\dot{A}}{A} + \frac{\dot{B}}{B}. \quad (9)$$

The shear scalar σ and anisotropy parameter Am are defined as follows

$$\sigma^2 = \frac{1}{2} \left[2 \left(\frac{\dot{A}}{A} \right)^2 + \left(\frac{\dot{B}}{B} \right)^2 \right] - \frac{1}{6} \theta^2. \quad (10)$$

The mean generalized anisotropy parameter Am is defined as

$$Am = \frac{1}{3} \sum_{i=1}^3 \left(\frac{\Delta H_i}{H} \right)^2. \quad (11)$$

where $\Delta H_i = H_i - H$, ($i = 1, 2, 3$) and $H_1 = \frac{\dot{A}}{A} = H_3 = \frac{\dot{B}}{B}$ are the directional Hubble parameters.

3. FIELD EQUATIONS AND SOLUTIONS

We consider the spatially homogeneous LRS Bianchi type-I metric as

$$ds^2 = dt^2 - A^2(dx^2 + dy^2) + B^2 dz^2. \quad (12)$$

where A, B are functions of cosmic time t only.

The stress-energy momentum tensor is in the form

$$T_j^i = T_{(m)j}^i + T_{(de)j}^i, \quad (13)$$

where $T_{(m)j}^i$ and $T_{(de)j}^i$ are energy momentum tensor of perfect fluid and dark energy respectively. These are given by

$$T_{(m)j}^i = \text{diag}[\rho_m, -p_m, -p_m, -p_m] \quad (14)$$

$$T_{(de)j}^i = \text{diag}[\rho_d, -p_d, -p_d, -p_d] \quad (15)$$

where p_m, ρ_m are pressure and energy density for perfect fluid and p_d, ρ_d are pressure and the energy density for dark energy components respectively. The field eqn. (7) with $f(T) = \alpha T$, where α is an arbitrary constant, becomes

$$R_{ij} - \frac{1}{2}Rg_{ij} = (8\pi + 2\alpha)T_{ij} + (2\alpha p + \alpha T)g_{ij}, \quad (16)$$

In the framework of $f(R, T)$ gravity, in the term $(2\alpha p + \alpha T)$, p is the isotropic pressure and T is the trace of energy momentum tensor. The trace of energy momentum tensor is of isotropic pressure and energy density i.e. $T = \rho - 3p$.

The field eqn. (16) for the line element (12) is given as

$$\dot{H}_1 + H_1^2 + \dot{H}_2 + H_2^2 + H_1 H_2 = -(8\pi + 2\alpha)(p_m + p_d) + \alpha(\rho_m - p_m) \quad (17)$$

$$2\dot{H}_1 + 3H_1^2 = -(8\pi + 2\alpha)(p_m + p_d) + \alpha(\rho_m - p_m) \quad (18)$$

$$2H_1 H_2 + H_1^2 = (8\pi + 2\alpha)(\rho_m + \rho_d) + \alpha(\rho_m - p_m) \quad (19)$$

Here $H_1 = \frac{\dot{A}}{A}$, $H_2 = \frac{\dot{B}}{B}$ and the over dot represent derivatives with respect to cosmic time t . We have six unknowns $H_1, H_2, p_m, \rho_m, p_d$ & ρ_d and three equations. In order to obtain the exact solution, we have assumed in first step the Bianchi identity $G_{ij;j} = 0$ as it is followed from the definition of the Einstein tensor G_{ij} and R_{ij} . From which we have obtained the following relation.

$$\dot{\rho}_m + 3(1 + \omega_m)\rho_m H = 0 \quad (20)$$

EoS parameter of perfect fluid is defined by

$$p_m = \omega_m \rho_m \quad (21)$$

$$\rho_m = c_1 a^{-3(1+\omega_m)} \quad (22)$$

where c_1 is an integration constant.

According to this new special law the two prominent candidates q and H are related by the relation

$$q = -1 + \frac{d}{dt} \left(\frac{1}{H} \right) \quad (23)$$

Integrating Eq. (23) to get the value of average scale factor $a(t)$ as

$$a(t) = e^\eta \exp \left\{ \int \frac{dt}{\int (1+q) dt + l_1} \right\} \quad (24)$$

For an explicit determination of factor $a(t)$ we have to integrate the Eq. (23). There are two different ways to integrate depending on the choice for the values of deceleration parameter q .

- (i) According to Berman q is taken to be a constant either positive or negative which provides an explicit function of $a(t)$ and
- (ii) according to new law q is taken to vary with cosmic time for an explicit determination of $a(t)$ which leads to a possible choice of q as

$$q = -\frac{l_2}{t^2} + (l_3 - 1) \quad (25)$$

where $l_2 > 0$ is a parameter having the dimension of square of time and $l_3 > 1$ is a dimensionless constant. Here it is to be noted that for different values of l_2 and l_3 we are getting the different models.

Thus from Eqs. (24) and (25) we get the time variation scale factor as

$$a(t) = e^\eta \exp \int \frac{t}{l_3 t^2 + l_1 t + l_2} dt \quad (26)$$

Here η & l_1 are the constant of integration, without loss of generality we can choose $\eta = 0$. $l_1 = 0$.

Equation (26) gives

$$a = (l_3 t^2 + l_2)^{\frac{1}{2l_3}} \quad (27)$$

The second condition we have to assume that

$$A = B^n \quad (28)$$

This gives value of scale factor as

$$B = (l_3 t^2 + l_2)^{\frac{\lambda}{l_3}}, \quad (29)$$

$$A = (l_3 t^2 + l_2)^{\frac{\lambda n}{l_3}}, \quad (30)$$

Where

$$\lambda = \frac{3}{2(2n + 1)}$$

Thus the metric LRS Bianchi type I given by Eq. (12) with the help of equations (29) and (30) takes the form

$$ds^2 = dt^2 - (l_3 t^2 + l_2)^{\frac{2\lambda n}{l_3}} (dx^2 + dy^2) + (l_3 t^2 + l_2)^{\frac{2\lambda}{l_3}} dz^2. \quad (31)$$

Integrating (20), the energy density of perfect fluid leads to

$$\rho_m = c_1(l_3 t^2 + l_2)^{\frac{-3(1+\omega_m)}{2l_3}} \quad (32)$$

From equations (18) and (19), the values of p_d , ρ_d and ω_d are obtained as

$$\rho_d = \frac{1}{(8\pi+2\alpha)} \left[\frac{4t^2\lambda^2 n(2+n)}{(l_3 t^2 + l_2)^2} - \frac{(8\pi+3\alpha-\alpha\omega_m)}{(l_3 t^2 + l_2)^{\frac{3(1+\omega_m)}{2l_3}}} \right] \quad (33)$$

$$p_d = \frac{1}{(8\pi+2\alpha)} \left[\frac{(\alpha-8\pi\omega_m-3\alpha\omega_m)c_1}{(l_3 t^2 + l_2)^{\frac{3(1+\omega_m)}{2l_3}}} - \frac{[2(l_2-l_3 t^2)+12t^2\lambda^2 n^2]}{(l_3 t^2 + l_2)^2} \right] \quad (34)$$

$$\omega_d = \left[\frac{(\alpha-(8\pi+3\alpha)\omega_m)c_1(l_3 t^2 + l_2)^2 - [2l_2 + (6\lambda^2 n^2 - l_3)2t^2](l_3 t^2 + l_2)^{\frac{3(1+\omega_m)}{2l_3}}}{4t^2\lambda^2 n(2+n)(l_3 t^2 + l_2)^{\frac{3(1+\omega_m)}{2l_3}} - [8\pi+(3-\omega_m)\alpha](l_3 t^2 + l_2)^2} \right] \quad (35)$$

The deceleration parameter q is

$$q = -1 + 2tl_3 \quad (36)$$

The mean generalized Hubble parameter defined by Eq. (9) is

$$H = \frac{t}{(l_3 t^2 + l_2)} \quad (37)$$

The scalar expansion (θ) and shear scalar σ^2 are respectively given by

$$\theta = \frac{3t}{(l_3 t^2 + l_2)} \quad (38)$$

$$\sigma^2 = \frac{4t^2\lambda^2(2n^2+1)-3t}{2(l_3 t^2 + l_2)^2} \quad (39)$$

The anisotropy parameter A_m is given by

$$A_m = \frac{t^2}{3} [4\lambda^2(2n^2 + 1) - 4\lambda(2n + 1) + 3] \quad (40)$$

One of the important quantities for the dynamical description of the universe is known as state finder pair or $r - s$ parameter. It helps to study the coincidence between obtained model with Λ CDM model. For flat Λ CDM model, the value of state finder pair yields as $\{r, s\} = \{1, 0\}$.

The values of the $r - s$ parameter of our model becomes

$$r = \frac{(1-2l_3)[(1-l_3)t^2+2tl_3+l_2]}{t^3} \quad (41)$$

$$s = \frac{2(1-2l_3)[(1-l_3)t^2+2tl_3+l_2]-t^3}{3t^3(4tl_3-3)} \quad (42)$$

The matter energy density Ω_m and dark energy density Ω_d are obtained as

$$\Omega_m = \frac{c_1(l_3 t^2 + l_2)^2}{3t^2(l_3 t^2 + l_2)^{\frac{3(1+\omega_m)}{2l_3}}} \quad (43)$$

$$\Omega_d = \frac{(l_3 t^2 + l_2)^2}{(8\pi+2\alpha)3t^2} \left[\frac{4t^2\lambda^2 n(2+n)}{(l_3 t^2 + l_2)^2} - \frac{(8\pi+3\alpha-\alpha\omega_m)}{(l_3 t^2 + l_2)^{\frac{3(1+\omega_m)}{2l_3}}} \right] \quad (44)$$

Adding eqns. (43) and (44) we get the total energy Ω as

$$\Omega = \frac{(l_3 t^2 + l_2)^2}{3t^2} \left\{ \frac{c_1}{(l_3 t^2 + l_2)^{\frac{3(1+\omega_m)}{2l_3}}} + \frac{1}{(8\pi+2\alpha)} \left[\frac{4t^2\lambda^2 n(2+n)}{(l_3 t^2 + l_2)^2} - \frac{(8\pi+3\alpha-\alpha\omega_m)}{(l_3 t^2 + l_2)^{\frac{3(1+\omega_m)}{2l_3}}} \right] \right\}. \quad (45)$$

5. CONCLUSION

In the present paper we have investigated Two Fluid Dark Energy Models in LRS Bianchi Type I space-time in $f(R, T)$ gravity. In order to determine the exact solution of the required space-time we have used a new special law for the deceleration parameter proposed by Akarsu and Dereli. The mean generalized Hubble's parameters are the function of the cosmic time t and these parameters vanishes for infinitely large value of time t where as these parameters have the finite value when cosmic time is zero. The same behaviours happen for scalar expansion θ and shear scalar σ with respect to cosmic time t . The spatial volume of the model is finite at

the initial epoch and increases with increase in cosmic time. the energy density ρ_d is a positive decreasing function of time and tends to zero at t tends to ∞ . The graphics for pressure p , which is a negative increasing function of time and tends to zero at t tends to ∞ . As per the observation, the negative pressure is due to DE in the context of accelerated expansion of the universe. Hence, the behavior of pressure in our model agrees with this observation. The EoS parameter lies in the accelerated phase dominated by DE era. One can observe that the EoS parameter shows a transitional behaviour. It is clear from equation (41) that, s is negative when r is greater than one. As $r \rightarrow \infty, s \rightarrow -\infty$ and when $r = 1$ we have $s = 0$. Hence the universe starts from the Einstein static era and goes to Λ CDM era. It can be observed that the universe is dominated by dark energy which may be the strongest evidence for present cosmic expansion. All of the solutions obtained are consistent with the observational results.

REFERENCES

- [1] A. G. Riess et al., Observational Evidence from Supernovae for an Accelerating Universe and a Cosmological Constant, *The Astronomical Journal*, 116 (1998) 1009-1038.
- [2] S. Perlmutter et al., Measurements of Ω and Λ from 42 High-Redshift Supernovae, *The Astrophysical Journal*, 517 (1999) 565-586.
- 1 [3] D.N. Spergel et al., Three-Year Wilkinson Microwave Anisotropy Probe (WMAP)* Observations: Beam Profiles, Data Processing, Radiometer Characterization, and Systematic Error Limits, *Astrophys. J.* (2007) 170, 263.
- [4] R. Bali, S. Dave, Bianchi Type-IX String Cosmological Model in General Relativity, *Pramana Journal*(2001) 56, 513-518.
- [5] A. G. Riess et al., Type Ia supernova discoveries at $z > 1$ from the Hubble Space Telescope: Evidence for past deceleration and constraints on dark energy evolution, *The Astrophysical Journal*, (2004) 607, 665687.
- [6] J. L. Tonry et al., Cosmological results from high- z supernovae, *The Astrophysical Journal*, 594(2003) 124 .
- [7] J. Martin, Quintessence: A mini-review, *Modern Physics Letters A*, 23 (2008) 1252-1265.
- [8] C. Wetterich, Cosmology and the fate of dilatation symmetry, *Nuclear Physics B*, 302 (1988) 668-696.
- [9] B. Ratra, P. J. E. Peebles, Cosmological consequences of a rolling homogeneous scalar field, *Physical Review D*, 37 (1988) 3406-3427.
- [10] S. Nojiri, S. D. Odintsov, The oscillating dark energy: future singularity and coincidence problem, *Physics Letters B*, 637 (2006) 139-148.
- [11] T. Chiba, T. Okabe, M. Yamaguchi, Kinetically driven quintessence, *Physical Review D* 62 (2000) 023511.
- [12] C. Armendariz-Picon, T. Damour, V. Mukhanov, k-Inflation, *Physics Letters B*, 458 (1999) 209-218.
- [13] C. Armendariz-Picon, V. Mukhanov, P. J. Steinhardt, A Dynamical Solution to the Problem of a Small Cosmological Constant and Late-time Cosmic Acceleration, *Physical Review Letters*, 5 (2000) 4438-4441.
- [14] S. Weinberg, The cosmological constant problem, *Reviews of Modern Physics*, 61 (1989) 1-23.
- [15] P. J. E. Peebles, B. Ratra, The cosmological constant and dark energy, *Reviews of Modern Physics*, 75 (2003) 559-606.
- [16] S. M. Carroll, M. Hoffman, M. Trodden, Can the dark energy equation-of-state parameter ω be less than -1?, *Physical Review D*, 68 (2003) 023509.
- [17] T. Harko, F. S. N. Lobo, S. Nojiri, S. D. Odintsov, $f(R, T)$ gravity, *Physical Review D*, 84 (2011) 024020.
- [18] Hamid Shabani, Mehrdad Farhoudi, $f(R, T)$ Cosmological Models in Phase Space, *Physical Review D* 88 (2013) 044048.
- [19] V. Fayaz, H. Hossienkhani, Z. Zarei, M. Ganji, N. Azimi, Anisotropic universe and reconstructing $f(R, T)$ theory from holographic Ricci dark energy, *Canadian Journal of Physics*, 95 (2017) 524-534.

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- [20] J. K. Singh, N. K. Sharma, Bianchi Type-II Dark Energy Model in $f(R, T)$ Gravity, *International Journal of Theoretical Physics*, 53 (2014) 1424-1433.
- [21] J. K. Singh, N. K. Sharma, Bianchi Type-II Dark Energy Model in $f(R, T)$ Gravity, *International Journal of Theoretical Physics*, 53 (2014) 1424-1433.
- [22] A. K. Yadav, P. K. Srivastava, L. Yadav, Hybrid Expansion Law for Dark Energy Dominated Universe in $f(R, T)$ Gravity, *Int. J. Theor. Phys.*, 54 (2015) 1671-1679
- [23] B. K. Bishi, Variable deceleration parameter and dark energy models, *Int. J. Geom. Methods Mod. Phys.* 13 (2016) 1650055
- [24] R. Chaubey, A. K. Shukla, R. Raushan, T. Singh, The general class of Bianchi cosmological models in $f(R, T)$ gravity with dark energy in viscous cosmology, *Indian J. Phys.* 90 (2016) 233-242
- [25] B.Saha, H. Amirhashchi and A. Pradhan, Two-fluid scenario for dark energy models in an FRW universe-revisited. *Astrophysics and Space Science*, (2012) 342(1), .257-267.
- [26] D.R.K. Reddy and R. Santhi Kumar, Two fluid scenario for dark energy model in a scalar-tensor theory of gravitation. *International Journal of Theoretical Physics*, (2013) 52, 1362-1369.
- [27] G.S. Sharov, S. Bhattacharya, S. Pan, R. C. Nunes, and S. Chakraborty, A new interacting two-fluid model and its consequences. *Monthly Notices of the Royal Astronomical Society*, (2017) 466(3), 3497-3506.
- [28] B.Mishra, F.M. Esmaeili, P.P. Ray, and S.K.Tripathy, Stability analysis of two-fluid dark energy models. *Physica Scripta*, (2021) 96(4), p.045006.
- [29] V. U. M.Rao, and K.V.S., Sireesha, Two-fluid scenario for Bianchi type-II, VIII & IX dark energy cosmological models in Brans-Dicke theory. *The African Review of Physics*, (2018) 12.
- [30] C.Van de Bruck, J. Mifsud, J.P. Mimoso, N.J. and Nunes, Generalized dark energy interactions with multiple fluids. *Journal of Cosmology and Astroparticle Physics*,(2016) 2016(11), 031.
- [31] G. K.Goswami, M. Mishra, M., A. K. Yadav, A. Pradhan, Two-fluid scenario in Bianchi type-I universe. *Modern Physics Letters A*, (2020) 35(12), 2050086.
- [32] S.Pan, W. Yang, E. Di Valentino, E.N. Saridakis, and S. Chakraborty, Interacting scenarios with dynamical dark energy: observational constraints and alleviation of the H_0 tension. *Physical Review D*,(2019) 100(10), 103520.
- [33] H. Amirhashchi, D. S. Chouhan, and A. Pradhan, Interacting and non-interacting two-fluid atmosphere for dark energy in FRW universe. *Electronic Journal of Theoretical Physics*, (2014) 11(30), 109-126.
- [34] T. Singh, and R. Chaubey, An interacting two-fluid scenario for dark energy in anisotropic cosmological model. *Canadian Journal of Physics*, (2013) 91(2),.180-187.
- [35] N. J. Poplawski, A Lagrangian description of interacting dark energy,(2006) arXiv:gr-gc/0608031.
- [36] N. J. Poplawski, Acceleration of the universe in the Einstein frame of a metric-affine $f(R)$ gravity, *Classical and Quantum Gravity* 23 (2006) 2011-2020.
- [37] C. Misner, Thorne, K. S., and J. Wheeler, *Gravitation* (W.H. Freeman and Company, 1970).
- [38] O. Akarsu, C. B. Kilinc, LRS Bianchi type I models with anisotropic dark energy and constant deceleration parameter, *General Relativity and Gravitation* 42, 119 (2010).
- [39] C. Chawla, R. K. Mishra, A. Pradhan, Anisotropic Bianchi-I Cosmological Model in String Cosmology with Variable Deceleration Parameter. *Romanian Journal of Physics*, 58(2013) 1000-1013.
- [40] C.J. Feng, Statefinder Diagnosis for Ricci Dark Energy, *Physics Letters B* 670 (2008) 231.

Role of Special form of Deceleration Parameter in $f(R, T)$ theory

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Abstract:

We have studied locally rotationally symmetric Bianchi-V Universe in the presence of modified theory for gravitation and for that, we considered perfect fluid with heat conduction as the energy source. We have obtained the solutions of field equations by assuming the special form of deceleration parameter and arrived at values of the scale factor. Also, we have discussed the physical and geometrical properties of the model in detail.

Keywords: $f(R, T)$ gravity, LRS Bianchi type V, perfect fluid, deceleration parameter.

1. Introduction

Modern cosmology achieved a new path because of the idea of accelerated expansion of the Universe. This is the main reason why the modern cosmology is the fastest-growing field in the study of the Universe. It is well known as $f(R, T)$ theory of gravity which was proposed by Harko et al.(2011), where R is the Ricci scalar and T is a trace of the stress-energy tensor. The $f(R, T)$ theory has attracted a lot of attention of the astrophysicist in recent times and hence discussion is going on by many researchers in this modified theory because of its ability to explain mysterious things in cosmology and astrophysics, for more detail one can refer the work by [Barrow and Turner (1981), Sahoo et al. (2016), Gron (1983), Yousaf et al. (2017), Pawar et al. (2016), Pawar and Shahare (2019, 2020), Khade (2022, 2023)]. The most curious mystery of the Universe is Big-Bang singularity and hence it is very obvious that researchers are interested to study the behavior of the Universe near the Big-Bang singularity. We are interested and motivated by one of the alternative theory of gravitation.

From the above work, we got a motivation to study the behavior of the Universe by considering LRS Bianchi-V space-time, filled with perfect fluid with heat conduction in $f(R, T)$ theory. The physical and dynamical behavior of the Universe is also observed. The paper is organized as follows: In section 2 we discussed the $f(R, T)$ gravity. In Section 3, we have studied the metric (Bianchi type-V) and field equations for $f(R, T)$ gravity. In Section 4, we have studied solution of the field equation using special form of deceleration parameter. we have discussed the physical and dynamical parameters in section 5. At the last section 6, we have discussion and conclusion our work.

2. Field equation of $f(R, T)$ theory

Hilbert-Einstein variational principle on which field equation of $f(R, T)$ theory formed, is given by,

$$S = \int \left[\frac{1}{2\kappa} f(R, T) + L_m \right] \sqrt{-g} d^4x, \quad (1)$$

The gravitational field equations for $f(R, T)$ gravity are,

$$f_{R(R, T)} R_{ij} - \frac{1}{2} f(R, T) g_{ij} + (g_{ij} \nabla^i \nabla_j - \nabla_i \nabla_j) f_{R(R, T)} = \kappa T_{ij} - f_T(R, T) T_{ij} - f_T(R, T) \theta_{ij}. \quad (2)$$

where ∇_i being the covariant derivative and

$$f_R = \frac{\partial f(R, T)}{\partial R} \quad \text{and} \quad f_T = \frac{\partial f(R, T)}{\partial T} \quad \theta_{ij} = g^{\alpha\beta} \frac{\partial T_{\alpha\beta}}{\partial g^{ij}} \quad (3)$$

we choose $\kappa = \frac{8\pi G}{c^4}$.

The energy-momentum tensor for a perfect fluid with heat flow is given by Singh (2008)

$$T_{ij} = (\rho + p)u_i u_j + p g_{ij} + h_i u_j + h_j u_i \quad (4)$$

Where ρ is the energy density, p is the thermodynamic pressure, u_i is the four-velocity of the fluid, h_i is the heat flow vector satisfying

$$h^i u_i = 0 \quad h^i u_i > 0 \quad (5)$$

Let us consider that $h^i = \delta_0^i$. Then the field equation and eq.(5) give that the heat flow is in the x-direction only, and therefore we have

$$h_i = (h_1(t), 0, 0, 0) \quad (6)$$

In the present work, we have taken particular functional as $f(R, T) = R + 2f(T)$ otherwise functional can be taken in different ways corresponding to viable models. Here $f(T)$ is a function of the trace of the energy-momentum tensor. Also, we have obtained the variation of stress-energy for perfect fluid with heat flow is

$$\theta_{ij} = -2T_{ij} - p g_{ij} \quad (7)$$

By using this functional and θ_{ij} field equation can be rewritten as,

$$R_{ij} - \frac{1}{2} R g_{ij} = k T_{ij} - f_T T_{ij} + 2 f_T T_{ij} + f_T p g_{ij} \quad (8)$$

where f_T is a partial derivative of f with respect to T .

$$\text{Assuming } f(T) = \lambda T, \quad (9)$$

where λ being constant, we have chosen a system for $\kappa = 1$.

3. Metric and field equations

We consider Locally Rotationally Symmetric (LRS) Bianchi type-V space-time described by the line element

$$ds^2 = A^2 dx^2 + B^2 e^{2x} (dy^2 + dz^2) - dt^2 \quad (10)$$

Here, A and B are functions of cosmic time t only.

Now using a co-moving coordinate system, the field Eqn.(8) with the help of Eqn.(4) and Eqn.(5) for the metric Eqn.(10), can be explicitly written as

$$2 \frac{\ddot{B}}{B} + \frac{\dot{B}^2}{B^2} - \frac{1}{A^2} = -p \quad (11)$$

$$\frac{\ddot{A}}{A} + \frac{\dot{B}}{B} + \frac{\dot{A}\dot{B}}{AB} - \frac{1}{A^2} = -p \quad (12)$$

$$2 \frac{\dot{A}\dot{B}}{AB} + \frac{\dot{B}^2}{B^2} - \frac{3}{A^2} = \rho \quad (13)$$

$$2 \left(\frac{\dot{B}}{B} - \frac{\dot{A}}{A} \right) = h_1 \quad (14)$$

Here over-headed dot means derivative with respect to t .

The average scale factor is

$$a(t) = (AB^2)^{\frac{1}{3}} \quad (15)$$

The spatial volume is

$$V = a^3 = AB^2 \quad (16)$$

The directional Hubble parameters are

$$H_x = \frac{\dot{A}}{A} \quad H_y = H_z = \frac{\dot{B}}{B} \quad (17)$$

The average Hubble parameter is

The dynamical scalar expansion θ and shear scalar σ^2 are

$$\theta = 3H = \left[\frac{\dot{A}}{A} + 2 \frac{\dot{B}}{B} \right] \quad (18)$$

$$\sigma^2 = \frac{1}{2} \sigma^{ij} \sigma_{ij} = \frac{1}{2} \left[\frac{\dot{A}}{A} - \frac{\dot{B}}{B} \right]^2 \quad (19)$$

The average anisotropic parameter Δ is

$$\Delta = \frac{1}{3} \sum_{i=1}^3 \left[\frac{H_i - H}{H} \right]^2 \quad (20)$$

Here H_i represents the directional Hubble parameters ($i = 1, 2, 3$)

The deceleration parameter (DP) is

$$q = -1 + \frac{d}{dt} \left(\frac{1}{h} \right) \quad (21)$$

Now, Eqns.(11)-(14) can be written in terms of H, q, σ^2 as

$$\rho = 3H^2 - \sigma^2 + \frac{1}{A^2} \quad (22)$$

$$p = H^2(2q - 1) - \sigma^2 + \frac{1}{A^2} \quad (23)$$

4. Solution of the field equations

In order to solve the system completely, we use a special form of deceleration parameter defined by Debnath et al. (2009) for FRW metric as

$$q = - \left[\frac{a\ddot{a}}{\dot{a}^2} \right] = -1 + \frac{\alpha}{1+a^\alpha} \quad (24)$$

where, $\alpha > 0$ is a constant and a is scale factor of the universe.

After solving equation (24) one can obtain the mean Hubble parameter H as

$$H = \frac{\dot{a}}{a} = k(1 + a^{-\alpha}) \quad (25)$$

where $k > 0$ is a constant of integration.

On integrating equation (25), we obtain the mean scale factor as

$$a = (e^{kat} - 1)^{\frac{1}{\alpha}} \quad (26)$$

Choose $k = 1$.

$$a = (e^{at} - 1)^{\frac{1}{\alpha}} \quad (27)$$

To find the determinate solution of the system, we used the law of variation. Now, from Eqn.(11) and Eqn.(12), we get

$$\frac{\ddot{B}}{B} - \frac{\ddot{A}}{A} + \frac{\dot{B}^2}{B^2} - \frac{\dot{A}\dot{B}}{AB} = 0 \quad (28)$$

This, on integration gives,

$$\frac{\dot{B}}{B} - \frac{\dot{A}}{A} = \frac{c_1}{AB^2} \quad (29)$$

Where c_1 is constant of integration.

$$\frac{B}{A} = c_2 \exp \left[\int \frac{c_1}{a^3} dt \right] \quad (30)$$

Using Eqn.(15) in Eqn.(29) and integrating again, the metric functions A and B in terms of average scale factor $a(t)$ are given by

$$A = c_2^{-2/3} a \exp \left[\frac{-2c_1}{3} \int a^{-3} dt \right] \quad (31)$$

$$B = c_2^{1/3} a \exp \left[\frac{c_1}{3} \int a^{-3} dt \right] \quad (32)$$

Now using Eqn.(27) in Eqn.(31) and Eqn.(32), we get

$$A = c_2^{-2/3} (e^{at} - 1)^{\frac{1}{\alpha}} \exp \left[\frac{-2c_1 (e^{at} - 1)^{\frac{\alpha-3}{\alpha}}}{3 (\alpha-3)e^{at}} \right] \quad (33)$$

$$B = c_2^{1/3} (e^{at} - 1)^{\frac{1}{\alpha}} \exp \left[\frac{c_1 (e^{at} - 1)^{\frac{\alpha-3}{\alpha}}}{3 (\alpha-3)e^{at}} \right] \quad (34)$$

$$ds^2 = c_2^{-4/3} (e^{at} - 1)^{\frac{2}{\alpha}} \exp \left[\frac{-4c_1 (e^{at} - 1)^{\frac{\alpha-3}{\alpha}}}{3 (\alpha-3)e^{at}} \right] dx^2 + c_2^{2/3} (e^{at} - 1)^{\frac{2}{\alpha}} \exp \left[\frac{2c_1 (e^{at} - 1)^{\frac{\alpha-3}{\alpha}}}{3 (\alpha-3)e^{at}} \right] e^{2x} (dy^2 + dz^2) - dt^2 \quad (35)$$

5. Physical parameters of the model

Dynamical parameters are quite significant in the discussion of the physical properties of the cosmological model and to develop a cosmological theory in $f(R, T)$ theory of gravity. We

compute the following cosmological parameters for the model given by Eqn.(25). The spatial volume of the metric is

$$V = (e^{\alpha t} - 1)^{\frac{3}{\alpha}} \quad (36)$$

The directional Hubble parameters are

$$H_x = \frac{\dot{A}}{A} = \left\{ \frac{-2c_1}{3(e^{\alpha t} - 1)^{\frac{3}{\alpha}}} + \frac{e^{\alpha t}}{(e^{\alpha t} - 1)} \right\} \quad (37)$$

$$H_y = \frac{\dot{B}}{B} = \left\{ \frac{c_1}{3(e^{\alpha t} - 1)^{\frac{3}{\alpha}}} + \frac{e^{\alpha t}}{(e^{\alpha t} - 1)} \right\} \quad (38)$$

The average Hubble parameter is

$$H = \frac{e^{\alpha t}}{(e^{\alpha t} - 1)} \quad (39)$$

The dynamical scalar expansion θ and shear scalar σ^2 are

$$\theta = 3H = \frac{3e^{\alpha t}}{(e^{\alpha t} - 1)} \quad (40)$$

$$\sigma^2 = \frac{1}{2} \frac{c_1^2}{(e^{\alpha t} - 1)^{\frac{6}{\alpha}}} \quad (41)$$

The solution of heat conduction can be obtained as

$$h_1 = \frac{2c_1}{(e^{\alpha t} - 1)^{\frac{3}{\alpha}}} \quad (42)$$

The anisotropic parameter Δ is

$$\Delta = \frac{2c_1^2}{9e^{2\alpha t}(e^{\alpha t} - 1)^{\frac{2(3-\alpha)}{\alpha}}} \quad (43)$$

Now using the above equations in Eqn.(22) and Eqn.(23), we get energy density and pressure as follows:

$$\rho = 3 \frac{e^{2\alpha t}}{(e^{\alpha t} - 1)^2} - \frac{1}{2} \frac{c_1^2}{(e^{\alpha t} - 1)^{\frac{6}{\alpha}}} - \frac{3}{c_2^{\frac{-4}{3}} (e^{\alpha t} - 1)^{\frac{2}{\alpha}} \exp \left[\frac{-4c_1(e^{\alpha t} - 1)^{\frac{\alpha-3}{\alpha}}}{3(\alpha-3)e^{\alpha t}} \right]} \quad (44)$$

$$p = \frac{e^{2\alpha t}}{(e^{\alpha t} - 1)^2} \left[-3 + \frac{2\alpha}{e^{\alpha t}} \right] - \frac{1}{4} \frac{c_1^4}{(e^{\alpha t} - 1)^{\frac{12}{\alpha}}} + \frac{3}{c_2^{\frac{-4}{3}} (e^{\alpha t} - 1)^{\frac{2}{\alpha}} \exp \left[\frac{-4c_1(e^{\alpha t} - 1)^{\frac{\alpha-3}{\alpha}}}{3(\alpha-3)e^{\alpha t}} \right]} \quad (45)$$

6. Discussion and Conclusion:

we have studied locally rotationally symmetric Bianchi-V with perfect fluid and heat conduction as the energy source. The solutions of the field equations are obtained under the assumption of special form of deceleration parameter. So we found solutions in the presence of heat conduction only and we have not discussed the solutions without heat conduction. Here we found some of the dynamical parameters, metric potentials, internal pressure, density and mainly the heat flow for which our work is devoted. We observed that at an initial time, metric potential $A(t)$ and $B(t)$ are zero. Also, it tends to zero as well as infinity depending on the value of α , i.e. for $\alpha < 3$ and $\alpha > 3$ respectively. The average Hubble parameter (H) and shear scalar (σ) are the function of time t and have a singularity at $t = 0$ and it tends to zero for large t . dynamical expansion scalar (θ) and Heat flow is infinite at initial epoch but it will vanish for large t . The volume of the universe is zero when $t \rightarrow 0$ and as time increases volume V increases exponentially. When $t \rightarrow 0, \rho \rightarrow \infty$ and when $t \rightarrow \infty, \rho \rightarrow 0$, which indicates that the universe starts with initial (Big-Bang) type of singularity and the models reduces to vacuum at very late time. The anisotropy of expansion is maintained throughout the evolution of the universe. The deceleration parameter q varies from 1 to -1. It shows that the universe accelerates after an epoch of deceleration. The deceleration parameter q is in the range $-1 \leq$

$q \leq 0.5$ which matches with the observations made by Riess et al. (1998) and Perlmutter et al. (1999) and the present day universe is undergoing accelerated expansion.

Reference:

- [1] T Harko et al, Phys. Rev. D Part. Fields 84, 024020 (2011)
- [2] J D Barrow and M S Turner, Nature 292, 35 (1981)
- [3] P K Sahoo, B Mishra and P Sahoo, Eur. Phys. J. Plus 131, 333 (2016)
- [4] O Gron, Phys. Rev. D 33, 1204 (1983)
- [5] Z Yousaf, M Ilyas and M Zaeem-ul-Haq Bhatti, Eur. Phys. J. Plus 132, 268 (2017)
- [6] D D Pawar, V J Dagwal and P K Agrawal, Malaya J. Mat. 4(1), 111 (2016)
- [7] D D Pawar and S P Shahare, J. Astrophys. Astr. 40, 13 (2019)
- [8] D D Pawar and S P Shahare, New Astron. 75, 101318 (2020)
- [9] P P Khade, IJSR, 11, 10 (2022)
- [10] P P Khade, Jordan Journal of Phys. 16, 1 (2023)
- [11] C P Singh, M Zeyauddin and S Ram, Int. J. Theor. Phys. 47(12), 3162 (2008)
- [12] B C Paul, P S Debnath, S Ghose, Physical Review D, 8, 79 (2009)
- [13] A G Riess et al, Astron. J. 116, 1009 (1998)
- [14] S Perlmutter et al, Nature 391, 51 (1998)
- [15] S Nojiri and S D Odinstov, Phys. Lett. B 562, 147 (2003)
- [16] S Nojiri and S D Odinstov, Phys. Lett. B 565, 1 (2003)
- [17] C Wetterich, Nucl. Phys. B 302, 668 (1988)
- [18] B Ratra and J Peebles, Phys. Rev. D 37, 321 (1988)
- [19] J Hoftuft et al, Astrophys. J. 699, 985 (2009)
- [20] C L Bennett et al, Astrophys. J. Suppl. Ser. 148, 1 (2003)
- [21] A J Sen, High Energy Phys. 04, 048 (2002)
- [22] T Padmanabhan and T R Chaudhury, Phys. Rev. D 66, 081301 (2002)

Bianchi type-V Modified Holographic Ricci Dark Energy Model In $f(R, T)$ Gravity

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Abstract:

In the present study, we deal with the spatially homogeneous and anisotropic Bianchi type-V cosmological model in the presence of $f(R, T)$ theory of gravity. We have used energy momentum tensor of Modified Holographic Ricci Dark Energy. In order to find an exact solution of the field equations of the model, the model presented is based on a unique condition of periodically time varying deceleration parameter. The physical and geometrical characteristics of the universe model have been studied.

1. Introduction:

The purpose of modern cosmology is to determine the large-scale structure of the Universe. The astronomical observations of type-Ia supernovae experiments [Riess et al. (1998), Perlmutter et al (1998, 1999, 2003), Hoftuft et al. (2009), Bennett et al. (2003), Spergel et al. (2003)] suggest that the observable Universe is undergoing an accelerated expansion. According to the modern observations by Riess et al. (1998) our Universe is going through a phase of accelerated expansion that put new route in modern cosmology. A natural generalization is to choose a more general action in which the standard Einstein-Hilbert action is replaced by an arbitrary function of the Ricci scalar R (Nojiri and Odintsov (2003a, b)) (i.e, $f(R)$) and is the name applied to $f(R)$ -gravity. This modified theory may point this late-time cosmic acceleration (Carroll et al. (2004)). Recently, the dark energy models, which are inspiring many astrophysicists, are the holographic dark energy models. According to the holographic principle, the number of degrees of freedom in a bounded system should be finite and is related to the area of its boundary discussed by Sahoo et al. (2016). It is argued that this model may solve the cosmological constant problem and some other issues. Several aspects of holographic dark energy have been investigated by Sahu et. al. (2017) and Mishra et al. (2016). Tiwari et al. (2018, 2020), Pawar (2021, 2016), Khade (2022, 2023) have investigated different models in $f(R, T)$ theory.

The outline of this paper as follows: Basic formalism of $f(R, T)$ theory is given in Section 2; the model and the solutions of the field equations for Bianchi-type V universe are obtained the physical and geometrical characterization of the model is represented in Section 3; and the conclusions are given in Section 4.

2. Basic Formalism of $f(R, T)$ Theory

The $f(R, T)$ theory of gravity is the generalization or modification of General Relativity (GR). In this theory, the modified gravity action. Which can be varied with respect to the metric tensor g_{ij} to obtain the gravitational field equation for $f(R, T)$ gravity. The functional $f(R, T)$ can be chosen in many ways corresponding to viable models. In the present work, we have considered the functional as,

$$f(R, T) = R + 2f(T) \quad (1)$$

where $f(T)$ is an arbitrary function of the trace of the energy-momentum tensor. The corresponding field equations become,

$$R_{ij} - \frac{1}{2}Rg_{ij} = \kappa T_{ij} + 2f_T T_{ij} + [f(T)\theta_{ij} + 2P_\Lambda f_T]g_{ij},$$

(2)

Where f_T denotes the partial derivative of f with respect to T .

Assuming $f(T) = \lambda T$, λ being constant.

$$T_j^i = \text{diag}[-1, w_x, w_y, w_z]\rho_\Lambda = \text{diag}[-1, w_\Lambda, (w_\Lambda + \delta), (w_\Lambda + \gamma)]\rho_\Lambda$$

(3)

Here we have used the EoS parameter w given by

$$w_\Lambda \rho_\Lambda = P_\Lambda$$

(4)

And w_x, w_y, w_z are the directional EoS parameters along x, y, z axes respectively. For simplicity we use $w_\Lambda = 1$.

3. The Model and Solutions:

We consider the spatially homogeneous and anisotropic Bianchi type-V space-time described by the line element,

$$ds^2 = -dt^2 + A^2 dx^2 + B^2 e^{2x}(dy^2 + dz^2)$$

(5)

Where A and B are functions of cosmic time t only.

We have energy momentum tensor as

$$T_{ij} = T_{ij}' + \overline{T}_{ij}$$

(6)

Now using a co-moving coordinate system, the field Eqn.(2) with the help of Eqn.(6) and Eqn.(3) for the metric Eqn.(5), can be explicitly written as,

$$2\frac{\ddot{B}}{B} + \frac{\dot{B}^2}{B^2} - \frac{1}{A^2} = \lambda(8P_\Lambda + \rho_M) + P_\Lambda$$

(7)

$$\frac{\ddot{A}}{A} + \frac{\ddot{B}}{B} + \frac{\dot{A}\dot{B}}{AB} - \frac{1}{A^2} = \lambda(8P_\Lambda + \rho_M) + P_\Lambda$$

(8)

$$\frac{\ddot{A}}{A} + \frac{\ddot{B}}{B} + \frac{\dot{A}\dot{B}}{AB} - \frac{1}{A^2} = \lambda(8P_\Lambda + \rho_M) + P_\Lambda$$

(9)

$$2\frac{\dot{A}\dot{B}}{AB} + \frac{\dot{B}}{B^2} - \frac{3}{A^2} = \lambda(6P_\Lambda + 3\rho_M + 2\rho_\Lambda) + P_\Lambda + \rho_M$$

(10)

$$\frac{\dot{B}}{B} - \frac{\dot{A}}{A} = 0$$

(11)

Here an over head dot indicates differentiation with respect to cosmic time t .

The average scale factor $a(t)$ of the Bianchi type - V space-time is defined as

$$a = (AB^2)^{\frac{1}{3}}$$

(12)

The spatial volume of the metric is

$$V = a^3 = AB^2$$

(13)

The directional Hubble parameters are

$$H_x = \frac{\dot{A}}{A} \quad H_y = H_z = \frac{\dot{B}}{B}$$

(14)

The average Hubble parameter is

$$H = \frac{\dot{a}}{a} = \frac{1}{3} \frac{\dot{V}}{V} \quad (15)$$

$$H = \frac{1}{3} \left[\frac{\dot{A}}{A} + \frac{2\dot{B}}{B} \right] \quad (16)$$

$$\theta = 3H \quad (17)$$

$$H = \left[\frac{\dot{A}}{A} + \frac{2\dot{B}}{B} \right] \quad (18)$$

The dynamical scalar expansion θ and shear scalar σ^2 are

$$\sigma^2 = \frac{1}{2} \left[\frac{\dot{A}}{A} - \frac{\dot{B}}{B} \right]^2 \quad (19)$$

The average anisotropic parameter Δ is defined as

$$\Delta = \frac{1}{3} \sum_{i=1}^3 \left[\frac{H_i - H}{H} \right]^2 \quad (20)$$

In order to find the solution such a system, one more relation is required. Hence, we carry out a law of variation of deceleration parameter (DP). The time varying DP is important in evolution of the universe. Its phase transition in expansion may be well explained by the time varying DP. Now, we adopt the following periodic time varying DP Shen and Zhao (2014).

$$q = m \cos(kt) - 1 \quad (21)$$

Here m and k are positive real numbers.

Using the definition of DP as

$$q = \left[\frac{-\dot{H}}{H^2} - 1 \right] \quad (22)$$

the integration of Equation (21) gives the Hubble parameter H as

$$H = \frac{K}{m \sin(Kt) + K_1} \quad (23)$$

Here K_1 is a constant of integration. Here we may choose $K_1 = 0$ and then Hubble parameter becomes

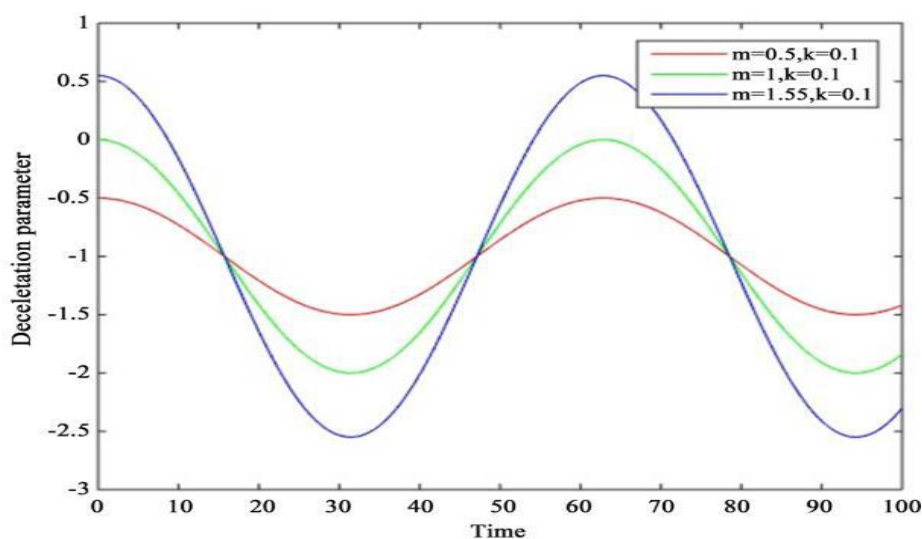


Figure 1. DP vs time in the units of Gyrs.

$$H = \frac{K}{m \sin(Kt)} \quad (24)$$

Using the definition of Hubble parameter as a $H = \frac{\dot{a}}{a}$ & in Equation (24), the average scale factors a is obtained as

$$a = a_0 \left[\tan\left(\frac{Kt}{2}\right) \right]^{\frac{1}{m}} \quad (25)$$

where a_0 is a constant of integration

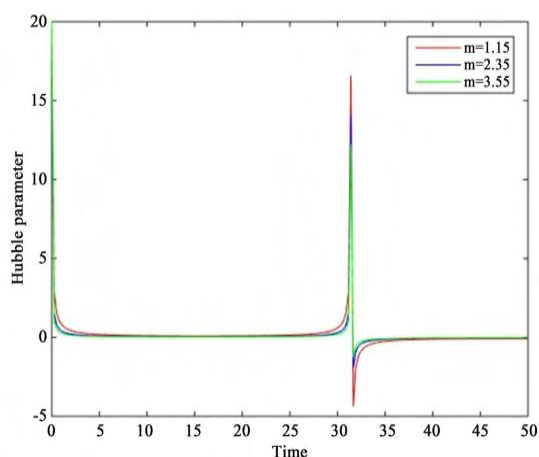


Figure 2. Hubble parameter vs time.

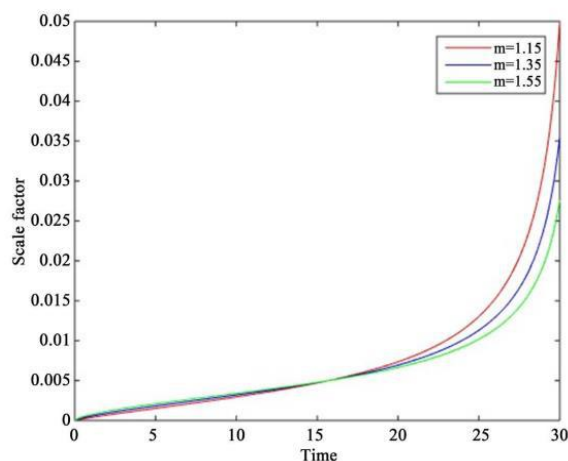


Figure 3. Scale factor vs time.

parameter and the scale factor in time with the units of giga years.

For our model, the directional Hubble parameters are obtained as follows:

$$H_x = \frac{K}{m \sin(Kt)} + \frac{2K_1}{3a_0^3 \left[\tan\left(\frac{Kt}{2}\right) \right]^{\frac{3}{m}}} \quad (26)$$

$$H_y = H_z = \frac{K}{m \sin(Kt)} - \frac{K_1}{3a_0^3 \left[\tan\left(\frac{Kt}{2}\right) \right]^{\frac{3}{m}}} \quad (27)$$

The anisotropisation in expansion of the model is given by the parameter Δ which is defined and found as

$$\Delta = \frac{2K_1^2 m^2 \sin^2(Kt)}{9K^2 a_0^2 \left[\tan\left(\frac{Kt}{2}\right) \right]^{\frac{6}{m}}} \quad (28)$$

The expansion scalar θ is

$$\theta = 3H = \frac{3K}{m \sin(Kt)} \quad (29)$$

The shear scalar σ^2 is found as

$$\sigma^2 = \frac{K_1^2}{3a_0^6 \left[\tan\left(\frac{Kt}{2}\right) \right]^{\frac{6}{m}}} \quad (30)$$

$$A = \alpha B$$

$$(31)$$

Where α is constant of integration and for simplicity we choose

$$\alpha = 1$$

$$A = B \quad (32)$$

Now from Equations (7), (8) and (32), we obtain the metric potentials

$$A = B = a = a_0 \left[\tan\left(\frac{Kt}{2}\right) \right]^{\frac{1}{m}} \quad (33)$$

$$w_\Lambda \rho_\Lambda = P_\Lambda \quad (34)$$

Also from Eqn.(2.2.5),(2.3.2),(2.3.3) and (2.5.9) we have the matter-energy density given by

$$\rho_m = \frac{1}{(2\lambda+1)} \left\{ \frac{2K^2 \cos(Kt)}{m \sin^2(Kt)} + \frac{KK_1}{3a_0^3 2^{\frac{3}{m}}} \frac{1}{[\sin(Kt)]^{\frac{6}{m}}} - \frac{2K_1^2}{3a_0^6 \left[\tan\left(\frac{Kt}{2}\right) \right]^{\frac{6}{m}}} - \frac{KK_1}{a_0^3 m \sin(Kt) \left[\tan\left(\frac{Kt}{2}\right) \right]^{\frac{3}{m}}} - \frac{2}{a_0^2 \left[\tan\left(\frac{Kt}{2}\right) \right]^{\frac{2}{m}}} \right\} \quad (35)$$

Now from Eqn.(2.2.5),(2.3.2),(2.3.3) and (2.4.2) the modified holographic Ricci dark energy density and pressure is determined as

$$\rho_\Lambda = \frac{1}{(8\lambda+1)} \left\{ \frac{-2(3\lambda+1)K^2 \cos(Kt)}{(2\lambda+1)m \sin^2(Kt)} + \frac{(3\lambda+2)KK_1}{3(2\lambda+1)a_0^3 2^{\frac{3}{m}}} \frac{1}{[\sin(Kt)]^{\frac{6}{m}}} + \frac{3K^2}{m \sin^2(Kt)} - \frac{(3\lambda+2)KK_1}{(2\lambda+1)a_0^3 m \sin(Kt) \left[\tan\left(\frac{Kt}{2}\right) \right]^{\frac{3}{m}}} + \frac{(4\lambda+1)K_1^2}{3(2\lambda+1)a_0^6 \left[\tan\left(\frac{Kt}{2}\right) \right]^{\frac{6}{m}}} - \frac{(4\lambda+1)}{(2\lambda+1)a_0^2 \left[\tan\left(\frac{Kt}{2}\right) \right]^{\frac{2}{m}}} \right\} \quad (36)$$

4. Conclusion

We have studied the modified holographic Ricci dark energy model in $f(R, T)$ theory of gravity by using anisotropy Bianchi type-V. In order to obtain the solutions of field equations, we used EoS $w_\Lambda \rho_\Lambda = P_\Lambda$. We see that the average scale factor is zero at initially. It increases in cosmic time and changes periodically. The metric potentials are vanish initially it means our model has point type singularity. All the cosmological parameters ρ_m , ρ_Λ , θ , σ and Δ are infinite initially and they preserve their periodic behavior in time. Also, we have explained and discussed the kinematical and dynamical character of the model that all the quantities are infinite initially and they preserve their periodic behavior against the cosmic time.

References:

- [1] Riess, A.G., Filippenko, A.V., Challis, P., Clocchiatti, A., Diercks, A., Garnavich, P.M., et al. (1998) 116, 1009-1038.
- [2] Perlmutter, S., et al. 1998, Nature, 391, 51.
- [3] Perlmutter, S., et al. 1999, Astrophys. J., 517, 565.
- [4] Perlmutter, S., et al. 2003, Astrophys. J., 598, 102.
- [5] Hofuuf, J., et al. 2009, Astrophys. J., 699, 985.
- [6] Bennett, C. L., et al. 2003, Astrophys. J. Suppl. Ser., 148, 1.
- [7] Spergel, D. N., et al. 2003, Astrophys. J. Suppl. Ser., 148, 175.
- [8] Nojiri, S., Odinstov, S. D. 2003a, Phys. Lett. B, 562, 147 2003; Phys. Letts. B, 565, 1.
- [9] Nojiri, S., Odinstov, S. D. 2003b, Phys. Rev. D, 68, 123512.
- [10] Nojiri, S., Odinstov, S. D., Tretyakov, P. V. 2008, Prog. Theor. Phys. Suppl., 172, 81.
- [11] Carroll, S. M., Duvvuri, V., Trodden, M., Turner, M. S. 2004, Phys. Rev. D, 70, 043528.
- [12] Sahoo, P. K., Mishra, B., Sahoo, P., Pacif, S. K. J. 2016, Eur. Phys. J. Plus, 131, 333.
- [13] Sahu, S. K., Tripathy, S. K., Sahoo, P. K., Nath, A. 2017, Chin. J. Phys., 55, 862.
- [14] Mishra, B., Tarai, S., Tripathy S. K. 2016, Adv. High. Energy Phys., 8543560.
- [15] Sahoo, P. K., Mishra, B., Sahoo, P., Pacif, S. K. J. 2016, Eur. Phys. J. Plus, 131, 333.
- [16] Tiwari, R.K. and Sofuoglu, D. 2020 International Journal of Geometric Methods in Modern Physics, 17, Article ID: 2030003.
- [17] Tiwari, R.K. and Beesham, A. 2018 Astrophysics and Space Science, 363, Article No. 234.
- [18] Pawar, D. D., Solanke, Y. S. 2014, Int. J. Theor. Phys., 53, 3052.
- [19] Pawar, D. D., Dagwal, V., Agrawal, P. 2016, Malaya J. Mat., 4(1), 111-118.
- [20] Khade, P. P. 2023 Jordan Journal of Phys. 16, 1.
- [21] Khade, P. P. 2022 IJSR, 11, 10.
- [22] Shen, M. and Zhao, L. 2014 Chinese Physics Letters, 31, Article ID: 010401.

Quadratic equation of State With Variable Deceleration Parameter In $f(R)$ Gravity

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Abstract:

In this paper we have studied the plane symmetric cosmological model with perfect fluid in the $f(R)$ theory of gravity. The exact solution of the field equations is obtained under a variation law of the Hubble parameter (H) which yields a time dependent deceleration parameter. The model presents a cosmological scenario which describes early deceleration and late time acceleration. The physical parameters of the model have been analyzed.

1.Introduction:

The general theory of relativity successfully explains the origin and evolution of the universe but late time acceleration of the universe and the existence of dark matter challenged general relativity. To explain the observational results of the cosmological model recently many different approaches have been proposed. Different types of modified theories of gravity have been formulated to explain the nature of dark energy which is responsible for the accelerated expansion of the universe. $(G), f(R, G), f(R), f(T)$ and $f(R, T)$ gravity theory are some generalization of GR theory. In (R) modified theory of gravity, the Ricci scalar R in the Einstein-Hilbert action is replaced by an arbitrary function of R belongs to the well-known. Nojiri and Odintsov studied late time acceleration of universe by using $f(R)$ gravity model [1]. Furthermore, it is believed that the early universe may not have been exactly uniform. Therefore, inhomogeneous and anisotropic models of universe plays important role in theoretical cosmology. This prediction encourages us to explore the initial phases of the universe using models with an anisotropic background. Among which, Bianchi type models are the simplest models with anisotropic background. Numerous researchers have explored Bianchi type spacetimes in various contexts [2][3][4][5]. Kumar and Singh solved the field equations using a Bianchi type I spacetime in the presence of a perfect fluid [6].

To explore in cosmological models, Quadratic equation of state is needed. The general form of the quadratic equation of state is given by $p = p_0 + \alpha\rho + \beta\rho^2$, where p_0, α , and β , are the parameters. In our work, we have consider the quadratic equation of state of the form $p = \varepsilon\rho^2 - \rho$, where ε is constant and strictly $\varepsilon \neq 0$. Several researchers have explored the quadratic equation of state in various contexts using cosmological models [7-12]. Camera investigated The effective equation of state in Palatini in $f(R)$ cosmology [13]. Chirde et al. had investigated Quadratic Equation of State with Constant Deceleration Parameter in $f(R)$ Gravity [14].

Inspiring from above discussion, we have examined Bianchi Type I cosmological model with quadratic EoS in the metric version of $f(R)$ gravity by using variable deceleration parameter. The organisation of the paper is as follows: In Sect. 2, Some Basics of $f(R)$ gravity is given, whereas in Sect. 3, we present the Metric and Fiel Equation. The solution of the field equations has been explored in Sect. 4. Section 5 gives the physical and geometrical properties of the field equations, and in the last Sect. 6, we cover the discussion and conclusion.

2. Some Basics of $f(R)$ gravity

$f(R)$ theory of gravity is generalization of GR, The action of $f(R)$ gravity is given by

$$S = \frac{1}{2k^2} \int d^4x \sqrt{-g} f(R) + \int d^4x L_m(g_{ij}, \psi_m) \quad (1)$$

Where $k^2 = 8\pi G = 1$ and $f(R)$ is some function of the Ricci scalar.

$g = \det g_{ij}$ is the determinant of the metric tensor. and L_m is the metric Lagrangian that depends on g_{ij} and the matter field ψ_m .

The corresponding $f(R)$ gravity field equations is obtained by varying the action with respect to the metric g_{ij}

$$F(R)R_{ij} - \frac{1}{2}f(R)g_{ij} - \nabla_i\nabla_j F(R) + g_{ij}\square F(R) = T_{ij} \quad (2)$$

$$\text{Where, } \square = \nabla^i\nabla_j, F(R) = \frac{d}{dR}f(R) \quad (3)$$

∇_i is the covariant derivative and T_{ij} is the standard matter energy-momentum tensor derived from the Lagrangian L_m .

3. The Metric and Field Equation

We consider a Bianchi type-I space-time of the form

$$ds^2 = dt^2 - A^2 dx^2 - B^2(dy^2 + dz^2) \quad (4)$$

where, A and B are the functions of t only.

Let us consider that the matter content is a perfect fluid such that the Energy momentum tensor T_{ij} is taken as

$$T_{ij} = (p + \rho)u_i v_j - p g_{ij} \quad (5)$$

Let p and ρ be the pressure and energy density of the fluid respectively which satisfy the general form of the quadratic equation of state (EoS) [15].

$$p = \varepsilon\rho^2 - \rho \quad (6)$$

where ε is constant and strictly $\varepsilon \neq 0$.

The field equations in Eqn. (2) corresponding to the metric in Eqn. (4) gives the following set of linearly independent differential equations

$$\left[\frac{\ddot{A}}{A} + 2\frac{\dot{A}\dot{B}}{AB}\right]F - \frac{1}{2}f(R) + 2\frac{\dot{B}}{B}\dot{F} + \ddot{F} = \rho - \varepsilon\rho^2 \quad (7)$$

$$\left[\frac{\ddot{B}}{B} + \frac{\dot{A}\dot{B}}{AB} + \frac{\dot{B}^2}{B^2}\right]F - \frac{1}{2}f(R) + \left[\frac{\dot{A}}{A} + \frac{\dot{B}}{B}\right]\dot{F} + \ddot{F} = \rho - \varepsilon\rho^2 \quad (8)$$

$$\left[\frac{\dot{A}}{A} + 2\frac{\dot{B}}{B}\right]F - \frac{1}{2}f(R) + \left[\frac{\dot{A}}{A} + 2\frac{\dot{B}}{B}\right]\dot{F} = \rho \quad (9)$$

Here an overhead dot indicates differentiation with respect to cosmic time t.

From equations (7) and (8), We get

$$\left(\frac{\dot{A}}{A} - \frac{\dot{B}}{B}\right) + \left(\frac{\dot{A}^2}{A^2} - \frac{\dot{B}^2}{B^2}\right) + \left(\frac{\dot{A}}{A} - \frac{\dot{B}}{B}\right)\left(\frac{\dot{B}}{B} - \frac{\dot{F}}{F}\right) = 0 \quad (10)$$

Integrating Eqn. (10),

$$\frac{A}{B} = \exp\left[\int \frac{cF}{AB^2} dt\right] \quad (11)$$

Kotub Uddin et al. have established a power law relation between F and a in the context of $f(R)$ gravity, where $a(t)$ is the average scale factor [16].

$$F \propto a^m$$

$$F = \alpha a^m$$

$$F = a^m, \quad \alpha = 1$$

$$F = (AB^2)^{\frac{m}{3}} \quad (12)$$

The spatial volume of the metric is given as

$$V = AB^2 = a^3$$

$$F = V^{\frac{m}{3}} \quad (13)$$

Eqn. (11) implies,

$$\frac{A}{B} = \exp\left[c \int V^{\frac{m-3}{3}} dt\right] \quad (14)$$

4. Solution of the field equations

To get a solution, we do not assume an equation of state, but we take the special type of Hubble parameter proposed by Benerjee and Das [22] as follows

$$H = \beta(a^{-n} + 1) \quad (15)$$

Where β is an arbitrary constant and n is constant, β is taken to be positive which ensure positivity of Hubble parameter irrespective of constant n .

Integrating Eqn. (14),

$$a^n = e^{n\beta t} - 1 \quad (16)$$

The deceleration parameter is given by,

$$q = -1 + \frac{n}{e^{n\beta t}} \quad (17)$$

The directional Hubble parameters is given as,

$$\frac{\dot{A}}{A} = H_1 = \frac{\beta e^{n\beta t}}{(e^{n\beta t} - 1)} + \frac{2K_1}{3(e^{n\beta t} - 1)^{\frac{3}{n}}} \quad (18)$$

$$\frac{\dot{B}}{B} = H_2 = H_3 = \frac{\beta e^{n\beta t}}{(e^{n\beta t} - 1)} - \frac{K_1}{3(e^{n\beta t} - 1)^{\frac{3}{n}}} \quad (19)$$

And the mean Hubble parameter is given as,

$$H = \frac{\beta e^{n\beta t}}{(e^{n\beta t} - 1)} \quad (20)$$

The spatial volume of the metric is given as

$$V = (e^{n\beta t} - 1)^{\frac{3}{n}} \quad (21)$$

The anisotropy parameter is given by,

$$A_m = \frac{2K_1^2}{3\beta^2 e^{2\beta t} (e^{n\beta t} - 1)^{\frac{6-2n}{n}}} \quad (22)$$

The dynamical scalar expansion θ and shear scalar σ are

$$\theta = \frac{3\beta e^{n\beta t}}{(e^{n\beta t} - 1)} \quad (23)$$

$$\sigma = \frac{K_1}{\sqrt{3}(e^{n\beta t} - 1)^{\frac{3}{n}}} \quad (24)$$

The metric functions A and B are given by

$$A = (e^{n\beta t} - 1)^{\frac{1}{n}} \exp \left[\frac{2c(e^{n\beta t} - 1)^{\frac{(m+n-3)}{n}}}{3\beta(m+n-3)e^{n\beta t}} \right] \quad (25)$$

$$B = (e^{n\beta t} - 1)^{\frac{1}{n}} \exp \left[\frac{-1c(e^{n\beta t} - 1)^{\frac{(m+n-3)}{n}}}{3\beta(m+n-3)e^{n\beta t}} \right] \quad (26)$$

5. Physical and geometrical properties of the model

Now, The corresponding Ricci scalar is given by [17],

$$R = (2 - n)6\beta^2 \frac{e^{2n\beta t}}{(e^{n\beta t} - 1)^2} + \frac{6K_1^2}{9(e^{n\beta t} - 1)^{\frac{6}{n}}} \quad (27)$$

$$f(R) = 12n\beta^3(n-2) \frac{(e^{n\beta t} - 1)^{\frac{m}{n}-2} [(m-2n)e^{n\beta t} + n]}{\beta(m-2n)(m-n)} - \frac{4K_1^2 \beta (e^{n\beta t} - 1)^{\frac{m-6}{n}}}{\beta(m-6)} \quad (28)$$

Energy density and Pressure is given as follows

$$\rho = \left\{ \frac{(m+1-n)3\beta^2 e^{2n\beta t}}{(e^{n\beta t} - 1)^2} + \left(\frac{1}{3} + \frac{1}{m-6} \right) \frac{2K_1^2}{(e^{n\beta t} - 1)^{\frac{6}{n}}} - \frac{6n\beta^2(n-2)[(m-2n)e^{n\beta t} + n]}{(m-2n)(m-n)(e^{n\beta t} - 1)^2} + \frac{2\beta K_1 e^{n\beta t}}{3(e^{n\beta t} - 1)^{\frac{3}{n}+1}} \right\} (e^{n\beta t} - 1)^{\frac{m}{n}} \quad (29)$$

$$\begin{aligned}
p = \varepsilon & \left\{ \frac{(m+1-n)3\beta^2 e^{2n\beta t}}{(e^{n\beta t} - 1)^2} + \left(\frac{1}{3} + \frac{1}{m-6} \right) \frac{2K_1^2}{(e^{n\beta t} - 1)^{\frac{6}{n}}} \right. \\
& \left. - \frac{6n\beta^2(n-2)[(m-2n)e^{n\beta t} + n]}{(m-2n)(m-n)(e^{n\beta t} - 1)^2} + \frac{2\beta K_1 e^{n\beta t}}{3(e^{n\beta t} - 1)^{\frac{3}{n}+1}} \right\}^2 (e^{n\beta t} - 1)^{\frac{2m}{n}} \\
& - \left\{ \frac{(m+1-n)3\beta^2 e^{2n\beta t}}{(e^{n\beta t} - 1)^2} + \left(\frac{1}{3} + \frac{1}{m-6} \right) \frac{2K_1^2}{(e^{n\beta t} - 1)^{\frac{6}{n}}} \right. \\
& \left. - \frac{6n\beta^2(n-2)[(m-2n)e^{n\beta t} + n]}{(m-2n)(m-n)(e^{n\beta t} - 1)^2} + \frac{2\beta K_1 e^{n\beta t}}{3(e^{n\beta t} - 1)^{\frac{3}{n}+1}} \right\} (e^{n\beta t} - 1)^{\frac{m}{n}}
\end{aligned} \tag{30}$$

6. Discussion and Conclusion

In this paper, we have investigated Bianchi I Cosmological Model with quadratic EoS in the metric version of $f(R)$ gravity has been investigated. For obtaining a solution to the field equations, we do not assume an equation of state, but rather we take a variation law for the Hubble parameter H (Banerjee and Das 2005) that yields a deceleration parameter q . We have evaluated some important cosmological physical and kinematical quantities for this model. We observe that the spatial volume V of the model is zero at $t = 0$. Hence the model starts evolving at $t = 0$ and expands continuously. The expansion scalar θ and shear scalar σ diverge at $t = 0$. For the deceleration parameter, we have $q \rightarrow n - 1$ (> 0 for $n > 1$). Hence the expansion in the model initially decelerates. Since the deceleration parameter is -1 for large t , The universe beings with a decelerating expansion, and it changes to accelerating later on. In the derived model, It is observed that energy density is a function of time I and always decrease positively with the expansion. At the initial stage $t \rightarrow 0$, pressure p , energy density ρ diverges and vanishes for large value of t . The anisotropy parameter A_m tends to zero for large t . Therefore the model approaches isotropy at late times.

References:

- [1] Nojiri, S. I., & Odintsov, S. D. (2008). Dark energy, inflation and dark matter from modified $F(R)$ gravity. *arXiv preprint arXiv:0807.0685*.
- [2] Hanquin, J. L., & Demaret, J. (1984). Exact solutions for inhomogeneous generalisations of some vacuum Bianchi models. *Classical and Quantum Gravity*, 1(3), 291.
- [3] Chakraborty, S., Chakraborty, N. C., & Debnath, U. (2003). A quintessence problem in Brans–Dicke theory with varying speed of light. *International Journal of Modern Physics D*, 12(02), 325-335.
- [4] Christodoulakis, T., & Terzis, P. A. (2007). The general solution of Bianchi type III vacuum cosmology. *Classical and Quantum Gravity*, 24(4), 875.
- [5] Bagora, A. (2009). Bianchi Type-III stiff fluid cosmological model in general relativity. *Astrophysics and Space Science*, 319, 155-159.
- [6] Kumar, S., & Singh, C. P. (2007). Anisotropic Bianchi type-I models with constant deceleration parameter in general relativity. *Astrophysics and Space Science*, 312, 57-62.
- [7] Feroze, T., & Siddiqui, A. A. (2011). Charged anisotropic matter with quadratic equation of state. *General Relativity and Gravitation*, 43, 1025-1035.
- [8] Maharaj, S. D., & Mafa Takisa, P. (2012). Regular models with quadratic equation of state. *General Relativity and Gravitation*, 44, 1419-1432.
- [9] Chavanis, P. H. (2013). A cosmological model based on a quadratic equation of state unifying vacuum energy, radiation, and dark energy. *Journal of Gravity*, 2013.

-
- [10] Chavanis, P. H. (2015). A cosmological model describing the early inflation, the intermediate decelerating expansion, and the late accelerating expansion of the universe by a quadratic equation of state. *Universe*, 1(3), 357-411.
- [11] Singh, G. P., Bishi, B. K. (2015). Bianchi Type-I universe with cosmological constant and quadratic equation of state in modified gravity. *Advances in High Energy Physics*, 2015.
- [12] Reddy, D. R. K., Adhav, K. S., & Purandare, M. A. (2015). Bianchi type-I cosmological model with quadratic equation of state. *Astrophysics and Space Science*, 357, 1-5.
- [13] Camera, S., Capozziello, S., Fatibene, L. *et al.* (2023) The effective equation of state in Palatini $f(R)$ cosmology. *Eur. Phys. J. Plus* 138, 180.
- [14] Chirde, V. R., & Shekh, S. H. (2017). Quadratic equation of state with constant deceleration parameter in $f(R)$ gravity. *J. Theor. Phys. Cryptogr*, 13, 14-19.
- [15] Ananda, K. N., & Bruni, M. (2006). Cosmological dynamics and dark energy with a nonlinear equation of state: A quadratic model. *Physical Review D*, 74(2), 023523.
- [16] Uddin, K., Lidsey, J. E., & Tavakol, R. (2007). Cosmological perturbations in Palatini-modified gravity. *Classical and Quantum Gravity*, 24(15), 3951.
- [17] Shamir, M. F. (2010). Some Bianchi type cosmological models in $f(R)$ gravity. *Astrophysics and Space Science*, 330, 183-189.
- [18] Pawar, D. D. and Agrawal, P. K. (2018) Vacuum Solutions of FRW and Axially Symmetric Space–Time in $f(R)$ Theory of Gravity. *Iranian Journal of Science and Technology* 42, 3.
- [19] Pawar, D. D. and Shahare, S. P., (2020) Anisotropic tilted cosmological model in $f(R, T)$ theory of gravity *New Astron.* 75, 101318.
- [20] Khade, P. P., (2022) Two Fluid Anisotropic Model with Hybrid Scale Factor. *International Journal of Science and Research*, 11, 10.
- [21] Khade, P. P. (2023) Behaviour Of Bianchi Type V Model In Modified Theory Of Gravity With Specific form of Hubble Parameter. *Jordan Journal of Phys.* 16, 1.
- [22] Banerjee, N., & Das, S. (2005). Acceleration of the universe with a simple trigonometric potential. *General Relativity and Gravitation*, 37, 1695-1703.

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About the Book :

Vertebrate, also called Craniata, any animal of the subphylum Vertebrata, the predominant subphylum of the phylum Chordata. They have backbones, from which they derive their name. The vertebrates are also characterized by a muscular system consisting primarily of bilaterally paired masses and a central nervous system partly enclosed within the backbone. The subphylum is one of the best known of all groups of animals. Its members include the classes Agnatha, Chondrichthyes, and Osteichthyes (all fishes); Amphibia (amphibians); Reptilia (reptiles); Aves (birds); and Mammalia (mammals). Although the vertebral column is perhaps the most obvious vertebrate feature, it was not present in the first vertebrates, which probably had only a notochord. The vertebrate has a distinct head, with a differentiated tubular brain and three pairs of sense organs (nasal, optic, and otic). The body is divided into trunk and tail regions. The presence of pharyngeal slits with gills indicates a relatively high metabolic rate. A well-developed notochord enclosed in perichordal connective tissue, with a tubular spinal cord in a connective tissue canal above it, is flanked by a number of segmented muscle masses. A sensory ganglion develops on the dorsal root of the spinal nerve, and segmental autonomic ganglia grow below the notochord. The trunk region is filled with a large, bilateral body cavity (coelom) with contained viscera, and this coelom extends anteriorly into the visceral arches. A digestive system consists of an esophagus extending from the pharynx to the stomach and a gut from the stomach to the anus. A distinct heart, anteroventral to the liver, is enclosed in a pericardial sac. A basic pattern of closed circulatory vessels is largely preserved in most living forms. Unique, bilateral kidneys lie retroperitoneally (dorsal to the main body cavity) and serve blood maintenance and excretory functions.

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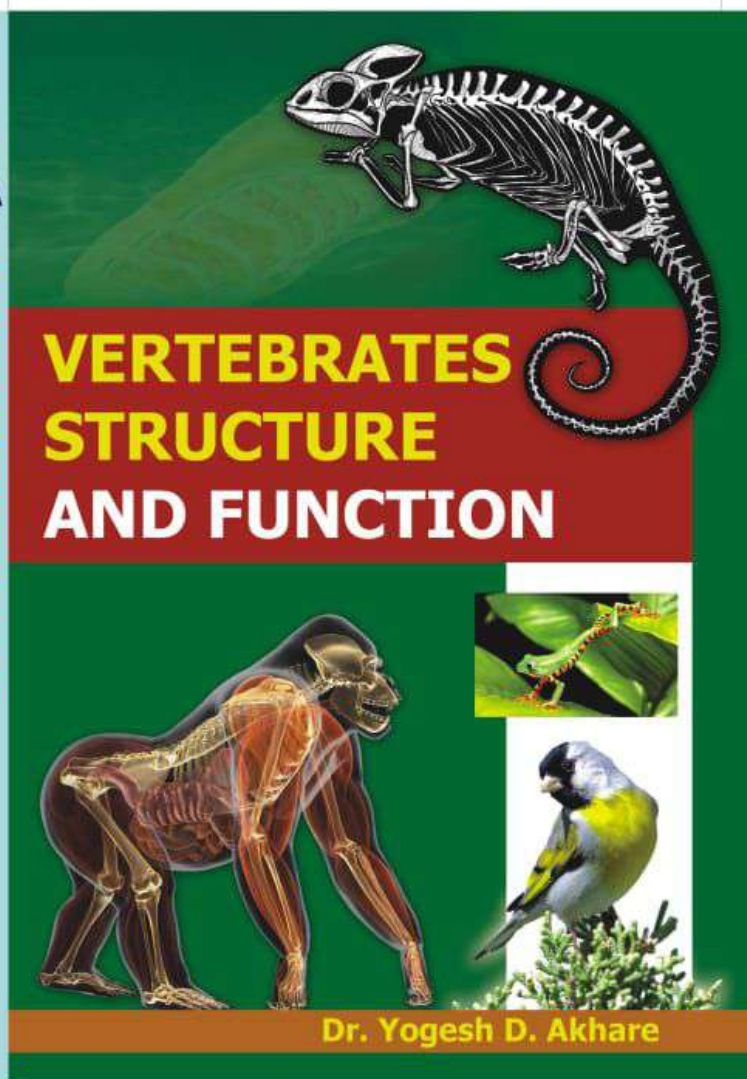
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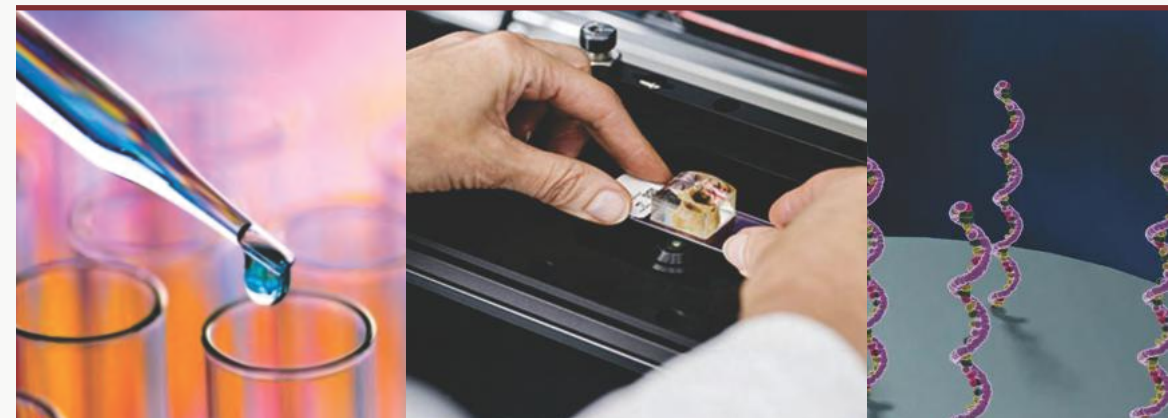
TOOLS AND TECHNIQUES
IN BIOLOGY

DR. YOGESH D. AKHARE
DR. NANDKISHOR R. THORAT
DR. SIDDHU H. RATHOD



TOOLS AND TECHNIQUES IN BIOLOGY

**Dr. Yogesh D. Akhare • Dr. Nandkishor R. Thorat
Dr. Siddhu H. Rathod**



Animal Physiology and Endocrinology

Dr. Yogesh D. Akhare • Dr. Nandkishor R. Thorat • Dr. Siddhu H. Rathod

Animal physiology is the scientific study of the life-supporting properties, functions and processes of animals or their parts. The discipline covers key homeostatic processes, such as the regulation of temperature, blood flow and hormones. The endocrine system encompasses a group of tissues that release hormones into circulation for travel to and action on distant targets. An endocrine tissue is typically a ductless gland that releases its hormones into capillaries that permeate the tissue. These glands are richly supplied with blood. Endocrinology has become a dominant field in veterinary medicine with the documentation of new disorders in many domestic and wildlife species. Disorders initially described in human medicine have now been documented in many animals with both similarities and specificities.

Contents

Introduction to Animal Physiology • Thermoregulation and Respiration • Circulation and Cardiovascular System • Physiology of Digestion and Excretion • Respiratory Pigments through Different Phylogenetic Groups • Physiology of Nervous system and Muscle Stimulation • History and Scope of Endocrinology • Histophysiology of vertebrate endocrine glands • Classification of Hormones and their diseases; Pituitary, Thyroid, Parathyroid, Adrenal gland, Islets of Langerhans • Histophysiology of Urohypophysis and Corpuscles of Staninus in fishes • Hormone action at cellular & genetic level • Hormones in biological clock • Role of hormones in digestion • Hormonal regulation of carbohydrate, Lipid, Protein metabolism, Growth and Reproduction • Neuroendocrine mechanism in insects and crustacean & in Amphibian metamorphosis



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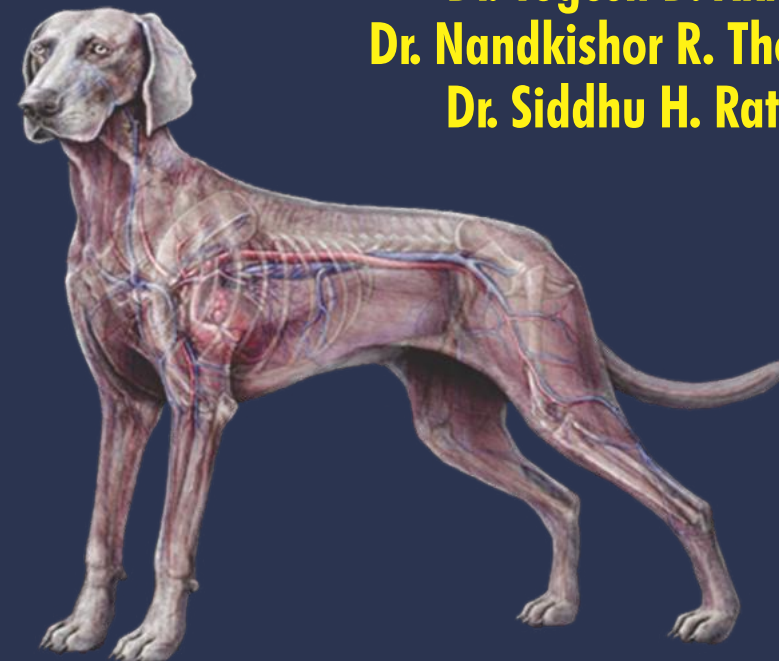
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Feminism in the Works of John Steinbeck

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Introduction:

John Steinbeck, a prolific American novelist of the 20th century, is widely recognized for his realistic portrayal of social issues and human struggles. While Steinbeck's works often focus on themes such as poverty, inequality, and the human condition, his writings also reflect a nuanced understanding of gender dynamics and the evolving role of women in society. He also touches upon the theme of women empowerment. The present paper aims to explore the presence of feminism in Steinbeck's works and also to explore the portrayal of women characters, their challenges and underlying message of empowerment. The novelist in his vein of feminism highlights progressive views on gender equality and the challenges faced by women in a patriarchal society. It is obvious that Steinbeck is not a feminist writer by vocation and by school but feminism is evident in his writings by practice and he has a natural bent of mind to see well being of the female world. In short, Steinbeck is a feminist by practice and not by school.

Steinbeck's novels frequently feature strong and complex female characters who challenge traditional gender roles. His *The Grapes of Wrath* often depicts women characters in traditional gender roles. His works often focus on male protagonists, his women characters is crucial in understanding his perspective on gender dynamics and societal norms. They are primarily portrayed as wives and mothers, responsible for maintaining domestic harmony and supporting their families. These characters, while important to the narrative, often lack agency and are confined within societal expectations. In '*The Grapes of Wrath*,' Ma Joad emerges as a resilient matriarch who takes charge of her family's survival during the Great Depression. Through her character, Steinbeck emphasizes the strength and determination of women, highlighting their ability to navigate adversity and provide emotional support.

Despite being confined to traditional roles, Steinbeck's women characters exhibit resilience and strength in the face of adversity. In *Of Mice and Men*, the character of Curley's wife, though unnamed, showcases determination and a longing for a better life. Steinbeck portrays her as a complex individual with dreams and desires, challenging the notion that women are merely secondary to men.

Steinbeck often critiques the oppressive nature of patriarchy and its detrimental effects on women's lives. In "East of Eden," the character Cathy Ames embodies the destructive power of gender inequality. By portraying Cathy as a manipulative and morally bankrupt individual, Steinbeck exposes the consequences of a society that denies women agency and perpetuates harmful stereotypes.

Steinbeck's writings also demonstrate his empathy for women and their struggles. In "Of Mice and Men," Curley's wife is portrayed as a misunderstood character who yearns for companionship and dreams beyond her limited circumstances. Steinbeck's portrayal humanizes her, eliciting sympathy from readers and highlighting the isolation experienced by many women in a male-dominated society.

Steinbeck challenges traditional gender norms by depicting women who defy societal expectations. In "The Pearl," Juana, the protagonist's wife, questions her husband's obsession with wealth and material possessions. Her refusal to conform to gender roles and her insistence on prioritizing family and well-being over material gain reflect Steinbeck's progressive stance on gender equality.

It is essential to acknowledge that Steinbeck's writings were products of their time, and his portrayal of women may not align entirely with contemporary feminist ideals. However, by examining his works through a feminist lens, we can appreciate the ways in which Steinbeck challenged societal norms and contributed to the ongoing discourse on gender equality.

Steinbeck's early works, such as "The Grapes of Wrath," often depict women characters in traditional gender roles. They are primarily portrayed as wives and mothers, responsible for maintaining domestic harmony and supporting their families. These characters, while important to the narrative, often lack agency and are confined within societal expectations.

Steinbeck also explores the theme of female sexuality and objectification in his writings. In "East of Eden," the character Cathy Ames embodies the femme fatale archetype, using her sexuality to



manipulate and control men. Through Cathy's character, Steinbeck delves into the darker aspects of female sexuality and the consequences of objectifying women.

Motherhood is a recurring theme in Steinbeck's works, often portraying women characters as selfless nurturers. In "The Pearl," Juana, the protagonist's wife, represents the sacrificial nature of motherhood as she protects her family at great personal cost. Steinbeck's portrayal of motherhood highlights the strength and love of women, albeit within traditional gender roles.

While Steinbeck's women characters display resilience, their agency is often limited by societal norms and patriarchal structures. In "The Chrysanthemums," the protagonist Elisa Allen's desires and talents are stifled by her husband and society's expectations. Steinbeck's depiction of such subjugation reflects the constraints faced by women in a patriarchal society.

Steinbeck's writings subtly critique gender inequality by exposing the limitations imposed on women. Through his portrayal of women characters, he highlights the injustices they face and challenges the societal norms that restrict their freedom and potential. Steinbeck's critique contributes to the broader conversation on gender equality and the need for societal change.

Conclusion:

John Steinbeck's works provide valuable insights into the feminist movement, as he explores the complexities of women's lives and challenges traditional gender roles prevalent during his time. Through his strong female characters and critique of patriarchal systems, Steinbeck highlights the struggles faced by women and advocates for their empowerment. While acknowledging the limitations of his era, it is evident that Steinbeck's writings contribute to the broader conversation on feminism and continue to resonate with readers today.

While John Steinbeck's works primarily focus on social issues faced by the working class, they also touch upon the theme of women empowerment. Steinbeck challenges gender norms, highlights women's economic contributions, showcases their resilience, explores expanding roles, emphasizes solidarity and support among women, and calls for gender equality. Through his writings, Steinbeck contributes to the ongoing dialogue on women empowerment and the need for a more inclusive and equal society.

John Steinbeck's representation of women characters in his writings provides insights into his perspective on gender dynamics and societal norms. While some characters conform to traditional gender roles, others exhibit resilience, strength, and a longing for agency. Steinbeck's exploration of female sexuality, motherhood, and the limitations imposed on women contributes to the broader discourse on gender inequality. By shedding light on the struggles faced by women, Steinbeck's works encourage readers to question societal norms and advocate for gender equality.

References:

1. Steinbeck, John. "The Grapes of Wrath." Penguin Classics, 2006.
 - This classic novel by John Steinbeck provides valuable insights into the portrayal of women and their struggles during the Great Depression.
2. Ricketts, Edward F. "John Steinbeck: A Biography." Viking Adult, 1990.
 - This biography of John Steinbeck offers background information on the author's life, which can be useful for understanding the context in which he wrote his works.
3. Wexler, Laura. "Tender Violence: Domestic Visions in an Age of U.S. Imperialism." University of North Carolina Press, 2000.
 - This book explores feminist perspectives in literature, including Steinbeck's works, and can help in analyzing the feminist themes in his writing.

Academic Journals:

4. Lang, Mary K. "Revisiting the Joad Family: Motherhood and Representation in 'The Grapes of Wrath'." *Women's Studies*, vol. 39, no. 1, 2010, pp. 18-40.
5. Wagner-Martin, Linda. "John Steinbeck's Re-Vision of Women: Feminist Criticism and 'The Chrysanthemums'." *Modern Fiction Studies*, vol. 30, no. 3, 1984, pp. 487-495.
6. The John Steinbeck Center - <https://www.steinbeck.org/>
7. Feminist Literary Criticism - <https://www.poetryfoundation.org/learn/glossary-terms/feminist-literary-criticism>

**Dear Mrs Naidu: Feminine Sensibilities And Its Expressions
In Epistolary Form****Mrs.Vaishali Satish Dubey**

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ABSTRACT:The present paper is an attempt to depict how Epistolary form is best suited for expression of feminine sensibilities in the novel, 'Dear Mrs Naidu' by Mathangi Subramanian. Though, Epistolary form of novel writing happens to be the earliest and the oldest one, still it is again being incorporated for weaving tales of modern times because it does not require an omniscient narrator to explain what is going on in character's mind especially if the protagonist happens to be a female who is often not allowed to express her feelings and thoughts because of many constraints forced upon her by the society. 'Dear Mrs Naidu' is a story of a young, bright and determined Sarojini who lives in slums of Bangalore along with her mother who singlehandedly takes care of her by working as a maid in different households. Sarojini writes letters to Mrs Sarojini Naidu, her namesake and a freedom fighter and poet as a part of her assignment. The paper traverse the journey of Sarojini who through her letters opens up to Mrs Naidu and finds a confidant in her and freely expresses her feelings, observations and thoughts on different issues affecting her life. Somewhere drawing parallels from Mrs Naidu's life to her life she learns to fight and stand for her. The paper is an attempt to record how letters further the narrative in this Epistolary novel and most effectively portrays the upheaval of feelings that the young female protagonist is going through when standing for herself in a society which doesn't appreciate a female voicing her opinions.

Key words :Feminine sensibilities, Epistolary novel, confidant.

Introduction: Originating in 18 century, Novel soon became the dominant genre in world literature. It took a place of prominence as a popular form of literary expression reflecting the society. Its identity has evolved and developed encompassing and achieving different milestone over the years. 'Pamela' by Samuel Richardson is considered as the first real English novel and is written in a series of fictional letters. Novels where letters play a major role in advancing the story or plot are known as 'Epistolary'. Novel emerged as a hugely popular genre in 18th century which is often regarded as the great age of letter writing.

From the very starting Epistolary novels seemed perfect format for expressions of female emotions and sentiments. In earlier times when public spaces were especially dominated by men, letters were the only place where women could express their experiences or thoughts freely without any constraints. Even the earliest Epistolary novels written by males had female protagonists voicing their emotions and sentiments through letters. Expression of feminine sensibilities in subtle way or as a principle theme has often been incorporated in Epistolary novels by male as well as female writers. Female writers have utilised the form better than their male counterparts imitating female voice. The popular form of 18th century has once again become popular in 21st century with authors incorporating newer technology such as text messages, email, blog posts, tweets and so on.

Though society has progressed still it has not given the same freedom to women to express their thoughts as it has given to men. And, in light of these constraints and social taboos, letters still offer the space where women can express their personal sentiments and communicate their perspective in spite of their marginalized social position. One such Epistolary novel where the writer has used the traditional form of letter writing for narrating the story is Mathangi Subramanian's, "Dear Mrs Naidu". The novel plays out in letters written to Mrs Sarojini Naidu by Sarojini as a part of assignment. The letters traverse the journey of twelve year determined young girl Sarojini giving an insight into her feelings, thoughts and emotions as she tries to take a stand for herself and voice her thoughts. She opens to Mrs Naidu in the letters addressed to her revealing her observations, concerns, dreams and aspirations without any inhibitions, somewhere taking inspiration from her.

**Feminine Sensibilities and its Expressions in "Dear Mrs Naidu"**

As a part of an assignment given by her new teacher, Annie Miss, Sarojini starts writing letters to Mrs Sarojini Naidu, a poet, a long dead freedom fighter with whom she also shares her name and lately about whose life and work she has been reading about from a book. In the very first letter she reveals to Mrs Naidu that her Amma forbids her from speaking to strangers and by writing a letter to her she is violating her but elders agree to anything if it is said to be a part of school assignment. She also explains that she loves detective stories though her teacher doesn't appreciate reading one but she has learned so many words from such stories and comments, maybe her teacher must be wrong. She writes her thoughts in brackets. She also strikes words which expresses perfectly her state of mind. But well knowing that she will not be reprimanded or judged by a deceased person who will never reply, she opens her mind without any hesitation and writes, "It seems like you stood up to parents and teachers and all the adults who don't understand anything at all but act like they do"¹. Each letter is written with a specific purpose as a part of assignment like in first letter Sarojini introduces herself, in the second she writes about her Amma who is the most important person in her life, in the third she describes her neighbourhood which is actually a slum in Bangalore. Each letter gives a glimpse of the pathetic life of a young and bright, Sarojini. Each letter revealing the state of mind of an intelligent girl who is keenly observing people and world around and the society she lives in. She discloses that, "It's easy to write honestly when I'm writing to a friend like you."² Before writing the word 'friend' she strikes words like listener, reader. Even after declaring that the assignment being completed she will not write any letter, she starts writing again and she even states, "I want to talk about it but I can't, really - at least I can't with anyone I know. Except maybe you".³ So she keeps on writing to Mrs Naidu as in her, she has found a confidant, a friend who only listens, never judges nor advice or reprimands. Each letter reveals Sarojini's journey of knowing about the term like RTE which will give her an opportunity of getting good education thereby ensuring a good life in future for her and her Amma. She discloses her frustration, her anger and her struggle to first get admission at a posh private school and then her attempts of trying to improve her own government school. She reveals how people from slum, her friends Amir, Deepti and Vimala Madam, a human rights lawyer, Rohini reporter are supporting her in her fight and how people like the Councilor, Block Development Officer, her Headmaster, are not. Things change after they receive support from all quarters ensuring positive changes in her school. She reports each and every development, her feelings and state of mind, her thoughts in detail to Mrs Naidu in each letter. Each letter getting her more closer to her pen friend and making her think and take inspiration from Mrs Naidu's life, her fight for rights and equality of women and freedom. It is because of confiding in Mrs Naidu through letters, Sarojini gets clear insight about her own thoughts, she gets courage to voice her thoughts and take a stand for her rights.

Conclusion:

The Epistolary form and that too the traditional way of letter writing blended seamlessly in recent times, incorporated in the novel, "Dear Mrs Naidu" by Mathangi Subramanian is something which no where appears to be out of context. Epistolary form infused in the novel directly gives an insight into the psyche of the young girl, Sarojini without any omniscient narrator revealing her thoughts and what is going on in her mind. The letters give a first hand account of her sentiments when she observes an unequal society and musters courage to voice her thoughts and learns to fight for her rights. The letters reveal thoughts and emotions which females usually never disclose and say due to constraints forced upon them by society. Knowing well that she will never be judged or mocked for accepting her thoughts, Sarojini never hesitates in revealing her emotions, anger, happiness and disappointment in her letters when she is trying to stand and fight for her rights. Epistolary form surely gives an unhindered space for expression of personal sentiments and emotions without any filter in this novel where the main protagonist is female.

References :

- 1) Subramanian, Mathangi. Dear Mrs Naidu (New Delhi : Zubaan Publishers 2017), Page 04.
- 2) Ibid., p.17
- 3) Ibid., p.41
- 4) Campbell, Elizabeth. Re-Vision, Re-Flections, Re-Creation: Epistolary in Novels by Contemporary Women. Twentieth Century Literature, vol.41, no.3, 1995, pp.332-
- 5) Singer, Godfrey Frank. The Epistolary Novel : Its Origin, Development, Decline and Residuary Influence. New York: Russel And Russell, 1963

The Evolving Role of Libraries to Boost Research in Humanities

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Abstract:

Libraries have long been essential institutions supporting research in humanities disciplines. However, as the landscape of scholarship evolves, so too must the role of libraries. This paper explores the evolving role of libraries in boosting research in humanities, examining the challenges and opportunities presented by digital technologies, interdisciplinary approaches, and changing scholarly practices. Drawing on theoretical frameworks and case studies, this research highlights the innovative strategies adopted by libraries to facilitate access to resources, foster collaboration, and enhance scholarly communication in the humanities. By examining the evolving role of libraries, this paper aims to contribute to ongoing discussions about the future of research support services in humanities disciplines.

Keywords: Libraries, Humanities, Research, Digital Technologies, Interdisciplinary, Scholarly Communication

Introduction:

Libraries have historically served as vital hubs for scholarly research, providing access to a wealth of resources, expertise, and support services. In the humanities, where research often relies on extensive reading, critical analysis, and interdisciplinary engagement, libraries play a central role in facilitating scholarly inquiry and advancing knowledge. However, as the digital revolution transforms the research landscape and scholarly practices evolve, libraries face new challenges and opportunities in supporting research in humanities disciplines. Libraries play a pivotal role in assisting researchers in reaching their research goals by providing access to a wealth of resources, expertise, and support services. Through their extensive collections of books, journals, manuscripts, and digital archives, libraries offer researchers access to a diverse range of primary and secondary sources relevant to their research interests. Moreover, libraries employ knowledgeable librarians who can assist researchers in navigating complex databases, locating obscure materials, and refining their research strategies. Additionally, libraries may offer specialized research assistance services, including workshops, seminars, and one-on-one consultations, to help researchers develop their research skills and enhance their scholarly productivity. By serving as invaluable repositories of knowledge and expertise, libraries empower researchers to conduct rigorous and comprehensive research, ultimately enabling them to achieve their research goals and make meaningful contributions to their field of study.

This paper explores the evolving role of libraries in boosting research in humanities, examining how libraries are adapting to meet the changing needs of researchers and scholars.

The environment for libraries and research:

The environment for libraries and research in humanities is undergoing significant transformation in response to technological advancements, evolving scholarly practices, and shifting funding priorities. In today's digital age, libraries are adapting to meet the changing needs of researchers in humanities disciplines by providing access to a wide range of digital resources, online databases, and specialized collections. Moreover, libraries are fostering interdisciplinary collaboration and promoting open access to scholarly materials, facilitating the exchange of ideas and knowledge across disciplinary boundaries. However, libraries also face challenges such as budget constraints, rising subscription costs for electronic resources, and the need to ensure equitable access to information for all users. Despite these challenges,

libraries remain vital hubs for research in humanities, serving as catalysts for innovation, exploration, and discovery in an increasingly interconnected and dynamic scholarly landscape.

The Impact of Digital Technologies:

The advent of digital technologies has revolutionized the way research is conducted in humanities disciplines. Digital libraries, online databases, and digital humanities tools have expanded access to scholarly resources and facilitated new modes of research and collaboration. Libraries have responded by digitizing their collections, developing online research guides, and providing training in digital tools and methodologies. By leveraging digital technologies, libraries are enhancing the discoverability and accessibility of humanities research materials, empowering researchers to explore new avenues of inquiry and analysis. Libraries are continually adapting to meet the changing needs of researchers and scholars by embracing new technologies, expanding their collections, and providing innovative services. One way libraries are adapting is by digitizing their resources, making them accessible remotely to accommodate the increasingly digital nature of research. Through online databases, digital archives, and electronic journals, libraries ensure that scholars have access to a wealth of resources from anywhere in the world. Moreover, libraries are enhancing their support services by offering specialized research assistance, including workshops, consultations, and training sessions on research methodologies and digital tools. Additionally, libraries are fostering interdisciplinary collaboration by creating collaborative spaces, organizing interdisciplinary seminars, and facilitating partnerships between scholars from different disciplines. By adapting to the changing needs of researchers and scholars, libraries are ensuring that they remain invaluable partners in the pursuit of knowledge and scholarship.

Interdisciplinary and Collaboration:

Interdisciplinary approaches are increasingly prevalent in humanities research, as scholars draw on insights from multiple disciplines to address complex questions and challenges. Libraries are playing a key role in facilitating interdisciplinary collaboration by providing spaces for cross-disciplinary dialogue, organizing interdisciplinary workshops and seminars, and curating interdisciplinary research collections. By fostering collaboration across disciplines, libraries are enriching the research ecosystem and stimulating innovative scholarship in humanities disciplines.

Enhancing Scholarly Communication:

Scholarly communication is undergoing a transformation in the digital age, with new models of publishing, dissemination, and peer review emerging. Libraries are at the forefront of this transformation, advocating for open access publishing, supporting digital scholarship initiatives, and providing platforms for sharing and disseminating research outputs. Through institutional repositories, digital archives, and scholarly publishing services, libraries are empowering researchers to reach broader audiences and maximize the impact of their work. Moreover, libraries are promoting ethical and responsible research practices, advocating for transparency and integrity in scholarly communication.

Technological Enhancement:

In the age of technological enhancement, the evolving role of libraries is playing a pivotal role in boosting research in humanities. Libraries, once known primarily for their vast collections of physical books and journals, have transformed into dynamic hubs of digital resources and technological innovation. Through digitization efforts, libraries have made invaluable historical manuscripts, rare texts, and scholarly articles accessible to researchers around the globe, breaking down barriers of time and space. Moreover, libraries have embraced cutting-edge technologies such as artificial intelligence, text mining, and data visualization tools, empowering researchers in humanities to analyze vast amounts of data, uncover hidden patterns, and generate new insights. Additionally, libraries serve as incubators for digital humanities projects, providing scholars with the resources, expertise, and collaborative spaces

needed to explore innovative research methodologies and interdisciplinary approaches. By harnessing the power of technology, libraries are revolutionizing the research landscape in humanities, facilitating new avenues of inquiry, fostering interdisciplinary collaboration, and advancing knowledge in the digital age.

Evolving role of libraries:

Libraries are undergoing a significant evolution to boost research in humanities, adapting to the changing needs and technological advancements of the digital age. One key way libraries are evolving is through the expansion of their digital resources and services. Digitization efforts have made vast collections of historical manuscripts, rare books, and scholarly journals accessible online, breaking down geographical barriers and allowing researchers to access materials remotely. Furthermore, libraries are embracing innovative technologies such as artificial intelligence, text mining, and data visualization tools to facilitate research in humanities. These tools enable researchers to analyze large datasets, uncover patterns, and gain new insights into complex cultural phenomena. Additionally, libraries are fostering interdisciplinary collaboration by providing collaborative spaces, organizing interdisciplinary seminars, and facilitating partnerships between scholars from different fields. By evolving to meet the changing needs of researchers in humanities, libraries are playing a crucial role in advancing knowledge and scholarship in this dynamic field.

The Future of Research in Humanities:

The future of research in humanities is poised for exciting developments as scholars and institutions adapt to the evolving needs of the digital age. With technological advancements and interdisciplinary approaches becoming increasingly prevalent, the future of humanities research promises to be characterized by innovative methodologies, collaborative endeavours, and global engagement. Digital humanities initiatives will continue to play a significant role, as scholars leverage computational tools, data analysis techniques, and digital archives to explore complex questions and generate new insights. Interdisciplinary collaboration will also flourish, as scholars from diverse fields come together to address pressing societal challenges and explore the intersections of culture, history, and technology. Moreover, the future of humanities research will be shaped by a commitment to inclusivity, diversity, and social justice, as scholars strive to amplify marginalized voices, challenge dominant narratives, and foster meaningful dialogue across cultures and communities. By embracing these opportunities and confronting the challenges ahead, the future of research in humanities holds immense potential for transformative scholarship and positive societal impact.

Conclusion:

The evolving role of libraries in boosting research in humanities reflects the dynamic and multifaceted nature of contemporary scholarship. By embracing digital technologies, fostering interdisciplinary collaboration, and enhancing scholarly communication, libraries are adapting to meet the changing needs of researchers and scholars in humanities disciplines. As libraries continue to evolve, it is essential to recognize their pivotal role in supporting and advancing research in the humanities, and to continue exploring innovative strategies for enhancing research support services in the digital age. Through collaboration and innovation, libraries will remain indispensable partners in the pursuit of knowledge and understanding in the humanities.

Works cited:-

1. Bates, Marcia J. "The role of the library in undergraduate education." *Journal of Academic Librarianship*, vol. 31, no. 6, 2005, pp. 559-564.
2. Bishop, Kerry L. "Information literacy and the undergraduate curriculum." *Journal of Academic Librarianship*, vol. 26, no. 3, 2000, pp. 192-198.
3. Brundin, Pia. "Teaching English as a Second Language through Literature." *Research in the Teaching of English*, vol. 9, no. 1, 2016, pp. 97-104.
4. Hunter, Jean, and Sam Wagner. "Supporting English Language Learners through the Library." *Knowledge Quest*, vol. 42, no. 1, 2013, pp. 44-49.
5. Kuhlthau, Carol C. "Teaching the Library Research Process." *School Library Media Activities Monthly*, vol. 22, no. 9, 2006, pp. 46-49.
6. Lewin, Beverly A. "The Library's Role in Improving English Language Proficiency." *The Journal of Academic Librarianship*, vol. 40, no. 2, 2014, pp. 178-183.
7. O'Grady, William. "The Role of the Library in English Language Learning." *Language Learning Journal*, vol. 37, no. 1, 2009, pp. 23-31.
8. Saracho, Olivia N., and Bernard Spodek. *Contemporary Perspectives on Literacy in Early Childhood Education*. Information Age Publishing, 2010.
9. Taranto, Maria. "Literature Circles: A Tool for Enhancing Reading Comprehension in English as a Second Language." *TESL Canada Journal*, vol. 23, no. 1, 2005, pp. 1-17.
10. Wallace, Betsy, et al. "Building English language learners' academic vocabulary." *The Reading Teacher*, vol. 59, no. 2, 2005, pp. 144-148.

Spirit of Women Empowerment in the Writings of Sudha Murty

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Introduction:

Sudha Murty, a renowned Indian author and philanthropist, has made significant contributions to literature by highlighting social issues and advocating for gender equality. Through her works, Murty explores the challenges faced by women in a patriarchal society and emphasizes the importance of empowerment and equal opportunities. The present research paper aims to delve into the presence of feminism in Sudha Murty's writings, examining her portrayal of female characters, critique of gender norms, and advocacy for women's rights. Women in Indian society have been deprived of the privileges since days long. Due to this the modern educated sensible woman that like of Sudha Murty, naturally gets restless to see the present status of women in India at large, still demand a special attention towards their present condition. Hence, Sudha Murty extensively made use of her pen to portray the woman today and their condition as such.

Murty's novels often feature strong and resilient female protagonists who challenge societal expectations. For instance, in "Dollar Bahu," the character Vinuta defies traditional gender roles by pursuing her dreams and aspirations despite societal pressures. Through such characters, Murty highlights the agency and determination of women, inspiring readers to question and challenge gender stereotypes.

Murty's works also critique the oppressive nature of patriarchy and its impact on women's lives. In "Mahashweta," she explores the stigma associated with divorce and the struggles faced by women in abusive marriages. By portraying the protagonist's journey towards self-empowerment and independence, Murty sheds light on the need for dismantling patriarchal structures that limit women's choices and perpetuate inequality.

Education and empowerment are recurring themes in Murty's writings. In "Wise and Otherwise," a collection of short stories based on real-life experiences, she emphasizes the transformative power of education in enabling women to break free from societal constraints. Murty's narratives highlight the importance of providing equal educational opportunities to girls and women, advocating for their economic independence and social mobility.

Murty's works also address intersectional issues, recognizing that gender inequality intersects with other forms of discrimination. In "Three Thousand Stitches," she discusses the challenges faced by women from marginalized communities, such as caste and religious minorities. Murty's writings emphasize the need for inclusive feminism that addresses the unique struggles faced by women from diverse backgrounds.

It is important to acknowledge that Sudha Murty's writings are influenced by her cultural and societal context in India. While her works may not align entirely with Western feminist ideals, they contribute to the broader conversation on gender equality and women's rights within an Indian context. Murty's portrayal of women's experiences and her advocacy for their empowerment reflect the evolving feminist discourse in India.

Sudha Murty's writings serve as a powerful platform for feminist discourse, as she challenges gender norms, critiques patriarchy, and advocates for women's rights and empowerment. Through her portrayal of strong female characters and exploration of intersectional issues, Murty highlights the complexities of women's lives and inspires readers to question societal norms. While acknowledging the cultural context of her works, it is evident that Sudha Murty's writings contribute significantly to the feminist movement and continue to inspire individuals towards gender equality and social justice.

References:

1. Murty, Sudha. "Wise and Otherwise: A Salute to Life." Penguin Books, 2006.
2. Murty, Sudha. "Dollar Bahu." Penguin Books, 2005.
3. Sharma, Sunita. "Empowerment of Women in Sudha Murty's Literature." *Indian Literature*, vol. 45, no. 3, 2001, pp. 96-111.
4. Prasad, Shweta. "Women Empowerment in the Novels of Sudha Murty: A Critical Study." *Journal of Indian Writing in English*, vol. 38, no. 2, 2010, pp. 78-93.



5. Sudha Murty Foundation - <https://www.sudhamurtyfoundation.org/>
6. "Sudha Murty: A Voice for Women's Empowerment" - <https://www.thebetterindia.com/97034/sudha-murthy-quotes-women-empowerment/>
7. Murty, Sudha. "Three Thousand Stitches: Ordinary People, Extraordinary Lives." Penguin Books, 2016.
8. Murty, Sudha. "The Day I Stopped Drinking Milk: Life Stories from Here and There." Penguin Books, 2012.
9. Kumar, Ramesh. "Women Empowerment in the Writings of Sudha Murty." Indian Literature Today, vol. 15, no. 2, 2018, pp. 123-138.
10. Joshi, Anjali. "Narratives of Empowerment: A Study of Sudha Murty's Short Stories." Journal of Contemporary Literature, vol. 29, no. 1, 2015, pp. 45-62.

Literary Lighthouses: Navigating the Role of Libraries in Enriching English Literature Research

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Abstract:

This paper explores the pivotal role of libraries in facilitating and enriching research in the field of English literature. By serving as intellectual hubs and repositories of knowledge, libraries provide invaluable resources, assistance, and spaces conducive to scholarly inquiry. Through an examination of diverse library services, including access to books and journals, digital resources, archival collections, and librarian support, this paper elucidates the multifaceted contributions of libraries in advancing literary research. Furthermore, it highlights the evolving role of libraries in adapting to technological advancements and fostering collaborative environments that promote exploration and discovery in English literature research.

Key words:- English Literature, Repositories, Multifaceted, Digital,

1. Introduction:

Libraries have long served as literary lighthouses guiding scholars through the vast ocean of knowledge in English literature. As repositories of literary treasures and havens of scholarly inquiry, libraries play a crucial role in enriching research endeavours in this field. This paper navigates the multifaceted role of libraries in supporting and enhancing English literature research, shedding light on the diverse resources, services, and collaborative spaces they offer to scholars and researchers.

Throughout history, libraries have stood as enduring beacons of knowledge, illuminating the path for scholars navigating the expansive sea of English literature. Like lighthouses perched on rugged cliffs, they offer guidance and direction, leading seekers of knowledge through the intricate maze of literary works and critical discourse. More than mere repositories of books, libraries are sanctuaries of learning, where minds converge and ideas flourish in the pursuit of scholarly inquiry. This paper embarks on a journey to unravel the intricate tapestry of the role played by libraries in nurturing and enhancing research endeavours within the realm of English literature. By delving into the multifaceted dimensions of library services, resources, and collaborative spaces, it endeavours to shed light on the invaluable contributions libraries make to the scholarly community. From rare manuscripts to cutting-edge digital resources, libraries serve as custodians of literary treasures, fostering an environment conducive to exploration, discovery, and intellectual growth for scholars and researchers alike.

2. The Foundation of Knowledge:

Libraries form the bedrock of English literature research by providing access to a vast array of books, journals, and literary works. From classical masterpieces to contemporary critical analyses, libraries offer a rich tapestry of resources that serve as the foundation upon which scholarly inquiry thrives.

At the core of English literature research lies the indispensable role of libraries, which serve as the bedrock upon which scholarly pursuits are built. Within the hallowed halls of these institutions, a vast and diverse array of literary treasures awaits exploration, beckoning scholars to embark on a journey through the annals of human creativity and expression. From revered classics that have withstood the test of time to the latest critical analyses shaping contemporary discourse, libraries curate a rich tapestry of resources that encapsulate the breadth and depth of

literary scholarship. Here, within the pages of meticulously catalogued books, journals, and literary works, lies the foundation upon which scholarly inquiry thrives, providing researchers with a reservoir of knowledge from which to draw inspiration, insight, and understanding. Whether delving into the timeless prose of Shakespeare or exploring the nuanced poetry of modernist writers, scholars find themselves immersed in a realm where the past converges with the present, shaping the trajectory of literary discourse and scholarly discovery. In this way, libraries stand as guardians of intellectual heritage, preserving the literary legacy of generations past while simultaneously nourishing the minds of scholars who seek to illuminate the path forward in the ever-evolving landscape of English literature research.

3. Digital Horizons:

In the digital age, libraries have expanded their horizons to encompass a wealth of digital resources that enhance research accessibility and efficiency. E-books, online databases, and electronic journals enable researchers to explore literary landscapes from anywhere in the world, transcending the limitations of physical space and time.

In the digital age, libraries have undergone a transformative evolution, extending their reach far beyond the confines of brick-and-mortar institutions to embrace the boundless realm of cyberspace. In this virtual domain, libraries have curated a treasure trove of digital resources that revolutionize the landscape of literary research, enhancing accessibility and efficiency in unprecedented ways. Among these digital marvels are e-books, which offer readers instant access to an extensive array of literary works at the click of a button. Whether perusing the pages of a classic novel or delving into the latest scholarly monograph, researchers can now immerse themselves in the world of literature from the comfort of their own devices, transcending the limitations of physical libraries and opening doors to new realms of knowledge and exploration.

Moreover, online databases serve as invaluable repositories of scholarly articles, critical analyses, and historical documents, providing researchers with a vast reservoir of information at their fingertips. From specialized databases dedicated to literary criticism to comprehensive archives spanning centuries of literary history, these digital collections empower scholars to conduct thorough and nuanced research with unparalleled ease and efficiency. For example, platforms like JSTOR and Project MUSE offer access to a wealth of peer-reviewed journals and academic publications, enabling researchers to stay abreast of the latest developments in literary scholarship and engage with diverse perspectives from around the globe.

In addition to e-books and online databases, electronic journals represent another cornerstone of digital resources available through libraries. With a multitude of scholarly journals now accessible in electronic format, researchers can explore cutting-edge research and critical discourse in English literature with unprecedented speed and convenience. Whether seeking to uncover groundbreaking insights or surveying the breadth of contemporary literary theory, scholars can navigate the vast landscape of academic publishing with ease, harnessing the power of digital technology to propel their research endeavours to new heights.

In this digital age, libraries serve as gateways to a world of literary exploration without boundaries, where researchers can traverse literary landscapes from anywhere in the world, transcending the constraints of physical space and time. By harnessing the power of digital technology, libraries empower scholars to navigate the ever-expanding horizons of English literature research with agility, precision, and boundless curiosity.

4. Guardians of Literary Heritage:

Beyond contemporary literature, libraries safeguard the literary heritage of the past through archival collections and special repositories. Rare manuscripts, letters, and documents housed within libraries provide researchers with invaluable insights into the lives and works of literary figures, enriching the tapestry of English literature scholarship.

In addition to preserving literary artifacts, libraries play a crucial role in promoting scholarship and public engagement with literary heritage through exhibitions, educational programs, and digital initiatives. By making these resources accessible to scholars, students, and the general public, libraries ensure that the legacy of past literary achievements continues to inspire and enrich contemporary discourse in English literature. In this way, libraries serve as custodians of cultural memory, preserving the treasures of the past while nurturing the intellectual curiosity and creativity of future generations.

5. Navigating the Seas of Information:

Librarians serve as expert navigators; guiding researchers through the seas of information and helping them navigate library catalogs, databases, and research tools. Their expertise and assistance are instrumental in facilitating efficient and effective literature searches, ensuring that researchers can navigate the vast expanse of literary resources with confidence.

In the vast ocean of information, librarians stand as experienced navigators, equipped with the knowledge and expertise to guide researchers through the complex currents of literary resources. With an intimate understanding of library catalogs, databases, and research tools, librarians serve as indispensable guides, steering scholars towards the treasures that lie hidden beneath the surface of the digital and physical collections.

6. Collaborative Beacons:

Libraries serve as collaborative beacons, fostering environments that encourage intellectual exchange and collaboration among scholars. Through workshops, seminars, and collaborative projects, libraries provide platforms for scholars to engage with one another, share ideas, and advance the boundaries of knowledge in English literature.

At the heart of this collaborative ethos are a myriad of initiatives and programs orchestrated by libraries, designed to foster a culture of intellectual exchange and interdisciplinary dialogue. Workshops, seminars, and colloquia serve as dynamic forums where scholars can come together to share their research findings, exchange insights, and engage in lively debates that transcend the boundaries of individual disciplines. Whether delving into the intricacies of literary theory, analyzing the socio-political implications of canonical texts, or exploring innovative approaches to digital humanities, these collaborative platforms provide fertile ground for the cross-pollination of ideas and the cultivation of new perspectives.

7. Adapting to Technological Tides:

In an era of rapid technological advancement, libraries must adapt to evolving trends and embrace innovative approaches to support English literature research. From digitization initiatives to the integration of cutting-edge research tools, libraries continue to evolve as dynamic hubs of scholarly inquiry in the digital age.

One of the most significant initiatives undertaken by libraries in response to the digital age is the widespread adoption of digitization initiatives. Recognizing the importance of preserving and making accessible rare and fragile materials, libraries have embarked on ambitious digitization projects to digitize their vast collections of manuscripts, rare books, and archival materials. By digitizing these resources, libraries not only ensure their long-term preservation but also broaden access to scholars and researchers around the globe, transcending the limitations of physical distance and enhancing the discoverability of invaluable literary treasures.

In addition to digitization, libraries are harnessing the power of cutting-edge research tools and technologies to enhance the research experience for scholars in English literature. From text mining and data visualization tools to artificial intelligence and machine learning algorithms, libraries are leveraging a diverse array of technological innovations to facilitate deeper insights and more nuanced analyses of literary texts and critical discourse. These tools empower researchers to uncover hidden patterns, explore thematic connections, and gain new

perspectives on familiar works, opening up new avenues for inquiry and discovery in the field of English literature.

8. Conclusion:

As literary lighthouses guiding scholars through the ever-expanding seas of knowledge, libraries play an indispensable role in enriching research endeavours in English literature. By providing access to diverse resources, expert assistance, and collaborative spaces, libraries empower researchers to navigate the complexities of literary scholarship with confidence and curiosity. As we chart a course towards new horizons in the field of English literature research, libraries will continue to serve as beacons of inspiration and discovery, illuminating the path for generations of scholars to come.

In conclusion, libraries stand as venerable lighthouses guiding scholars through the vast and ever-expanding seas of knowledge in the realm of English literature. Throughout history, these institutions have played an indispensable role in enriching research endeavours, serving as bastions of learning and guardians of intellectual heritage. By providing access to a diverse array of resources, offering expert assistance, and fostering collaborative spaces, libraries empower researchers to navigate the intricate complexities of literary scholarship with confidence and curiosity.

As stewards of knowledge and champions of intellectual curiosity, libraries will continue to illuminate the path for generations of scholars to come, ensuring that the legacy of English literature endures and thrives in the ever-changing landscape of academia. Through their unwavering dedication to the pursuit of learning and discovery, libraries embody the spirit of enlightenment, enriching the lives of scholars and researchers and inspiring a lifelong love of literature and learning. In the centuries to come, libraries will remain beacons of inspiration and discovery, guiding scholars towards new horizons and illuminating the path towards a deeper understanding of the richness and diversity of human expression in English literature.

Bibliography:-

1. Borgman, Christine L. "Scholarship in the Digital Age: Information, Infrastructure, and the Internet." MIT Press, 2007.
2. Cullen, Ryan. "Digital Humanities: An Introduction." Routledge, 2014.
3. Murray, Stuart A. P. "The Library: An Illustrated History." Skyhorse Publishing, 2012.
4. Owens, Trevor. "Library 2.0 and Beyond: Innovative Technologies and Tomorrow's User." Information Today, Inc., 2007.
5. Rayward, W. Boyd. "The History and Heritage of Scientific and Technological Information Systems: Proceedings of the 2002 Conference." Information Today, Inc., 2002.
6. Rupp-Serrano, Karen. "Library Services for Multicultural Patrons: Strategies to Encourage Library Use." Libraries Unlimited, 2015.
7. Shera, Jesse H., and Margaret E. Egan. "Foundations of the Public Library: The Origins of the Public Library Movement in New England, 1629-1855." Univ of Chicago Press, 1973.
8. Smith, Abby. "Archives and Archivists in 20th Century England." Routledge, 2009.
9. Van Orsdel, Lee C., and Kathleen Born. "The Role of the Electronic Serials Cataloger." Haworth Press, 2002.
10. White, Herbert S. "Introduction to Library Science: Basic Aspects of Library Service." Libraries Unlimited, 2000.

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Partial Molar Volumes of Glycine in Aqueous Electrolyte and Non-Electrolyte Solutions

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ABSTRACT

Partial molar volumes (v) of glycine ($c=0.02-0.22 \text{ mol}\cdot\text{dm}^{-3}$) in aqueous electrolyte solutions (NaCl and KCl, $c=0.15, 0.45$ and $0.60 \text{ mol}\cdot\text{dm}^{-3}$) and non-electrolyte solutions (sucrose, $c=0.15, 0.45$ and $0.60 \text{ mol}\cdot\text{dm}^{-3}$) were determined at 298.15 K. Partial molar volume of transfer ($\Delta_{\text{tr}} v$) of glycine from aqueous to aqueous electrolyte and non-electrolyte solutions has been calculated and interpreted in terms of different interactions. Dominating hydrophilic-hydrophilic or ion-hydrophilic interactions are observed in present systems and these interactions strengthen with increase in concentration of salts and sucrose. Hydration behavior of glycine perturbs in presence of salts and sucrose through solvation and hydrogen bonding effects of co-solutes and resulted in the overall enhancement of water structure.

Keywords: Density; apparent molar volume; ion-hydrophilic interactions; hydrophilic-hydrophilic interactions.

1. INTRODUCTION

Most biochemical processes take place in aqueous solutions and all the biological systems are aqueous solutions of salts, proteins, carbohydrates, and lipids [1]. Number of workers has studied aqueous glycine system and hydration structure of glycine in different environments [2-6]. Densities, partial molar volumes and heat capacities of glycine in aqueous magnesium chloride solutions at different temperatures have been studied by Lark et al. [7], transfer volumes of glycine, from water to 1,2- butanediol-water mixtures at 298.15 K were studied by Xu et al. [8] and influence of hydrotropic agents on the solute-solvent interactions in aqueous solutions of glycine were studied by Pattnaik et al. [9]. Viscosity

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behavior of α -amino acids in acetate salt solutions was studied by Siddique et al. [10]. Enthalpies of glycine in ureas solutions were studied by Taniewska-Osinska [11].

Interactions of glycine in aqueous electrolytes and sucrose solution plays a vital role in understanding the nature of action of bioactive molecules or thermodynamic behavior of biochemical processes in the body system [12]. Important information regarding ion-ion and ion-solvent interactions in solutions can be obtained from partial molar volumes [13-15]. Structure making and breaking properties of solutes can be understood from the physicochemical investigations of solutions [16].

The ion-ion, zwitterion-ion, zwitterion-water dipole, and ion-water dipole interactions in these systems are interesting to study. In continuation with our earlier studies [17-23], here, in view of physicochemical applications and research interests, the effect of electrolytes/ionic salts (NaCl and KCl) and non-electrolyte/sugar (sucrose) on volumetric behaviour of aqueous glycine solutions has been studied.

2. MATERIALS AND METHODS

Glycine (*sd fine*, AR Grade, purity>99%) was used. NaCl, KCl (Qualigens, >99.5) and sucrose (*sd fine*) solids were used as received. The HPLC grade deionized distilled water obtained from Millipore prefiltration kit (Direct-Q™ system series) was used for preparation of solutions. Solutions of glycine having different concentrations were prepared in calibrated volumetric flasks by dissolving accurately weighed glycine. Measurement of density was carried out using three different single capillary pycnometers and average values were considered for calculation of density of solution. Weighing was done on electronic balance (0.0001 g).

3. RESULTS AND DISCUSSION

3.1 Binary Aqueous Salts and Aqueous Sucrose Solutions

Density (ρ) data of aqueous NaCl/KCl/sucrose (0.15, 0.45 and 0.60 mol·dm⁻³) solutions at 298.15 K are presented in Fig. 1. Density increases with concentration of salts and sucrose and follows the order: ρ (aqueous sucrose solutions) > ρ (aqueous KCl solutions) > ρ (aqueous NaCl solutions). This indicates structural changes and molecular interactions in solution.

Density data was used to calculate apparent molar volume (φ_v) of salts and sucrose in aqueous solution. Calculated values of φ_v are presented in Fig. 2. It is seen that the φ_v increases with concentration KCl and sucrose and decreases with concentration of NaCl for aqueous NaCl solutions. The φ_v have been fitted to Massons relation and apparent molar volume at infinite dilution (partial molar volume, φ_v^0) was determined (Fig. 2). The φ_v^0 and experimental slope S_v for binary systems of aqueous salts and sucrose are reported in Table 1.

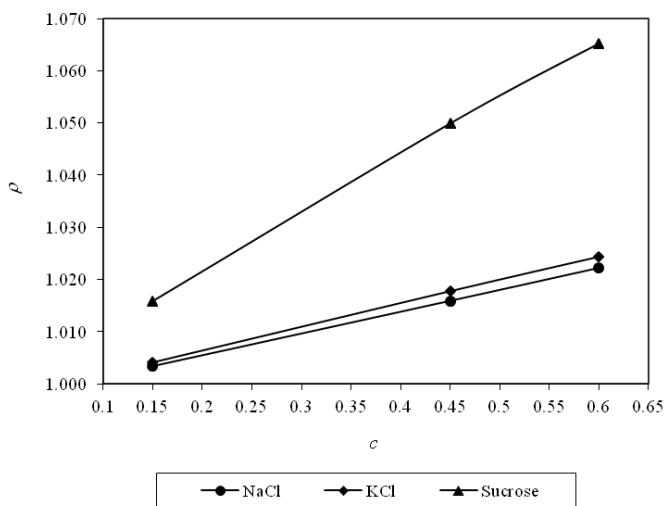


Fig. 1. Density of with concentration of NaCl/KCl/sucrose in binary solutions at 298.15 K

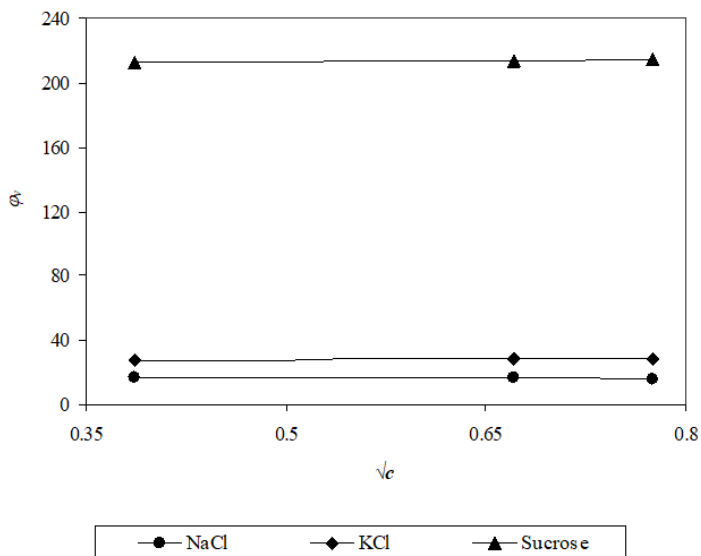


Fig. 2. Graphical determination of ϕ_v^0 and S_v for aqueous + NaCl/KCl/ Sucrose solutions at 298.15 K

Table 1. Partial molar volumes (V_m^*), molar volume in crystalline state (V_m) and experimental slope (S_v) for binary solutions at 298.15 K

System	Volumetric properties		
	V_m	V_m^* ($\text{cm}^3 \cdot \text{mol}^{-1}$)	S_v ($\text{cm}^2 \cdot \text{dm}^{1/2} \cdot \text{mol}^{-3/2}$)
Aqueous NaCl	27.0	17.20	-1.55
Aqueous KCl	37.6	27.31	1.17
Aqueous sucrose	215.7	211.56	3.36

Table 2. ρ and v of glycine in aqueous NaCl/KCl/Sucrose solutions at 298.15 K

c (Gly)	ρ		v		ρ		v	
	0.151 mol·dm ⁻³ NaCl		0.151 mol·dm ⁻³ KCl		0.156 mol·dm ⁻³ sucrose			
0.02	1.0038	47.96	1.0046	47.70	1.0165	44.35		
0.06	1.0050	46.29	1.0057	46.20	1.0177	44.22		
0.10	1.0062	45.92	1.0069	45.86	1.0190	43.98		
0.14	1.0076	44.44	1.0083	44.39	1.0202	43.72		
0.18	1.0088	44.09	1.0096	44.06	1.0215	43.65		
0.22	1.0101	43.85	1.0110	43.00	1.0227	43.46		
	0.455 mol·dm ⁻³ NaCl		0.457 mol·dm ⁻³ KCl		0.502 mol·dm ⁻³ sucrose			
0.02	1.0162	49.94	1.0182	51.65	1.0505	46.65		
0.06	1.0173	48.29	1.0192	50.29	1.0516	46.57		
0.10	1.0185	46.59	1.0203	48.22	1.0527	46.44		
0.14	1.0197	45.84	1.0216	46.68	1.0538	46.35		
0.18	1.0211	44.66	1.0231	44.83	1.0550	46.14		
0.22	1.0223	44.29	1.0243	44.42	1.0561	45.81		
	0.608 mol·dm ⁻³ NaCl		0.612 mol·dm ⁻³ KCl		0.698 mol·dm ⁻³ sucrose			
0.02	1.0223	50.77	1.0247	56.02	1.0658	47.39		
0.06	1.0233	48.77	1.0256	53.08	1.0669	47.14		
0.10	1.0245	47.28	1.0268	49.86	1.0679	46.90		
0.14	1.0257	46.62	1.0280	47.83	1.0690	46.76		
0.18	1.0270	45.74	1.0294	46.19	1.0701	46.58		
0.22	1.0281	45.56	1.0308	45.13	1.0712	46.41		

*Foot note: $c = \text{mol} \cdot \text{dm}^{-3}$; $\rho = \text{g} \cdot \text{cm}^{-3}$; $v = \text{cm}^3 \cdot \text{mol}^{-1}$

The V_m^* values of aqueous NaCl [24,25], KCl [24,26] and sucrose [27] are in good agreement with the literature values. The values of V_m^* for both salts and sucrose are positive which indicates presence of positive and strong ion-solvent (in case of salt solutions) and solute-solvent in (case of sucrose solutions) interactions. For aqueous NaCl and KCl solutions considerable shrinkage in volume is observed which is seen from the significantly lower values of V_m^* of these salts compared with their molar volumes in a crystalline state. The volume shrinkage in aqueous sucrose solution is very small as compared to volume shrinkage in

salts solutions. Hydrogen bonding is the main type of intermolecular interactions between sugar and water molecules in aqueous solutions [28].

Table 3. The φ_v and S_v of glycine in aqueous NaCl/KCl/sucrose solutions at 298.15 K

c (mol·kg ⁻¹)	φ_v^0 (cm ³ ·mol ⁻¹)	$\Delta_{tr} \varphi_v$ (cm ³ ·mol ⁻¹)	S_v (cm ² ·dm ^{1/2} ·mol ^{-3/2})
NaCl [34]			
0.60	52.83	9.67	-16.36
0.45	52.49	9.33	-17.93
0.15	49.68	6.52	-12.95
KCl			
0.60	61.05	17.89	-34.60
0.45	55.51	12.35	-23.85
0.15	49.76	6.60	-13.87
Sucrose [35]			
0.60	47.84	4.68	-2.98
0.45	47.10	3.94	-2.35
0.15	44.82	1.66	-2.82

The φ_v^0 for glycine in water = 43.16 cm³·mol⁻¹

3.2 Ternary Glycine + Aqueous Salts/Sucrose Solutions

Density data of ternary systems are reported in Table 1. The density of solutions increases with concentration of glycine in each system of aqueous NaCl, KCl and sucrose. Further densities of glycine in aqueous salts and sucrose solutions increase with concentration of salts and sucrose which may be attributed to enhanced structure of solvent due to added glycine in NaCl, KCl and sucrose solutions. Variation in density indicates changes in the structural arrangements and existence of molecular interactions between the components of the system.

The φ_v of glycine in aqueous NaCl, KCl and sucrose solutions were calculated from density of solvent, density of solution, molality of glycine and molar mass of glycine (M_2).

The calculated φ_v values are reported in Table 1. The values of glycine in aqueous solutions of salts and sucrose are higher than the values in water. It is seen that φ_v values of glycine decreases with increase in concentration of glycine and increases with increase in concentrations of NaCl, KCl and sucrose for given glycine concentration. An increase in φ_v with electrolyte and sucrose concentration is a result of increased interaction between polar ends of glycine and ions of the electrolytes or polar groups of sucrose which shields the polar terminal groups of glycine [29] and increased solute-solvent interactions.

The φ_v data of glycine was fitted to Massons linear relation, $\varphi_v = \varphi_v^0 + S_v \times \sqrt{c}$, [30,17] and from plots of φ_v vs. \sqrt{c} , apparent molar volume at infinite dilution (partial molar volume, φ_v^0) of glycine was determined as intercept and S_v , as slope.

The ϕ_v^0 and S_v are reported in Table 2. The ϕ_v^0 reflects solute-solvent interaction and magnitude of S_v reflects solute-solute interaction [31]. The ϕ_v^0 increases with increase in concentration of salts and sucrose which may be attributed to increase in the solvation of glycine at higher concentration of salts and sucrose [31]. Observed positive values of ϕ_v^0 indicate existence of solute-solvent interactions in all the solutions and presence of strong ion-solvent interactions due to solvation of ions.

Further, the values of ϕ_v^0 increased with increase in the concentration of salt and sucrose due to disruption of side group hydration by charged end [32]. The S_v values represent volumetric and energetic effects for the solute molecule and sign of S_v values can be related with the nature of interaction between the solvated solute molecules [33]. The negative S_v values are due to weak solute-solute interactions.

In order to understand interactions between solute and co-solute, partial molar volume of transfer (standard transfer volume of glycine, $\Delta_{tr} \phi_v$) from pure water to aqueous salts/sucrose solutions are studied. The $\Delta_{tr} \phi_v$ value obtained for glycine in water is $43.14 \text{ cm}^3 \cdot \text{mol}^{-1}$.

The $\Delta_{tr} \phi_v$ values were calculated and reported in Table 3. Variation in the $\Delta_{tr} \phi_v$ with salt concentration is presented in Fig. 3. The $\Delta_{tr} \phi_v$ values are positive for all the systems which is attributed to decrease in volume of shrinkage because of direct electrostatic interactions between salts/sucrose and charged centers of glycine which leads to the electrostriction of water.

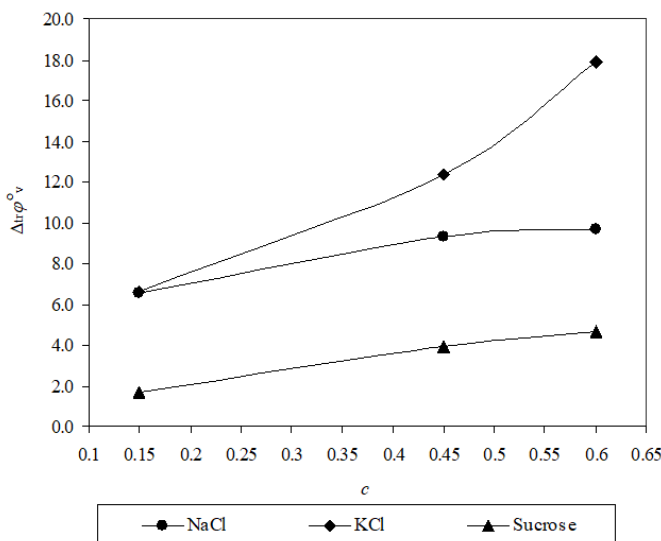


Fig. 3. Variation in $\Delta_{tr} \phi_v$ with concentration of salts and sucrose at 298.15 K

Positive $\Delta_{tr} v$ indicate dominating ion-hydrophilic and hydrophilic-hydrophilic interactions. Glycine gets less hydrated in presence of salts and sucrose as ions in salts (solvation) and sucrose molecules (hydrogen bonding) takes water molecule to hydrate and glycine will leave with less water molecules (overall enhancement of water structure). Therefore, hydration number of glycine decreases on addition of salts and sucrose and further decreases with concentration of salts and sucrose due to existence of solute-co-solute interactions. Dominating hydrophilic-hydrophilic or ion-hydrophilic interactions are observed and these interactions strengthen with increase in concentration of salts and sucrose. The terminal zwitter ionic groups of glycine ($-\text{NH}_3^+$ and $-\text{COO}^-$) are hydrated in electrostatic manner and electrostriction of $-\text{NH}_3^+$ group is greater than $-\text{COO}^-$ [29]. The increase of v and $\Delta_{tr} v$ suggests that electrostriction effect is decreased in salts + water and sucrose + water than in pure water which brings about increase in the volume of solvent [31]. Around each solute molecule there is a region of water where properties of these water molecules differ from those of bulk water.

4. CONCLUSION

It is concluded from the $\Delta_{tr} v$ values that, the ion-hydrophilic and hydrophilic-hydrophilic group interactions are predominant over hydrophilic-hydrophobic group interactions. Magnitude of $\Delta_{tr} v$ indicates the more interactions between glycine and sucrose compared to glycine and salts, whereas, the order of electrostriction of water are more in salts than in sucrose solution. The hydrophilic-ionic group interactions are weak in glycine + sucrose solution and are strongest in glycine + KCl solution. Further, increase in the v is due to dehydration of zwitterionic center of amino acids which is because of hydrophilic-ionic group interaction between the ion (from dissociation of salts) and water molecules. The increase of v and $\Delta_{tr} v$ suggests that electrostriction effect is decreased in salts + water and sucrose + water than in pure water which brings about increase in the volume of solvent.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Collins KD, Neilson GW, Enderby JE. Ions in water: characterizing the forces that control chemical processes and biological structure. *Biophys Chem.* 2007;128(2-3):95-104.
2. Sasaki M, Kameda Y, Yaegashi M, Usuki T. Hydration structure around the methylene group of glycine molecule. *Bull Chem Soc Jpn.* 2003;76(12):2293-9.
3. Kameda Y, Ebata H, Usuki T, Uemura O, Misawa M. Hydration structure of glycine molecules in concentrated aqueous solutions. *Bull Chem Soc Jpn.* 1994;67(12):3159-64.

4. Alonso JL, Cocinero EJ, Lesarri A, Sanz ME, López JC. The glycine-water complex. *Angew Chem Int Ed Engl.* 2006;45(21):3471-4.
5. Jensen JH, Gordon MS. On the number of water molecules necessary to stabilize the glycine zwitterion. *J Am Chem Soc.* 1995;117(31):8159-70.
6. Basch H, Stevens WJ. The structure of glycine water H-bonded complexes. *Chem Phys Lett.* 1990;169(4):275-80.
7. Lark BS, Patyar P, Banipal TS, Kishore N. Densities, partial molar volumes, and heat capacities of glycine, L-alanine, and L-leucine in aqueous magnesium chloride solutions at different temperatures. *J Chem Eng Data.* 2004;49(3):553-65.
8. Xu L, Ding CR, Lin RS. Transfer volumes of glycine, L-alanine, and L-serine from water to 1,2- butanediol-water mixtures at 298.15 K. *J Solut Chem.* 2006;35(2):191-200.
9. Pattnaik S, Dash UN. Influence of hydrotropic agents on the solute-solvent interactions in aqueous solutions of glycine at different temperatures. *J Chem Pharm Res.* 2012;4(9):4364.
10. Siddique JA, Naqvi S. Viscosity behavior of α -amino acids in acetate salt solutions at temperatures (303.15 to 323.15) K. *Int J Thermophys.* 2012;33(1):47-57.
11. Taniewska-Osinska S. Enthalpies of solution of glycine in solutions of aqueous ureas at 298.15 K. *Thermochim Acta.* 1990;27(173):295-9.
12. Mirikar SA, Pawar PP, Bichile GK. Studies in thermodynamic properties of glycine in aqueous solutions of mono and divalent electrolytes at different temperatures. *Arch Appl Sci Res.* 2011;3(5):233.
13. Parmar ML, Banyal DS. Effect of temperature on partial molar volumes of some bivalent transition metal nitrates and magnesium nitrate in DMF + water mixtures. *Ind J Chem A.* 2005;44:1582.
14. Krakowiak J, Koziel H, Grzybkowski W. Apparent molar volumes of divalent transition metal perchlorates and chlorides in n,n-dimethylacetamide. *J Mol Liq.* 2005;118(1-3):57-65.
15. Nikam PS, Shewale RP, Sawant AB, Hasan M. Limiting ionic partial molar volumes and viscosities of Cs⁺, Na⁺, (C₂H₅)₄N⁺, Cl⁻, Br⁻, I⁻. *J Chem Eng Data.* 2005;50(2):487-91.
16. Kannappan AN, Palani R. Ultrasonic investigations in amino acids with aqueous dimethyl formamide. *Ind J Chem A.* 2007;46:54.
17. Deosarkar SD, Mendkudle MS. Physicochemical properties and ion-solvent interactions in aqueous sodium, ammonium, and lead acetate solution. *Russ J Phys Chem A.* 2014;88(9):1527-32.
18. Deosarkar SD, Wanale SG, Shelke MP. Apparent molar and partial molar volumes of aqueous ceric ammonium nitrate solutions at 20, 25, 30, and 35°C. *Russ J Phys Chem A.* 2014;88(7):1124-8.
19. Deosarkar SD, Puyad AL, Shaikh UB, Solanke SS. Volumetric, rheological and optical properties of hydroxylamine hydrochloride in aqueous NaCl, KCl and NH₄Cl solutions at 30°C. *Russ J Phys Chem A.* 2014;88(4):596-600.
20. Deosarkar SD, Shaikh UB. Physico-chemical properties and components interaction in the solutions of *para*-substituted benzoic acids in aqueous ethanol. *Russ J Gen Chem.* 2013;83(12):2392-4.

21. Deosarkar SD, Narwade ML, Pandhare VV. Characterization of molecular interactions in ethanol-water mixtures in presence of potassium salts. *Chem Sci Trans.* 2013;2(S1):S37-42.
22. Deosarkar SD, Pandhare VV, Kattekar PS. Densities and refractive indices of potassium salt solutions in binary {ethanol + water} mixture of different compositions. *J Eng.* 2013;2013:1-4.
23. Deosarkar SD, Kalyankar TM. Structural properties of aqueous metoprolol succinate solutions. Density, viscosity, and refractive index at 311 K. *Russ J Phys Chem A.* 2013;87(6):1060-2.
24. Garcia-Pañeda E, Guardado P, Maestre A. Limiting partial molar volumes of electrolytes in 2-methyl-2-butanol +water mixtures at 298.15 K. *J Solut Chem.* 2004;33(10):1277-93.
25. Millero FJ. The apparent and partial molal volume of aqueous sodium chloride solutions at various temperatures. *J Phys Chem.* 1970;74(2):356-62.
26. Kabiraz DC, Biswas TK, Islam MN, Huque ME. Studies on molecular interactions of some electrolytes in water by volumetric and viscometric measurements at $T = (303.15 \text{ to } 323.15 \text{ K})$. *J Sci Res.* 2011;3(2):437-44.
27. Mathpal R, Joshi BK, Joshi S, Kandpal ND. Intermolecular forces of sugars in water. *Monatsh Chem.* 2006;137(3):375-9.
28. Mathlouthi M, Genotelle J. Role of water in sucrose crystallization. *Carbohydr Polym.* 1998;335.
29. Akhtar Y, Ibrahim SF. Ultrasonic and thermodynamic studies of glycine in aqueous electrolytes solutions at 303 K. *Arab J Chem.* 2011;4(4):487-90.
30. Delgado DR, Jiménez-Kairuz ÁF, Manzo RH, Vargas EF, Martínez F. Apparent molar volumes of the anesthetic drugs procaine-HCl and lidocaine-HCl in water at temperatures from 278.15 to 313.15 K. *Rev Colomb Cienc Quím Farm.* 2010;39(1):57.
31. Pal A, Kumar S. Volumetric and viscometric studies of glycine in binary aqueous solutions of sucrose at different temperatures. *Ind J Chem.* 2005;44A:469.
32. Nikumbh AB, Kulkarni GK. Volumetric and Thermodynamic parameters of L-leucine in ethanol+ water mixtures at different temperatures, *Comm. Appl Sci.* 2013;1(1):106.
33. Iqbal MJ, Malik QM. Partial molar volume of paracetamol in water, 0.1 M HCl and 0.154 M NaCl at $T = (298.15, 303.15, 308.15 \text{ and } 310.65) \text{ K}$ and at 101.325 kPa. *J Chem Thermodyn.* 2005;37(12):1347-50.
34. Li S, Sang W, Lin R. Partial molar volumes of glycine, l-alanine, and l-serine in aqueous glucose solutions at $T = 298.15 \text{ K}$. *The Journal of Chemical Thermodynamics.* 2002;34(11):1761-8.
35. Pitkänen I, Suuronen J, Nurmi J. Partial molar volume, ionization, viscosity and structure of glycine betaine in aqueous solutions. *Journal of Solution Chemistry.* 2010;39:1609-26.

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Structural Elucidation of Synthesized Substituted 1,3,4-Thiadiazole Molecules through Pharmacophore Modelling

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Abstract:

Heterocyclic compounds have found to be potent against microorganisms. Many heterocyclic molecules containing one or more heteroatom have been reported till date. Thiadiazoles are one of the biologically active heterocyclic compounds. Out of four isomers of thiadiazoles, 1,3,4-thiadiazole have reported to have better results. The synthesis of several 1,3,4-thiadiazole derivatives with increased antibacterial action is an ongoing endeavour. In this research article, prominent structural features of previously synthesised substituted 1,3,4-thiadiazole molecules are identified by studying their pharmacophore models comparatively. The comparative study of these 1,3,4-thiadiazoles resulted in variations in the hydrogen acceptor, hydrogen donor and lipophilic regions.

Keywords: 1,3,4-Thiadiazole, Pharmacophore Modeling, Antifungal, Antibacterial, Lipophilic, H-Bond Acceptor, H-Bond Donor

Introduction:

Heterocyclic compounds, characterized by the presence of at least one ring containing atoms other than carbon, such as nitrogen, sulphur, or oxygen, have emerged as a diverse and significant class of molecules with various biological activities. Among their many applications, heterocyclic compounds have gained considerable attention for their antimicrobial properties.[1-5] This note provides a comprehensive overview of the antimicrobial activities exhibited by various classes of heterocyclic compounds and their potential implications in the field of medicine. Thiadiazoles, a class of organic heterocyclic compounds containing a diazole ring with a sulphur atom, have garnered significant attention in recent years due to their diverse biological activities. Among these, the antimicrobial properties of thiadiazoles have been a subject of intense research. This note provides a concise overview of the antimicrobial activities exhibited by thiadiazoles and their potential implications in the field of medicine.[6-8] Thiadiazole exist in total four isomers which are 1,2,3-thiadiazole, 1,2,4-thiadiazole, 1,2,5- thiadiazol and 1,3,4-thiadiazole. 1,3,4-thiadiazole derivatives are reported to have various pharmacological activities.

Mallesappa N. Noolvi, Harun M. Patel, Sarita Kamboj and Swaranjit Singh Cameotra in 2012 synthesised some novel 1,3,4-thiadiazole derivatives of 2-(4-formyl-2-methoxyphenoxy) acetic acid and evaluated theres *in vitro* antimicrobial activities against several microbial strains.[9] variations in the antimicrobial activities of these molecules are observed with variation in the type number and position of substituents. The present work is intent on development of pharmacophore models of these molecules. The pharmacophore models reveal hydrogen donor, hydrogen acceptor and lipophilic centres in the molecules. The structural variation in the molecules results in the variation in pharmacological activities of the molecules.

Experimental methodology:**a. Selection of database: [9]**

The pharmacophore models of 19 previously synthesized molecules were developed using their database. The antibacterial activities of these molecules were screened against a bacterial strain 'S. enterica.' Almost all the molecules were found to be potent against S. enterica but some variations were observed. The % inhibitions values are mentioned in the table given below (Table:1). All the molecules are separated in some groups with similarity in the type, position and number of substituents and their % inhibition values were compared.

Table:1: Details of the molecules selected and their antibacterial activity against S. enterica

Sr . No.	Label	SMILES	% Inhibition
1	a	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=CC=C4)C3)=C1</chem>	-
2	b	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=CC=C4OC)C3)=C1</chem>	76.8
3	c	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=C(C1)C=C4C1)C3)=C1</chem>	85.0
4	d	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=CC(N)=C4)C3)=C1</chem>	68.6
5	e	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=CC([N+])([O-])=O)C4)C3)=C1</chem>	93.2
6	f	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=C(OC)C=C4)C3)=C1</chem>	78.3
7	g	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=C(F)C=C4)C3)=C1</chem>	76.8
8	h	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=C([N+])([O-])=O)C=C4)C3)=C1</chem>	97.0
9	i	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=C(Br)C=C4)C3)=C1</chem>	69.4
10	j	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=C(C)C=C4)C3)=C1</chem>	73.1
11	k	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=CC(O)=C4)C3)=C1</chem>	79.58
12	l	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=CC=C4O)C3)=C1</chem>	73.8
13	m	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=C(C1)C=C4)C3)=C1</chem>	79.1
14	n	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=CC=C4N)C3)=C1</chem>	70.8
15	o	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=C(O)C=C4O)C3)=C1</chem>	76.8
16	p	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=C(N)C=C4)C3)=C1</chem>	86.5
17	q	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=CC=C4C1)C3)=C1</chem>	85.8

18	r	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=C(O)C=C4)C3)=C1</chem>	81.3
19	s	<chem>COC1=C(OCC2=NN=C(N)C2)C=CC(C3=NN(C(N)=S)C(C4=CC=CC(C)=C4)C3)=C1</chem>	70.8

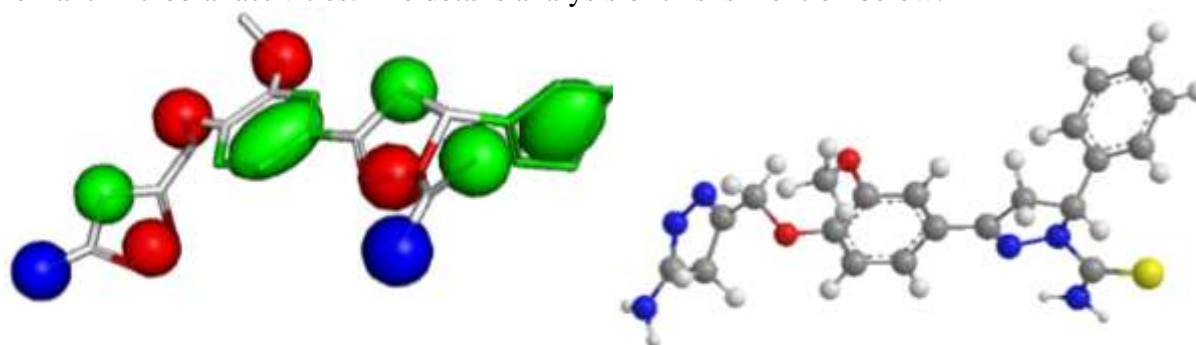
b. Development of pharmacophore model: [10-12]

Steps mentioned below are used for development of pharmacophore models.

- Structure drawing: ChemSketch 12 freeware was used to draw structures of the molecules.
- Structure optimization: Avogadro 2 was employed to optimize the 3D- structure.
- Alignment of molecules: This step was accomplished using Open3Dalign.
- Model generation: all the molecules were introduced in PyMOL 2.0. Then, PyMOL plugin 'LIQUID' was employed to generate consensus model using default settings.

Result and discussion:

All the molecules that are considered for comparative study of their pharmacophore models with respect to variation in the type and position of the substituents are divided into seven groups. Group I, II, IV, V and VI contains molecules which are positional isomers of each other. Pharmacophore based analysis of these molecules reveals the relation between their antibacterial activity against *S. enterica* and their H-bond donor, H-bond acceptor and lipophilic regions. All the molecules possess 5 lipophilic regions (green), 4 H-bond acceptor regions (red) and 2 H-bond donor regions in common as shown in the figure:1 given below. Variation in the substituents in the different molecules results in the variation in the number or size of H-bond acceptor, H-bond donor or lipophilic regions which eventually differentiate their antimicrobial activities. The details analysis of this is mention below.



Pharmacophore model of molecule-a

3D structure of molecule-a

Figure:1 Molecule-a

Table:2: Molecules divided in various groups

Sr. No.	Group	Label	Substitution	% Inhibition
1.	-	a	-H	-
2.	I	b	2-OCH ₃	76.8
		f	4-OCH ₃	78.3
3.	II	m	4-Cl	79.1
		q	2-Cl	85.8
4.	IV	n	2-NH ₂	70.8
		d	3-NH ₂	68.6
		p	4-NH ₂	86.5
5.	V	e	3-NO ₂	93.2

		h	4-NO ₂	97.0
6.	VI	j	3-CH ₃	73.1
		s	4-CH ₃	70.8
7.	VII	l	2-OH	73.8
		k	3-OH	79.58
		r	4-OH	81.3

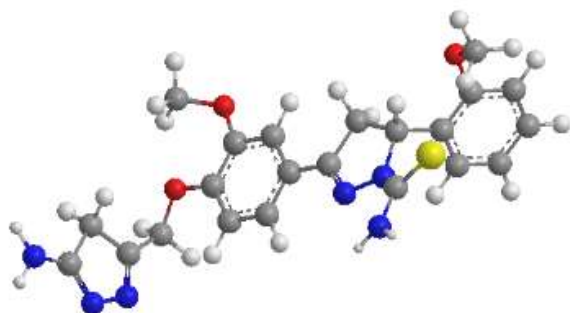
Group-I:

Fig 2: 3D structure of molecule-b

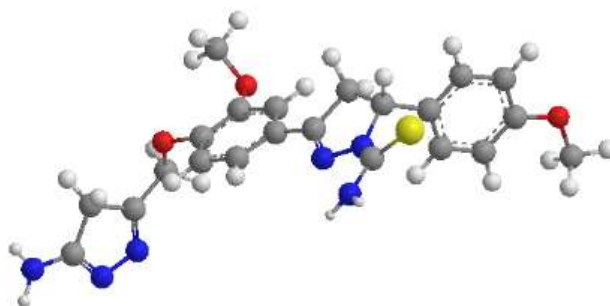


Fig 3: 3D structure of molecule-f

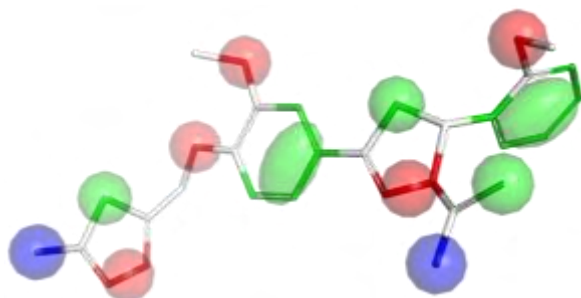


Fig 4: Pharmacophore model of molecule-b

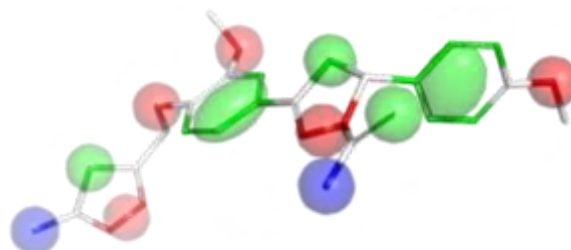


Fig 5: Pharmacophore model of molecule-f

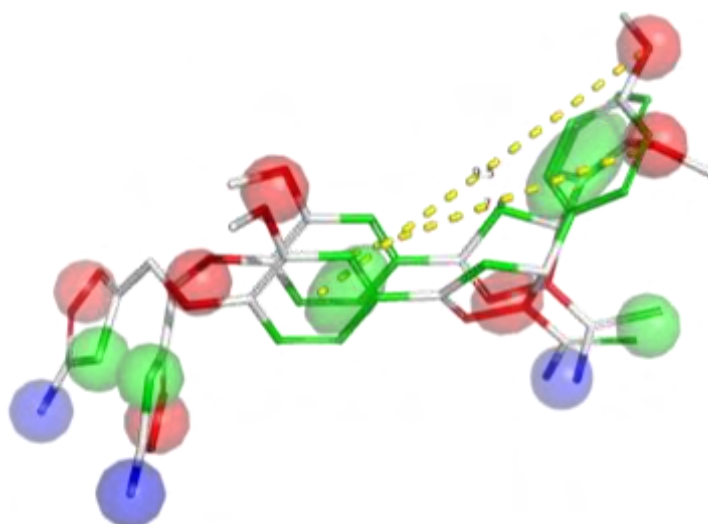


Fig 6: Consensus pharmacophore model of molecules b, and f representing various regions (Green: Lipophilic, Red: H-Bond acceptor region, Blue:H-Bond Donor)

Molecule b and f are positional isomers of each other. These molecules have almost similar potential against bacterial strain. The methoxy H-bond acceptor regions of methoxy groups are

responsible for increased antibacterial activity as compared to non-substituted ring. Though the distance between H-bond acceptor regions of methoxy groups and lipophilic region of central ring is not similar in both isomers but very small difference in their antibacterial activities is observed.

Group-II:

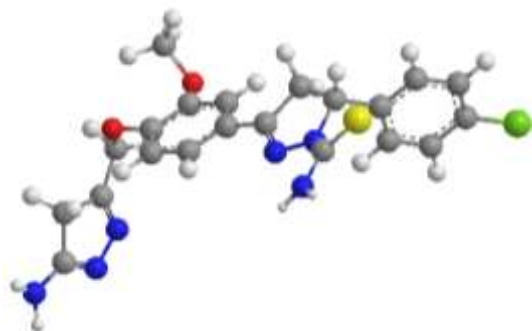


Fig 7: 3D structure of molecule-m

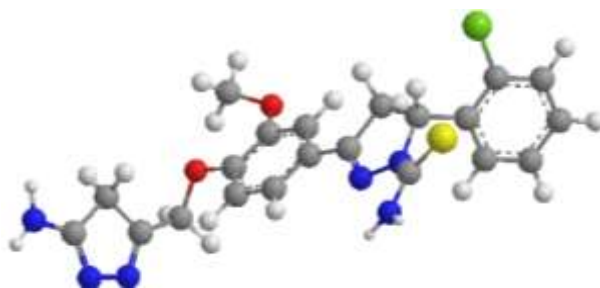


Fig 8: 3D structure of molecule-q

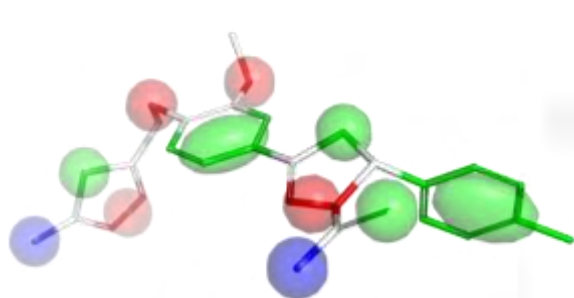


Fig 9: Pharmacophore model of molecule-m

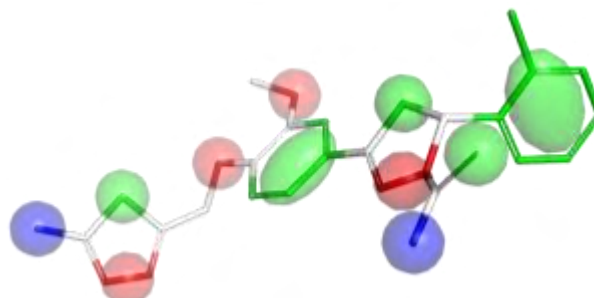


Fig 10: Pharmacophore model of molecule-q

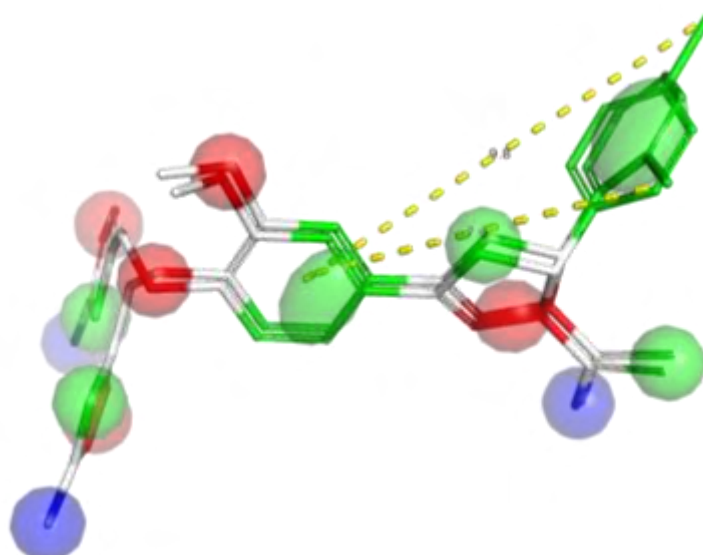


Fig 11: Consensus pharmacophore model of molecules m and q representing various regions (Green: Lipophilic, Red: H-Bond acceptor region, Blue: H-Bond Donor)

Positional isomers molecule m and q are due to change in the position of chlorine substituent. The increased lipophilic region of chlorine substituent is responsible for the increase in the antibacterial activity of molecule m and q. Much difference in the antibacterial activity of molecule m and q is observed. This might be because of the difference in the distance between central lipophilic region and lipophilic region of the chlorine substituents.

Group-III:

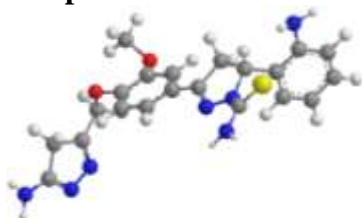


Fig 18: 3D structure of molecule-n

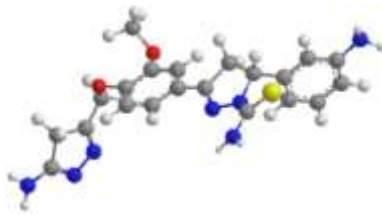


Fig 19: 3D structure of molecule-d

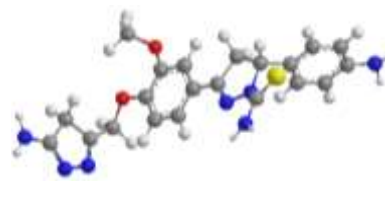


Fig 20: 3D structure of molecule-p

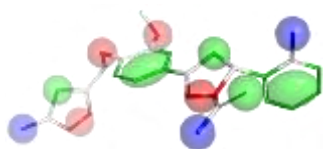


Fig 21: Pharmacophore model of molecule-n

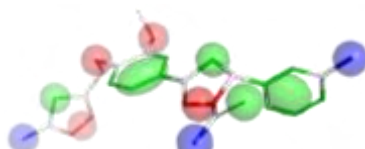


Fig 22: Pharmacophore model of molecule-d

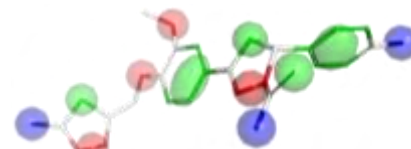


Fig 23: Pharmacophore model of molecule-p

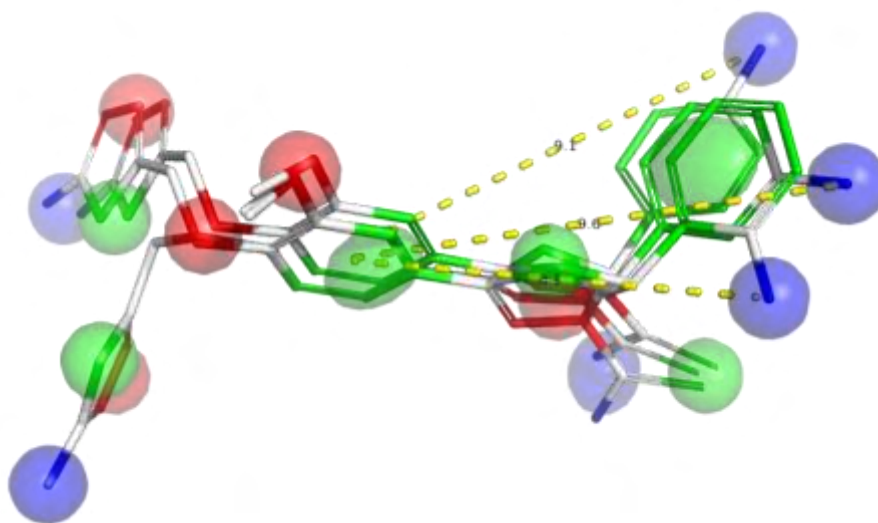


Fig 24: Consensus pharmacophore model of molecules n, d and p representing various regions

(Green: Lipophilic, Red: H-Bond acceptor region, Blue:H-Bond Donor)

Molecules n, d and are positional isomers of each other with variation in the position of amino group. The increased antibacterial activity of these molecules is due to the H-bond donor regions of amino substituents. Variation in the antibacterial activities of these molecules is observed with variation in the position of amino group. This variation is may be due to the difference in the distance between central lipophilic ring and H-bond donor amino groups. In the isomer with para-substituted amino group the distance is more and its antibacterial activity is also more as compared to ortho and meta isomers.

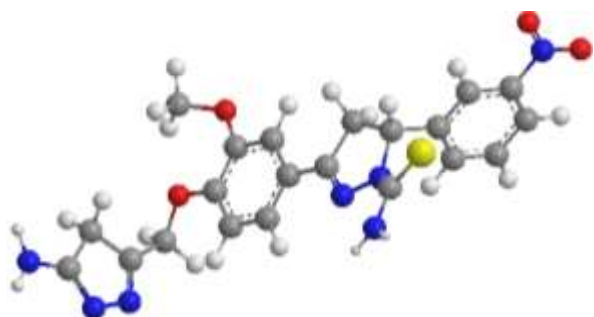
Group-IV:

Fig 25: 3D structure of molecule-e

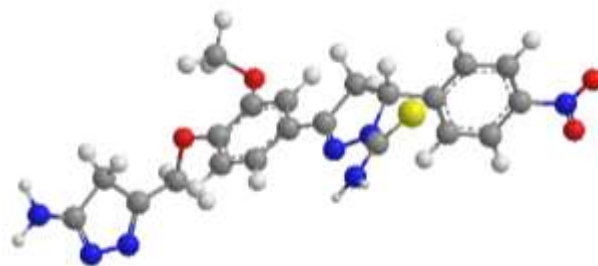


Fig 26: 3D structure of molecule-h

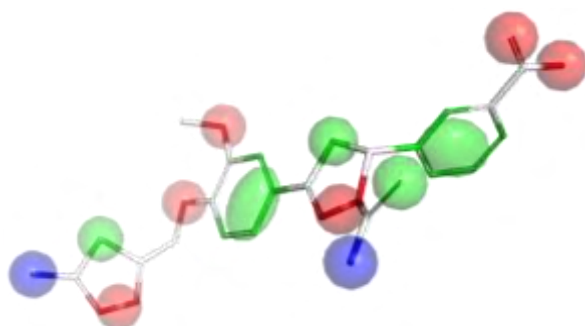


Fig 27: Pharmacophore model of molecule-e

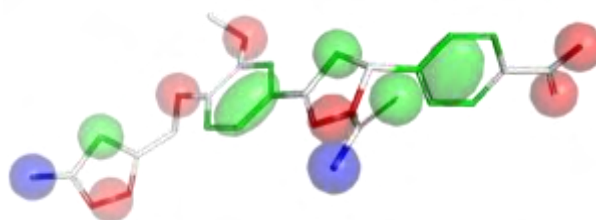


Fig 28: Pharmacophore model of molecule-h

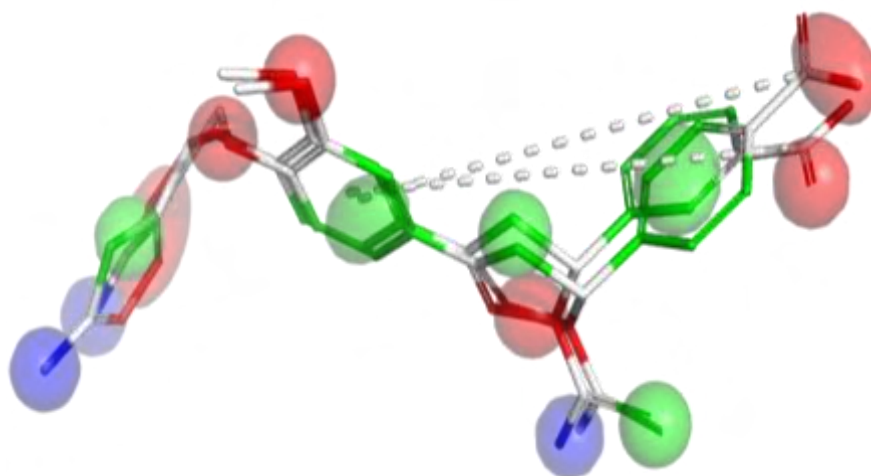


Fig 29: Consensus pharmacophore model of molecules e and h representing various regions (Green: Lipophilic, Red: H-Bond acceptor region, Blue: H-Bond Donor)

Molecules e and h are positional isomers each other with nitro group at meta position in molecule e and at para position in molecule h. The increased antibacterial activity of these molecules is due to the presence of H-bond acceptor region of nitro group. Both molecules have found to be most potent against bacterial strain amongst all the molecules examined. The para isomer is more potent as compared to the meta isomer due to increase in the distance

between H-bond acceptor region of nitro group at para position and central lipophilic region of ring.

Group-V:

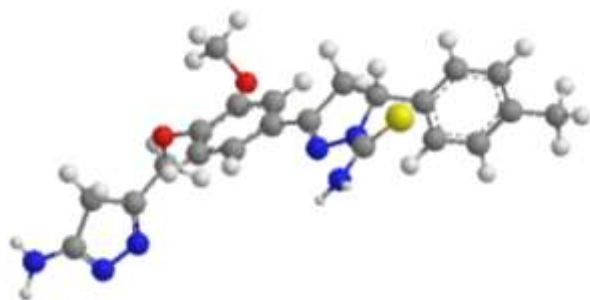


Fig 30: 3D structure of molecule-j

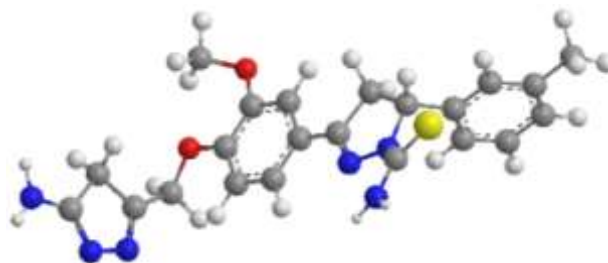


Fig 31: 3D structure of molecule-s

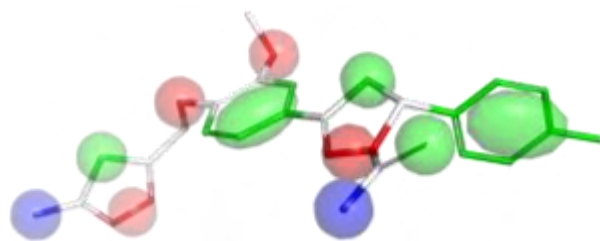


Fig 32: Pharmacophore model of molecule-j

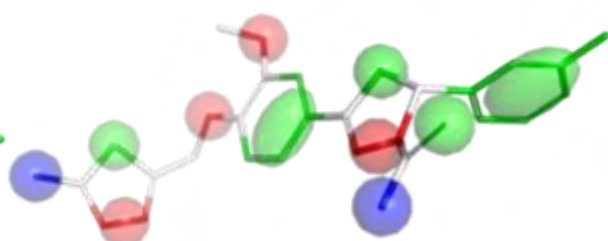


Fig 33: Pharmacophore model of molecule-s

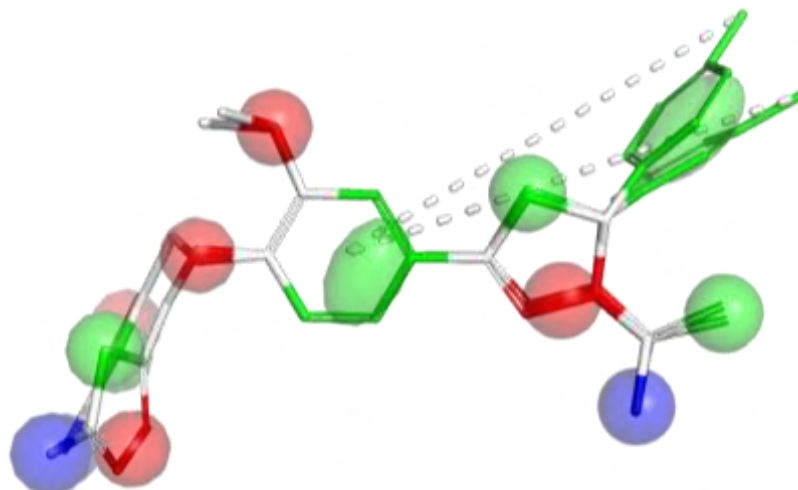


Fig 34: Consensus pharmacophore model of molecules j and s representing various regions (Green: Lipophilic, Red: H-Bond acceptor region, Blue:H-Bond Donor)

Molecules j and s are positional isomers of each other with methyl group at meta position in molecule j and at para position in molecule s. Increases in the antibacterial activity of these molecules is due to the increase in the lipophilic region of methyl group. Variation in the antibacterial activities of these molecules is observed with variation in the position of the methyl substituent. The para-methyl substituted isomer is found to be less potent as compared to the meta isomer due to increase in the distance between central lipophilic ring and lipophilic methyl substituent.

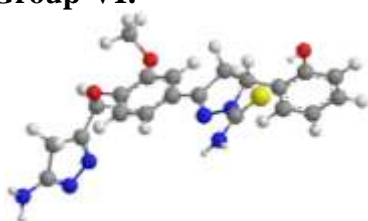
Group-VI:

Fig 34: 3D structure of molecule-l

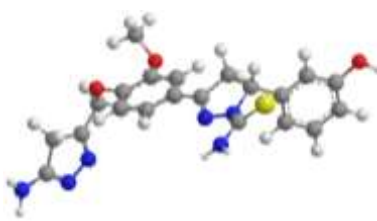


Fig 35: 3D structure of molecule-k

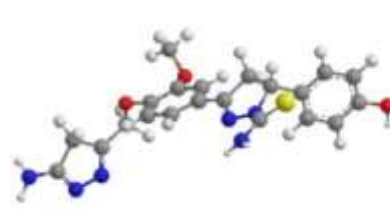


Fig 36: 3D structure of molecule-r

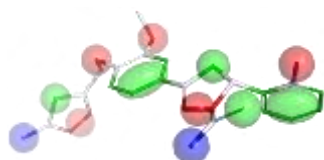


Fig 37: Pharmacophore model of molecule-l

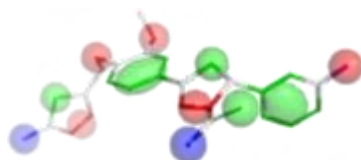


Fig 38: Pharmacophore model of molecule-k

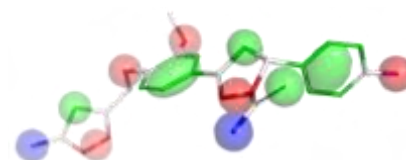


Fig 39: Pharmacophore model of molecule-r

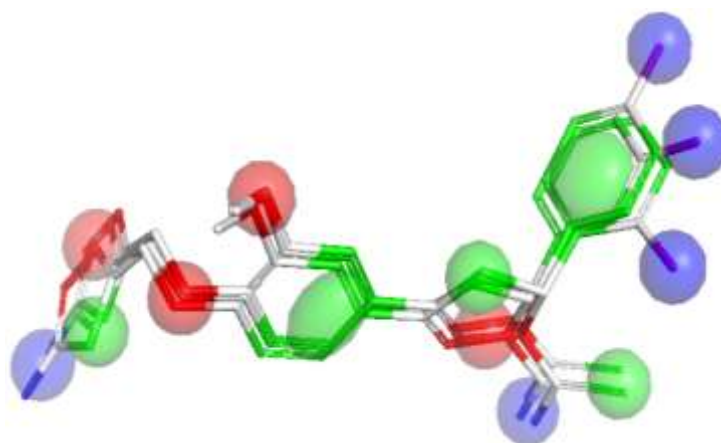


Fig 40: Consensus pharmacophore model of molecules l, k and r representing various regions

(Green: Lipophilic, Red: H-Bond acceptor region, Blue:H-Bond Donor)

Molecules l, k and r are positional isomers of each other with hydroxy substituent at ortho position in molecule l, at meta position in molecule k and at para position in molecule r. All these molecules have H-bond donor regions of hydroxy substituents at various positions which is responsible for their antibacterial activities. The variation in the antibacterial activity of these molecules is due to the variation in the position of hydroxy substituents. As distance between the central lipophilic ring and H-bond donor region of hydroxy groups increases in these positional isomers, the antibacterial activity increases.

A closer inspection of all molecules reveals that lipophilic, H-bond acceptor and H-bond donor regions of these molecules are responsible for their antibacterial activities. In group-I and group-II, H-bond donor region of methoxy and nitro group respectively are responsible for their antibacterial activities. Molecules with nitrogen substituents are most potent against bacterial strain amongst all the molecules studied. It is observed that in positional isomers with difference in the position of substituents responsible for H-bond donor regions, the antibacterial activity of these molecules increases with increase in the distance between the central lipophilic region of ring and the H-bond donor regions of methoxy or nitro substituents.

Molecules of group-II and group-V have chlorine and methyl substituents respectively that generates lipophilic regions which are responsible for their antibacterial activities. When the antibacterial activities of these molecules are studied, it is observed that distance between the central lipophilic region of the ring and lipophilic region of the substituents is inversely proportional to the potent of these molecules.

In case with molecules of group-III and group-VI, the amino and hydroxy substituents respectively are responsible for the H-bond donor regions. The potential of these molecules varies with position of the respective substituent. After observing the antibacterial activities of these molecules, it can be concluded that their potential increases with increases in the distance between the central lipophilic region of the ring and H-bond donor region of the amino or hydroxy substituent.

Conclusion:

The detailed study of the pharmacophore models of these molecules reveals that their antibacterial activity depends on the presence of the substituents responsible for lipophilic, H-bond acceptor and H-bond donor regions. The study also unveils that antibacterial potential of the positional isomers of these molecules depends on the distance between the central lipophilic region of ring the substituents, which is directly proportional for substituents responsible for H-bond acceptor and H-bond donor regions and inversely proportional for substituents responsible for lipophilic regions.

References:

- 1 A. Pandey, R. Rajavel, S. Chandraker, D. Dash; E-Journal of Chemistry; 9(2012), 2524
- 2 Kai Zhang, Peng Wang, Li-Na Xuan, Xiao-Yun Fu, Fen Jing, Sha Li, Yu-Ming Liu, Bao-Quan Chen, Bioorganic & Medicinal Chemistry Letters, 24 (2014) 5154–5156
- 3 M. M. Raj, H. V. Patel, L. M. Raj, N. K. Patel; IJPCBS, 3(2013), 814-819
- 4 Husam A. Ameen, Ahlam J. Qasir; Iraqi J Pharm Sci, 21(2012), 98-104
- 5 T. Ahmad, A. K. Singh, N. Jaiswal, D. Singh; IRJP, 3(2012), 70-82
- 6 W. Płonka, A. Paneth, P. Paneth; Molecules, 25(2020), 4645
- 7 Ming Chen, Wen-Gui Duan, Gui-Shan Lin, Zhong-Tian Fan, Xiu Wang; Molecules, 26(2021), 1708.
- 8 Georgeta Serban; Molecules, 25(2020), 942
- 9 Malleshappa N. Noolvi, Harun M. Patel, Sarita Kamboj, Swaranjit Singh Cameotra; AJC, 9(2016), S1283-S1289
- 10 Masand, V. H., & Rastija, V. (2017). PyDescriptor : A new PyMOL plugin for calculating thousands of easily understandable molecular descriptors. *Chemometrics and Intelligent Laboratory Systems*, 169, 12-18.
- 11 Masand, V. H., El-Sayed, N. N. E., Mahajan, D. T., & Rastija, V. (2017). QSAR analysis for 6-arylpyrazine-2-carboxamides as Trypanosoma brucei inhibitors. *SAR and QSAR in Environmental Research*, 28(2), 165-177.
- 12 Masand, V. H., El-Sayed, N. N. E., Mahajan, D. T., Mercader, A. G., Alafeefy, A. M., & Shibi, I. G. (2017). QSAR modeling for anti-human African trypanosomiasis activity of substituted 2-Phenylimidazopyridines. *Journal of Molecular Structure*, 1130, 711-718.

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A Study on Morpho- Anatomical and Phytochemical Characterization of *Euphorbia stenoclada* Baill. (An Endangered species)

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Abstract:

Euphorbia stenoclada Baill. is native of Madagascar, a very rigid upright growing shrub, used in folk medicine of various countries around the world. The present study deals with the morphological and anatomical characterization of various plant parts along with the determination of their phytoconstituents. Morphological characterization is based on vegetative and reproductive characters such as plant height, number of branches, size, and floral characteristics. The leaf was found to be absent. The anatomical studies of the root revealed that it is encircled by cork cells with single layered epidermis. The cortex is parenchymatous with laticiferous tissues, thick-walled polygonal cork cells, and intercellular spaces absent. Presence of endodermis and pericycle, below the cortical zone, a multi-seriate layer of very thick-walled sclerenchyma cells was found. The xylem is made up of tracheids and vessels with centrally located sclerenchymatous pith. The transverse section of the stem showed the presence of epidermis covered by a thick layered cuticle. Cortex consists of a few layers of chlorenchymatous, parenchyma cells. Laticifers are distributed throughout the cortex. Vascular bundles are collateral, conjoint & open type, and scattered forming a necklace shape. At the center of the stem, a massive pith is filled with oil droplets. A preliminary phytochemical analysis of the stem revealed the presence of carbohydrates, proteins and amino acids, anthraquinones, saponin, alkaloids, flavonoids, tannins, steroids, and terpenoids indicating that the plant has a potential towards various pharmacological activities etc. in the future.

Keywords: *Euphorbia stenoclada* Baill., morphological characters, anatomical characters, phytoconstituents.

Introduction

Euphorbia stenoclada Baill. (Euphorbiaceae), the endemic species is locally known as 'famata' or 'hamatse'. It is a spiny shrub belonging to the xerophytic vegetation native to the southeast of Madagascar (Tulear area). It belongs to the genus *Euphorbia* or spurge, the largest genus of Euphorbiaceae with about 1600 species characterized by the presence of white milky latex. Compounds isolated from this genus include flavonoids, triterpenoids, alkanes, amino acids and alkaloids (Singla and Pathak, 1990). Flavonoids from the Euphorbiaceae family have various effects, including anti-tumor (Bomser *et al.*, 1996), anti-inflammatory (Bani *et al.*, 2000), antioxidant (Lin *et al.*, 2002), anti-diuretic (Yoshida *et al.*, 1988), anti-diarrheic (Agata *et al.*, 1991) or anti-malaria (Tona *et al.*, 1999) is well documented. The genus *Euphorbia* has been subjected to extensive phytochemical research because it is used medicinally in the treatment of numerous diseases including skin diseases, gonorrhoea, migraine, intestinal parasites and wart cures.

Euphorbia stenoclada is traditionally used by the Malagasy population as an infusion of the aerial parts to treat respiratory diseases such as acute bronchitis and asthma (Peat and Mellis, 2002, Szeffler, 2002, Wood, 2002). An ethanolic extract of *E. stenoclada* inhibits IL-1-induced proliferation of the human airway smooth muscle and identifies quercetin as the major anti-proliferative compound it (Chhabi *et al.*, 2007). The genus *Euphorbia* has been the subject of intensive phytochemical research because of its medicinal uses. Extensive research work

has been carried out on various other sp. of *Euphorbia* but *E. stenoclada* still remains unstudied or unexplored, therefore the present attempt has been made to explore an endangered plant species *E. stenoclada* Baill. by studying the morphological, and anatomical variability of the species with the emphasis on analysis of its phytoconstituents.

Materials and Methods

Materials

The material selected for the present study comprised of root, stem and flowers of *Euphorbia stenoclada* Baill. (*Euphorbiaceae*).

Experimental methodology

Collection of plant:

The fresh whole plant was collected from Cactus Garden, Amravati (MS) on Oct. 22, 2022. The plant specimen was identified and authenticated by Dr. V.R.Marathe, Associate. Prof. Dept. of Botany, NES Science College, Nanded, by using Bentham and Hooker's system of classification and Angiosperm Phylogeny Group IV system of classification. Plant samples were dried in shade at 25 °C to 35 °C for 15-20 days in the laboratory and then crushed to a coarse powder using a grinder. The dried plant materials were stored in an airtight container.

Morphological characterization:

Fresh samples of roots, stems and flowers were collected from the plant. Collected fresh plant samples were characterized based on morphological traits such as habitat, habit, stem shape, size and color, branches, branch apex, structure and texture of stem and branches, pigmentation, inflorescence, detailed structure of the cyathium, fruit colors, type of root, structure, and texture of root were studied. Plant height, length, etc.

Anatomical characterization:

For microscopic (cellular) characterization, collected plant samples of *E. stenoclada* Baill. were subjected to microscopic analysis. The section of different parts like root, stem, and leaves were obtained in the transverse section. It was then observed under the microscope.

Extraction of crude drug:

Plant extraction was done by the Soxhlet extraction method (Sadasivam and Manickam, 1996) using distilled water as a solvent.

Preliminary Phytochemical Analysis:

The extracts were tested for the presence of bioactive compounds by using standard methods (Khandelwal, 2007).

Results & Discussion

The experiment methodology that has been adopted for the present study includes its morphology, anatomy, and phytochemical analysis. The findings of the present study were discussed as under:

Morphological characterization: Vegetative characterization

Euphorbia stenoclada Baill, is an upright branched large leafless succulent shrub or small tree usually seen around 6 feet tall but capable of growing to 12 feet tall or more by 4 to 6 feet wide.

Morphology of the Root: The root of *E. stenoclada* Baill. is a typical adventitious root system, growing positively geotropic, woody brown, and cylindrical. These root characteristics are typical of eudicots. Milky white latex is flowing in fresh samples when cut. No specialized structures for storage or enlarged portions for other metabolic functions were identified.



Fig.1 Habit

Fig 2. Structure of root

Fig 3. Latex in root

Morphology of Stem and Branches: It is a much-branched succulent shrub or small tree with leafless branches that bear alternate spines formed from modified branchlets. It grows up to 20 feet tall and develops a thick trunk and a flat-topped crown of olive-green wax-coated branches. The trunk is up to 8 inches in diameter and covered with rough bark. Spines are up to 1.2 inches long. The internode can grow with an average length of 2.49 cm. The stem possesses milky latex. Branches are many succulents in nature light olive green in color wax coated short with secondary twinges armed with paired, flat, modified, spinose branchlets, leafless. The stem has a strong pubescent adpressed vestiture; yellow-brown uniseriate multicellular trichomes are growing 1.5 mm shorter or longer. The base is woody and sparingly branched in monopodial pattern at the middle, the internode can grow with an average length of 2.49 cm. The nodes are a bit thickened characterized by the presence of small membranous linear stipules that shed off at early stage. The stem possesses milky latex.



Fig 4. Latex in stem

Fig 5. Modification of terminal branches into spines

Table: 1 Vegetative characteristics of *Acacia senegal*

ORGAN	Stem	Primary branches	Secondary branches	Tertiary branches	Node	Internode
MEASUREMENTS	Height of plant: 250-300 cm approx. Length: 153 cm (60 in.) Stem thickness: 36 cm (14 in)	Length: 153 cm (60 in.) Thickness: 16-19 cm	Length: 90 cm (35 in) Thickness: 6-8 cm (2 in)	Length: 4-5 cm (1-3 in) Thickness: 0.5-1 cm	Length: 1-2 cm	Alternate: 0.5 - 1 cm

Reproductive Characterization:

The inflorescence called 'cyathium' is present. It is clustered in dense cymose situated at the terminal or the upper nodal regions of the stem. The branches terminate in tightly packed clusters of tiny crimson cyathia in spring. Cyathia 3mm purplish in diameter sessile in densely clustered cymes at branch tips, violet-crimson, the flowers include a bract, nectar glands, and groups of female flowers, appearing in spring followed by small rounded green lightly hairy fruit.

Fruits: Fruits are not available but some research says subglobose lightly hairy fruit capsules of

6 x 7 mm found, fruits are green, that grow about 0.25 inches (0.6 cm) in diameter.

Seeds: Seeds are also not found but, in some research, globose 3 mm in diameter fruits were found frequently, the pedicelled cyathia are green and often tinged reddish, and all parts are very

hairy present in the involucre. It appears ovate on the transverse top view.



Fig.6: Inflorescence: Cyathium

Anatomical Characterization

Transverse Section (T.S.) Root: The transverse section of the root is circular in outline and shows features from the periphery to its center.

Cuticle: The Cuticle is one or two layers thick followed by the epidermis.

Epidermis: Epidermis single-layered.

Cortex: Next to the epidermis, the parenchymatous cortex is present with laticiferous tissues, cork cells are polygonal, thick-walled without any intercellular spaces. Endodermis and pericycle are also present, below the cortical zone, a multi-seriate layer of very thick-walled sclerenchyma cells.

Vascular Bundles: Next to the endodermis vascular bundle is present, which is differentiated into xylem and phloem. The xylem has tracheids and vessels with centrally located pith.

Pith: The sclerenchymatous pith is located in the center.

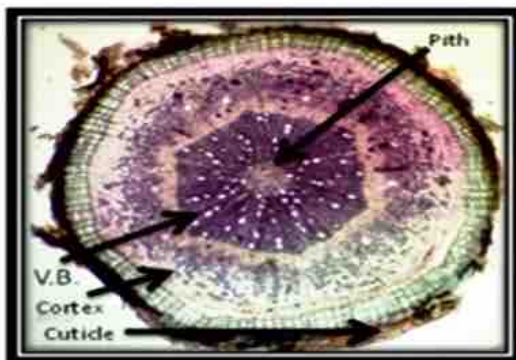


Fig.10 – Pith of root

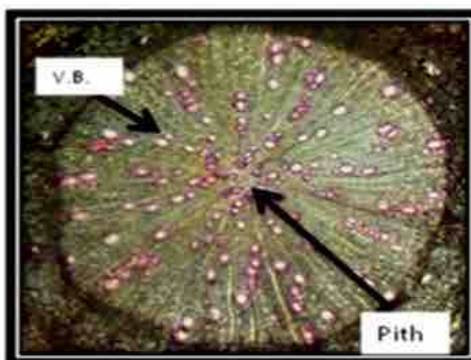


Fig.11 – T.S. of Root

Transverse Section (T.S.) of Stem: The transverse section of the stem is circular/oval in outline. Following tissue organization from the periphery towards the center of the stem is observed.

Cuticle: Single layer and well-developed cuticle followed by epidermis.

Epidermis: Epidermis single layered uniseriate with compactly packed arranged epidermal cells.

Cortex: The cortex is massive and consists of a few layers of chlorenchymatous cells; hypodermis followed by 15-20 layers of parenchyma. The cortex is differentiated into palisade and spongy parenchymatous tissue. Laticifers are distributed through the cortex.

Vascular Bundles: V.B. are collateral, conjoint and open, 15-20 in no. necklace shaped scattered in pith. A vascular cylinder consists of a proto-xylem and meta-xylem followed by a phloem. Central vascular bundles are distinct, conjoint, collateral, and open varying in size and shape. Bundles vary in size and shape phloem facing towards the outer side and the xylem facing inside.

Pith: At the center of the stem, a massive pith is present. Cells are very large, isodiametric, and parenchymatous. Oil droplets are present in pith.

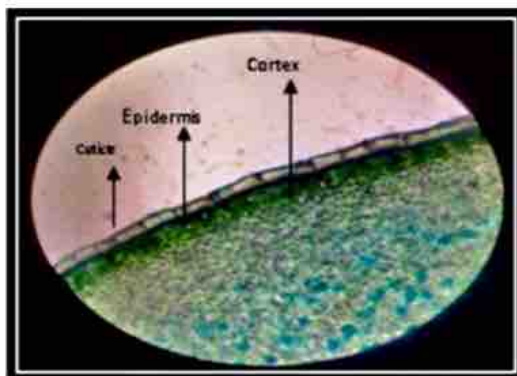


Fig.7 – T.S. of stem

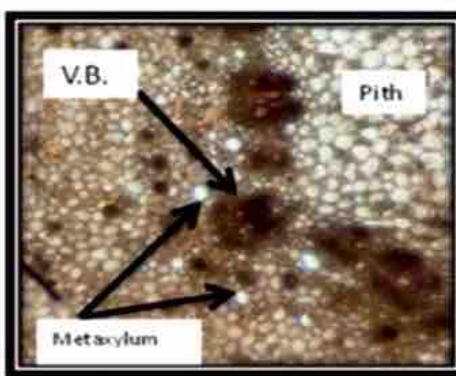


Fig.9 – Vascular bundles

Preliminary phytochemical analysis:

The term phytochemical generally refers to those chemicals of plant origin. Alkaloids, terpenoids, coumarins, tannins, quinines, flavonoids, glycosides, steroids, saponins, etc. are some of the phytochemicals. Not only do they play a variety of roles within plants, but they are also biologically active and used to treat various diseases. These compounds have anticancer, antioxidant, and anti-inflammatory properties (Barla *et al.*, 2006). In this study, preliminary qualitative phytochemical screening of *Euphorbia stenoclada* Baill. is performed with aqueous

extract and it confirms the presence of carbohydrates, alkaloids, flavonoids, proteins, phenols, tannins, cardiac glycosides, and terpenoids. Similar results were recorded in the alcoholic extract of *Euphorbia helioscopia* (Singh and Isfaq, 2017). Phytochemical screening revealed the presence of alkaloids, flavonoids, saponin, terpenoids, steroids, and sterols in the methanol, chloroform, and hexane extract of leaf and fruit extracts of *Euphorbia hirta* and were tested for antimicrobial activities using agar disc diffusion method (Ahmad Waseem *et al.*, 2017).

Table 2: Preliminary phytochemical analysis of *Euphorbia stenoclada* Baill. stem aqueous extract.

Sr. No.	Phytoconstituents	Present/Absent
1	Carbohydrates	+
2	Alkaloids	+
4	Proteins	+
5	Flavonoids	+
6	Phenols	+
7	Tannins	+
8	Cardiac glycosides	+
9	Terpenoids	+
10	Resins	-

Conclusion:

The present study was undertaken to validate the morphological, anatomical, and chemical characterization of *Euphorbia stenoclada* Baill. Its morphological and anatomical characterization revealed the vast structural diversity that existed in the studied species. Stem characters like the nature of vascular bundles and cortex etc. are of high taxonomic significance. The preliminary phytochemical analysis of the aqueous extract of the stem revealed the presence of bioactive compounds such as carbohydrates, alkaloids, flavonoids, proteins, phenols, tannins, cardiac glycosides, and terpenoids. The present study provides an important basis for further investigation of its pharmacological activities as well as the identification and isolation of unexplored compounds to establish its folklore claims.

Acknowledgement:

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References:

1. Agata, I., Hatano, T., Nakaya, Y., Sugaya, T., Yoshida, T., Nishibe, S., Okuda, T., 1991. Tannins and related polyphenols of Euphorbiaceous plants. VIII. Eumaculin A and cusupinin A, and accompanying polyphenols from *Euphorbia maculata* L. and *E. supina* Rafin. Chemical and Pharmaceutical Bulletin 39, 881–883.
2. Ahmad, Waseem, Shilpa Singh and Sanjay Kumar, 2017. Phytochemical Screening and antimicrobial study of *Euphorbia hirta* extracts. Journal of Medicinal Plants Studies. 5(2): 183-186.
3. Bani, S., Kaul, A., Jaggi, B.S., Suri, K.A., Suri, O.P., Sharma, O.P., 2000. Antiinflammatory activity of the hydrosoluble fraction of *Euphorbia royleana* latex. Fitoterapia 71, 655–662.

4. **Barla A, Birman H, Kultur S and Oksuz S., 2006.** Secondary metabolites from *Euphorbia helioscopia* and their vasodepressor activity. Turk. J. Chem.; 30: 325-32.
5. **Bomser, J., Madhavi, D.L., Singletary, K., Smith, M.A., 1996.** In vitro anticancer activity of fruit extracts from *Vaccinium species*. Planta Medica, 62: 212–216.
6. **Chaabi, M. V. Freund-Michel, N. Frossard, A. Randriantsoa, R. Andriantsitohaina, 2007,** Anti-proliferative effect of *Euphorbia stenoclada* in human airway smooth muscle cells in culture A. Lobstein Journal of Ethnopharmacology, 109 pp: 134–139.
7. **Khandalwal K.R., 2007.** Practical Pharmacognosy. Nirali Prakashan, Pune. 16 Edition: 149-156.
8. **Lin, C.C., Cheng, H.-Y., Yang, C.-M., Lin, T.-C., 2002.** Antioxidant and antiviral activities of *Euphorbia thymifolia* L. Journal of Biomedical Science 9, 656–664
9. **Peat, J.K., Mellis, C.M., 2002.** Early predictors of asthma. Current Opinion in Allergy and Clinical Immunology 2: 167–173.
10. **S. Sadasivam and A. Manickam 1996,** "Biochemical Methods," New Age International (P) Limited, New Delhi, Vol. 2: pp. 124-126.
11. **Singh, Maneesha and Mohd. Isfaq, 2017.** Study on Morpho- Anatomical And Phytochemical Characterization of *Euphorbia helioscopia* L. In Doon Valley. Int J Pharm Bio Sci 2017 Apr; 8(2): (B) 849-855.
12. **Singla, A.K., Pathak, k., 1990.** Phytoconstituents of *Euphorbia species*. Fitoterapia 6, 483–516.
13. **Szeffler, S.J., 2002.** The natural history of asthma and early intervention. Journal of Allergy and Clinical Immunology 109, S549–S553.
14. **Tona, L., Ngimbi, N.P., Tsakala, M., Mesia, K., Cimanga, K., APers, S., De Bruyne, T., Pieters, L., Totte, J., Vlietnick, A.J., 1999.** Antimalarial activity ' of 20 crude extracts from nine African medicinal plants used in Kinshasa, Kongo. Journal of Ethnopharmacology 68, 193–203.
15. **Wood, R.A., 2002.** Pediatric asthma. Journal of the American Medical Association 288, 745–747.
16. **Yoshida, T., Chen, L., Shingu, T., Okuda, T., 1988.** Tannins and related polyphenols of Euphorbiaceous plants. IV. Euphorbins A and B, novel dimeric dehydroellagitannins from *Euphorbia hirta* L. Chemical and Pharmaceutical Bulletin 36: 2940–2949.

To Investigate the Impact of Extraction Methods on the Presence of Organic Compounds in Natural Dye

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Abstract:

The present study aimed to investigate the impact of extraction methods on the presence of organic compounds in natural dye. This was the preliminary study to evaluate the Impact of extraction methods on the light absorbance of natural organic dyes for dye-sensitized solar cell applications. For this, aqueous extraction, cold ethanol, and Soxhlet hot ethanol extraction methods were used to study the performance of dyes as sensitizers for dye-sensitized solar cells (DSSC) based on optical absorbance, and consequently light harvesting efficiency (LHE). From the extract of *Bougainvillea glabra* floral bracts were used in this study. From the UV/Visible spectrophotometer with the recorded absorption measurements in the range between 300 – 700 nm, it was earmarked as a potential sensitizer candidate for DSSC. The phytochemical screening was applied to detect the presence of anthocyanins, quinones, coumarins, and others in the extracts. Based on the phytochemical screening, there was no appreciable impact of the extraction methods on the presence of the organic compounds relative to individual samples; also, the optical absorption showed that no extraction method was found consistently better than the other in all extracts.

Keywords: Extraction Method, Optical Absorbance, Light-Harvesting-Efficiency, Natural Organic Dye, Phytochemical Screening.

Introduction:

The use of natural dyes as sensitizing dyes for the conversion of solar energy into electricity is of great interest since it improves the economic aspects on the one hand and offers great advantages from an ecological point of view on the other hand (Kay and Graetzel, 1993). Some offer significant benefits from an ecological point of view (Kay and Graetzel, 1993).

Natural organic dyes are obtained from plants using a variety of extraction methods. The three most commonly used extraction methods are Soxhlet hot ethanol, Cold ethanol, and Heating in water. Each Extraction method is expected to impact the performance of the DSSC. Several studies have been conducted regarding extractions. Where one or two methods have been used to determine which one gives better results. The criterion for selecting a method was 'Trial and error.' It is believed that there is a strong correlation between the extraction method and the optical absorbance or light harvesting efficiency (LHE) of the dye. LHE indicates the incident photon to current conversion efficiency (IPCE) of the DSSC (Mphande & Pogrebnoi, 2014). The main objective of the research was to investigate the effects of extraction methods on the presence of organic compounds in Natural Dye. This was considered as a preliminary study to determine the influence of natural dyes upon LHE for DSSC applications for *Bougainvillea* plant species and how these natural dyes act as sensitizers in solar cells by absorbing photons from sunlight and converting them into electrical energy.

Materials and Method:

Materials:

Bougainvillea glabra pink-coloured flowers were collected from the Botanical garden of VidyaBharati Mahavidyalaya Amravati and bracts were separated from flowers and used for the extraction and dyeing process.



Fig.1 Floral bracts of *Bougainvillea glabra*

Chemicals:

The percent solution was prepared by adding the required amount of chemicals in gm per 100ml of distilled water and ethanol used as solvent system. 100ml hot ethanol, 100ml cold ethanol, and 100ml distilled water were used as extraction methods.

Methodology:

For extraction of natural dye, floral petals were shade-dried. They were ground into a fine powder using a mechanical blender and sieved and stored in an airtight container. Extraction of natural dye from floral bracts was carried out in the following steps.

- 1) Soxhlet Method
- 2) Cold Ethanol
- 3) Aqueous Extraction
- 4) Phytochemical Screening

1) Soxhlet Extraction:

10 g of the sample was extracted in a Soxhlet apparatus using 100 ml of ethanol as the solvent, and the Soxhlet was run for 6-8 cycles until the sample loaded became colourless. After the Soxhlet extraction was over, the extract was collected, weighed, and stored in a freezer.

2) Cold Ethanol:

In this method of extraction, the sample was soaked in ethanol for 1 week. Three Samples were kept. In each beaker 10 gm floral bracts were added in 100ml of ethanol were added, and wrapped with aluminum foil. After this process extract was filtered with Whatman filter paper no.41. and stored for further use.

3) Aqueous Extraction

For the aqueous extraction method, each sample was heated at six different temperatures (40-90°C with 10°C step) for 30-35min after which Whatman No.41 filter paper was used to filter out solid particles.



Fig. 2 Soxhlet Extraction



Fig. 3 Cold Ethanol Extraction



Fig. 4 Aqueous Extraction

4) Characterization

The sample underwent the optical absorbance test using the UV/Vis spectrophotometer. Where $A(\lambda)$ is the absorbance at a specific wavelength. To obtain the absorbance curve, the scanning of the sample was repeated at least three times in the wavelength range between 300-700nm.

5) Phytochemical Screening:

A qualitative screening was carried out to detect the presence of phytochemicals in the extract. Flavonoids, quinones, coumarins, anthocyanins, anthraquinones, and carotenoids are chemical compounds that are of practical relevance in DSSC applications. The phytochemical tests were performed on the liquid extract using standard methods (Sadashivam & Manikam, 1996).



Fig 5 UV/Vis Spectrophotometer Analysis



Fig.6 Phytochemical tests

Results and Discussion

This study was concerned with investigating the influence of extraction methods on the presence of organic compounds in natural pigments and determining the influence of natural pigments on light harvesting efficiency in dye-sensitized solar cell applications of *Bougainvillea glabra*. In this study, the Soxhlet method, aqueous method, and cold ethanol method were used to extract pigments from *Bougainvillea* flower bracts and find organic compounds and a sensitizer in dye-sensitized solar cells (DSSC). Although there are many methods for extracting natural dyes from plants, the most commonly used methods for DSSC applications are the Soxhlet method, the aqueous method, and the cold ethanol method. It is common to use trial and error methods to determine the appropriate extraction method for a particular plant species (Mphade & Pogrebnoi, 2014).

UV Spectrophotometric analysis:

The absorption spectrum of *Bougainvillea* floral bracts dye solutions was measured using UV-Vis spectroscopy. The UV-VIS profiles of plant extract were recorded at 200 to 800nm with sharp peaks and proper baseline in case of water, cold, and hot (Soxhlet) ethanol. The profile showed peaks at 316.40nm and 269.00 nm with the absorbance 1.223 and 2.119 respectively for aqueous extract (fig.7 and table-1), peaks at 315.20nm and 266.80nm for cold ethanol with the absorbance 0.548 and 0.810 respectively (fig.8 and table-2), peaks at 314.60nm, 283.29nm and 272.00nm with the absorbance 0.298, 0.402 and 0.440 respectively for hot ethanol (fig. 9 and table-3). The result showed that the absorption peaks for water, cold, and Soxhlet ethanol extracts occur at the same wavelength with a negligible difference (fig. 8,9,10 & Table 1,2,3). All the dyes have shown nearly the same absorbance this may be due to the similar chemical composition of the plant that is responsible for absorbance in the UV range.

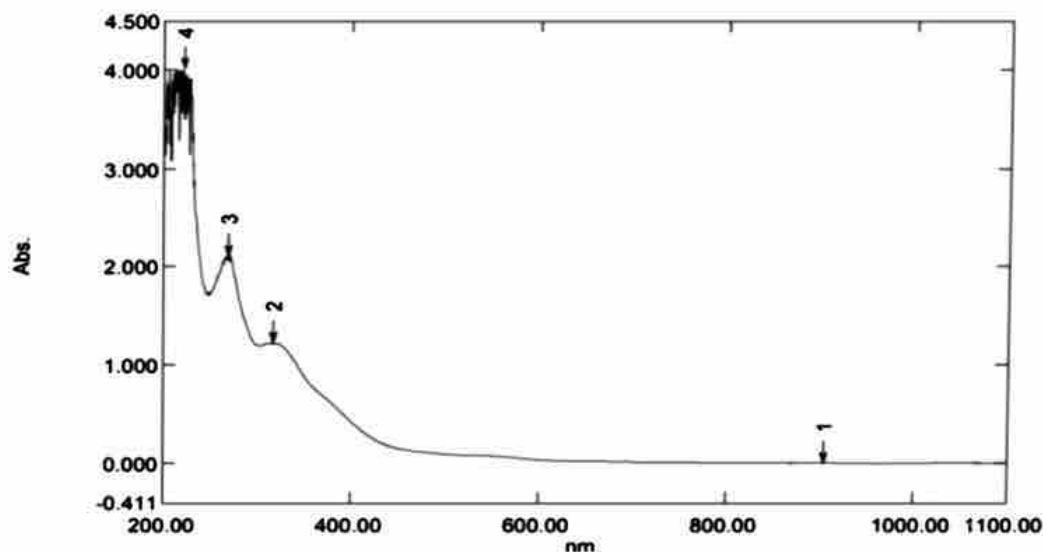


Fig 7: UV-VIS Spectrum of *Bougainvillea glabra* floral bract aqueous extract

Table 1: UV-VIS peak values of *Bougainvillea glabra* floral bract aqueous extract

No.	P/V	Wavelength	Abs.
1	↑	904.40	-0.005
2	↑	316.40	1.223
3	↑	269.00	2.119
4	↑	220.40	4.024

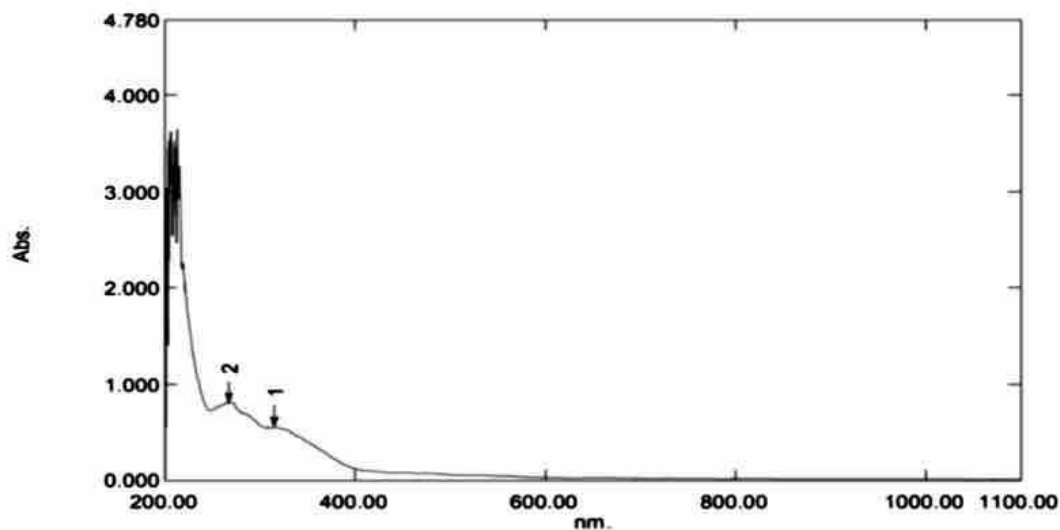


Fig 8: UV-VIS Spectrum of *Bougainvillea glabra* floral bract cold ethanol extract
Table 2: UV-VIS peak values of *Bougainvillea glabra* floral bract cold ethanol extract

No.	P/V	Wavelength	Abs.
1	↑	315.20	0.548
2	↑	266.80	0.810

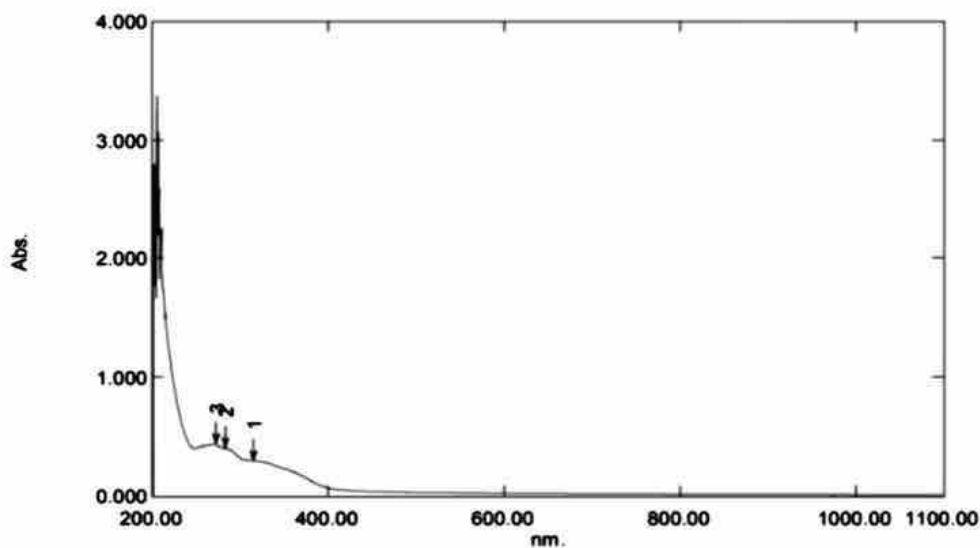


Fig 9: UV-VIS Spectrum of *Bougainvillea glabra* floral bract hot (Soxhlet) ethanol extract

Table 3: UV-VIS peak values of *Bougainvillea glabra* floral bract hot ethanol extract

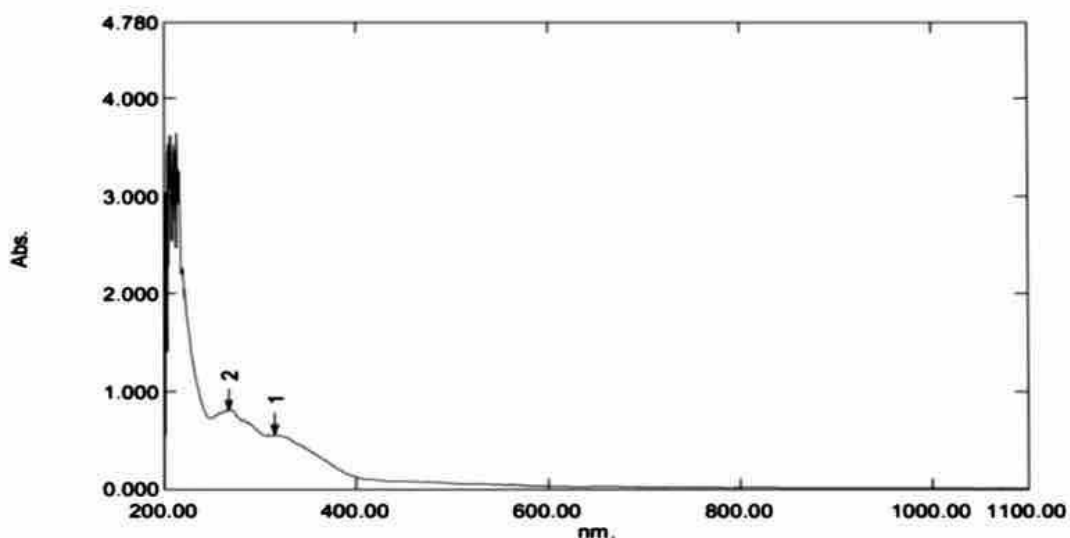


Fig 8: UV-VIS Spectrum of *Bougainvillea glabra* floral bract cold ethanol extract
Table 2: UV-VIS peak values of *Bougainvillea glabra* floral bract cold ethanol extract

No.	P/V	Wavelength	Abs.
1	↑	315.20	0.548
2	↑	266.80	0.810

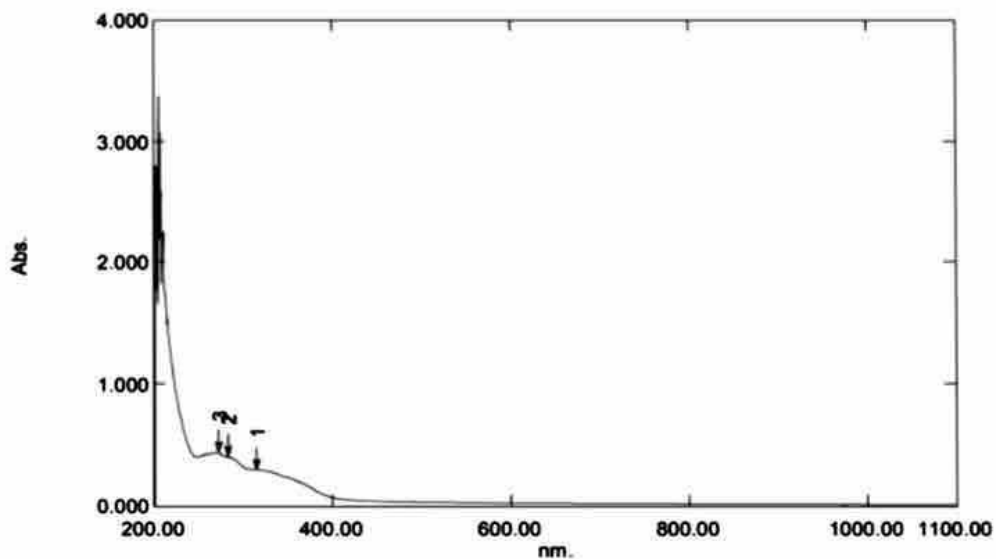


Fig 9: UV-VIS Spectrum of *Bougainvillea glabra* floral bract hot (Soxhlet) ethanol extract

Table 3: UV-VIS peak values of *Bougainvillea glabra* floral bract hot ethanol extract

No.	P/V	Wavelength	Abs.
1	↑	314.60	0.298
2	↑	283.20	0.402
3	↑	272.00	0.440

FTIR (Fourier Transform Infra-Red Spectroscopy) Analysis:

The FTIR spectrum was used to identify the functional groups of the active components present in the extract based on the peak values in the region of IR radiation. When the extract was passed through the FTIR, the functional groups of the components were separated based on their peak ratio. The results of FTIR analysis of aqueous, hot ethanol (Soxhlet) extract and cold ethanol extracts confirmed the presence of alcohol, phenol, alkanes, aldehydes, alkenes, and aromatic amines (fig.10,11,12 and Table 4). All three extracts showed the same frequency range, appearance of the vibration, and absorptions for functional groups.

Table 4: FTIR Peak values of *Bougainvillea glabra* floral bract extracts

S.N.	Peak Values in Aqueous extract (cm ⁻¹)	Peak Values in Soxhlet Extract (cm ⁻¹)	Peak Values in Cold Ethanol Extract (cm ⁻¹)	Stretching	Functional group
1	3361.00	3360.00	3361.93	O-H Stretching	Phenol/alcohol
2	2922.16	2922.16	2922.16	C-H Stretching	Alkane
3	2854.65	2856.58	2856.58	C-H Stretching	Alkane
4	1732.08	1732.08	1730.15	C=O Stretching	Aldehyde
5	1647.21	1647.21	1645.28	C=C Stretching	Alkene
6	1384.89	1388.75	1388.75	C-H Stretching	Alkane
7	1247.94	1242.16	1244.09	C-N Stretching	Aromatic amines

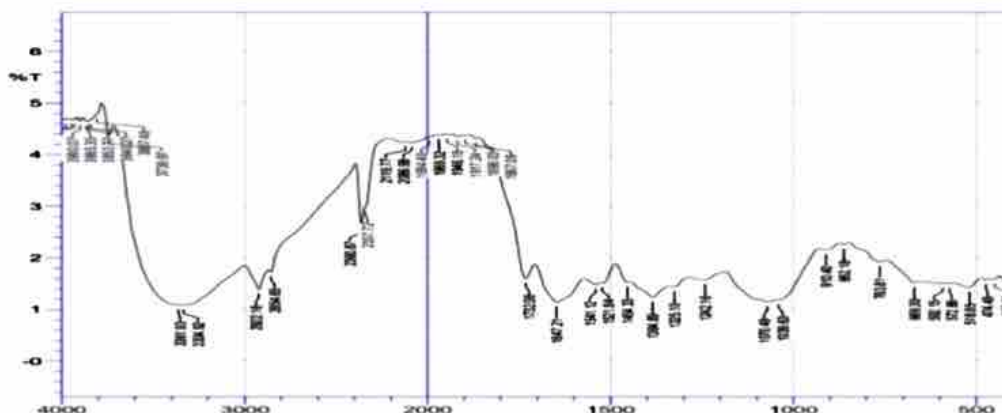


Fig. 10: FTIR Spectrum of *Bougainvillea glabra* floral bract aqueous extract

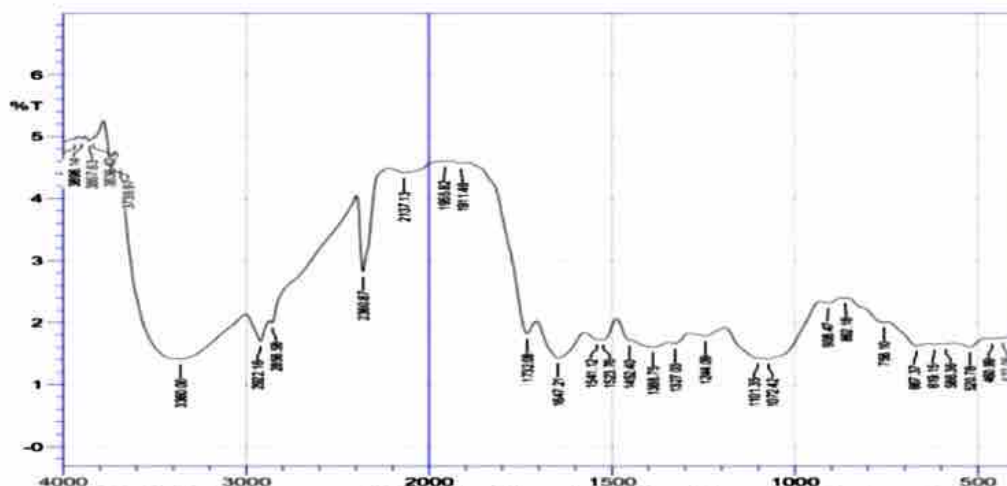


Fig. 11: FTIR Spectrum of *Bougainvillea glabra* floral bract cold ethanol extract

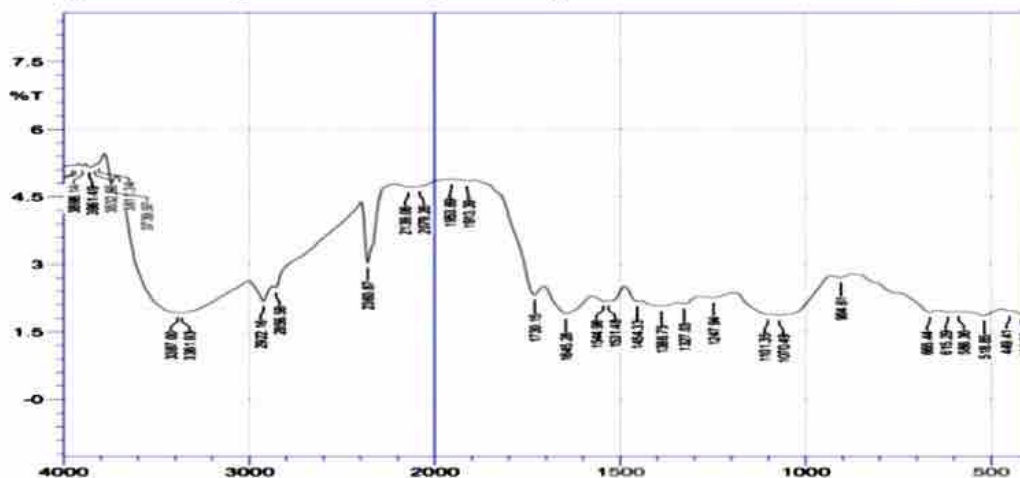


Fig. 12: FTIR Spectrum of *Bougainvillea glabra* floral bract Soxhlet extract

The IR spectrum of this plant extract shows the presence of OH groups and the UV-VIS spectrum of this plant extract shows absorption bands at 324 and 290 nm. These absorption bands are characteristic of flavonoids and their derivatives. The spectrum of flavonoids typically consists of two absorption maxima, one in the range 230–290 nm (band I) and the other in the case of flavones, in the range 300–350 nm (band II). The precise location and relative intensities of these maxima provide valuable information regarding the nature of the flavonoids. Analysis of the flower and bract extracts of the samples using FTIR and UV-VIS spectroscopy techniques revealed the presence of phenolic compounds and flavonoids, which can be isolated and further isolated depending on their therapeutic use. It has been shown that there are different types of biological activities that have been investigated. (Shivnarayan *et al.*, 2017). Further studies are required to clarify the structural analysis of flavonoid compounds using different analytical methods.

Phytochemical Screening:

Phytochemical screening is one of the methods used to explore bioactive compounds in plants. Phytochemicals are the individual chemicals from which plants are made and plants are a major source of raw materials for both the pharmaceutical and aromatic industries. Dyes are often used as crude extracts (extracts without isolation) for DSSC applications. There are a large number of plant components available in the crude extracts that contribute to absorbance and consequently the impact on dye sensitized solar cells. For this reason, a phytochemical

screening was conducted to study the effectiveness of the extraction methods. Phytochemicals such as quinones, anthraquinones, anthocyanins, and coumarins were the target compounds because they play very important roles to play in DSSC.

Table 3. Results of the preliminary phytochemical screening of the *Bougainvillea glabra* floral bracts crude extract

Phytochemicals	SHE	CE	AQ
Phenol	++	+	+
Anthocyanins	+	+	++
Quinones	-	-	+
Coumarins	+	+	+
Flavonoids	++	+	+
Carotenoids	+	+	-

*SHE-Soxhlet extract; CE-Cold Ethanol extract; AQ-Aqueous extract

*'+' & '-' indicates the presence or absence of phytoconstituents

Depending upon the extraction method, the trend of the presence of phytochemicals in all plant extracts are similar in both cold ethanol and Soxhlet hot ethanol extracts. The reason may be both the extraction methods used the same extraction solvent. The preliminary phytochemical screening showed the presence of anthocyanin in aqueous extract but the absorbance curves do not show any peak or elevation in the region within 460 – 550 nm where anthocyanins absorb (fig.5). Despite the high concentration of carotenoids in the ethanolic extract, the absorbance is very low. This indicates that carotenoids are not good enough in absorbing light. Flavonoids and phenols were found as the ubiquitous plant constituents in each sample .(Harborne,J.B.1973). Quinones produce yellow, red or brown coloration in plants and are very important in conversion of light into chemical energy (Delgado-Vargas,*et al.*,2000). Quinones in general are expected to absorb light between 420 – 430 nm (Reuch,W.2013) Carotenoids are involved in light absorption and energy transfer to the reaction centres (RC) complex and protection of the photosynthetic apparatus from damage by strong illumination.(Mimuro,*et al* 1991)Attempts have been made to apply carotenoids in DSSC.(Yamazaki *et al.*,2007) fabricated a DSSC using crocetin and crocin as photosensitizers from which crocetin performed the best with an IPCE of 0.56%. The absorption maximum depends on the number of conjugated bonds; it is around 450 nm for β -carotene .(Mimuro ,*et al.*, 1991)

Conclusion:

In the present study, three methods of extracting natural organic dyes (i.e. cold ethanol, Soxhlet hot ethanol, and aqueous methods) have been applied and analysed. Based on light absorption of the extracts, there was a slight difference between cold ethanol and Soxhlet hot ethanol. Although these two methods can be used interchangeably, other factors such as thermal degradation, time and ease of extraction, and availability of the apparatus must be considered. On the other hand, trend of absorbance of light were very similar for all the water extracts. Phytochemical screening demonstrated that the extraction method did not significantly affect the presence of organic compounds in individual samples. The findings showed that none of the three extraction methods is significantly better than the others. However, the difference in absorbance between water extracts and ethanol extracts may be due to differences in the concentration and nature of phytochemicals.

Acknowledgement:

The authors are grateful to Principal and Head, Department of Botany, VidyaBharati Mahavidyalaya, Amravati for their kind support and cooperation during the research work.

References:

1. Baeness, Mphade & Alexander, Pogrebnoi. (2014). Impact of Extraction Methods upon Light Absorbance of Natural Organic Dyes for Dye Sensitized Solar Cells Application. *Journal of energy and Natural Recourses* 3(3):38-45.
2. Delgado- Vargas, F., Jimenes, A. R., and Paredes Lopez, O. (2000). Natural Pigments: Carotenoids, Anthocyanins, and Betalains- Characteristics, Biosynthesis, Processing and Stability. *Critical Reviews in Food Science and Nutrition*. 40(3): pp.173-289.
3. Harborne, J. B. (1973). *Phytochemical Method: A guide to modern techniques of plant analysis*. New York: Chapman and Hall.279.
4. Kay, A. and Graetzel, M. (1993). Photosensitization of titania solar cells with chlorophyll derivatives and related natural porphyrins. *J. Phys.Chem.*,1144-1146.
5. Mimuro, M. and Katoh, T. (1991). Carotenoids in photosynthesis: absorption, transfer and dissipation of light energy. *Pure and Appl.Chem*.63(1): pp.123-130.
6. Sadasivam, S. and Manickam, A. (1996). *Biochemical Methods*. New Age International Publishers, New Delhi. 2, 154-155.
7. ShivNarayan Amitkumar, Sunil Kumar, Rityesh Govingsamy, Sharmila Chand, Drasekaran Muthukumaran (2017). Extraction optimization and characterization of water-soluble red purple pigment from floral bracts of *Bougainvillea glabra*. *Arabian Journal of Chemistry*, Volume 10: Pages S2145-S2150.
8. Yamazaki, E., Murayama, M., Nishikawa, N., Hashimoto, N., Hashimoto, N., Shoyama, M., and Kurita, O. (2007). Utilization of natural carotenoids as photosensitizer for dye-sensitized Solar cells. *Solar energy*.81(4): pp.512-516.

Plants are the treasure house of potential drugs, becoming potential source for phytoconstituents with varied pharmacological activities. Identification of such plants of potential use in medicine is of significance. Over one and a half million traditional healers use a wide range of medicinal plants for treating mild or chronic ailments of both humans and livestock across the length and breadth of the country. Today, safer use of natural plant based chemicals; crude compounds are gaining importance in medicine and pharmaceutical industry all over the world. The bioactive compounds have a great therapeutic potential providing the molecular basis for most of the drugs currently in clinical use, especially in cancer and infectious diseases. As traditional medicinal herbs are generally used crude extracts, so working with crude extracts means working with complex mixtures of biologically active compounds. These plants derived natural products or secondary metabolites are used as drugs and nutritional supplements. The findings of this investigations offer several benefits to human therapeutics and animal applications.



Monali Ghurde

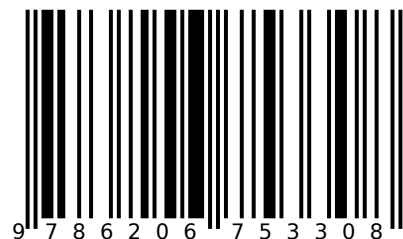
Phytochemical Evaluation of Some Medicinal Plants



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Qualitative Analysis of Phytochemicals in Leaf Extracts of *Dypsis lutescens*

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Abstract

The World Health Organization states that most people rely primarily on plants for their medical requirements. *Dypsis lutescens* commonly known as betel palm, catechu tree/palm, supari palm, Areca catechu or Areca Palm tree etc. This study was carried out to screen qualitatively the presence of phytochemicals in the leaf extracts of *Dypsis lutescens*. Solvents such as alcohol and water were used to extract the leaves and the presence of phytochemicals varies with the polarity of solvents. The study revealed the presence of phytochemicals such as such poly-phenolic compound, alkaloids, flavonoids, tannins, protein, Resin, fats etc. thereby, supported the use of leaves of plants in traditional medicine. This study indicates that the plant can be a valuable source for the creation of medications with specific effects.

Keywords: *Dypsis lutescens*, qualitative analysis, solvents, phytochemical tests.

Introduction

Phytochemical screening is to isolate various constituents of the plants in order to evaluate their biological activity or potential therapeutic applications. The medicinal value of plants is due to the presence of particular chemical substances that have a definite physiological action on the living system (Aslam et al., 2009). Plants are an essential part of biodiversity because they are essential to preserving the environmental balance and ecological stability of the planet (Ashvin Godghate A. & Sawant R., 2013).

Dypsis lutescens is commonly known as Areca Palm, betel palm, catechu tree/palm, supari Palm, Areca catechu tree etc. Areca Palm is a perennial evergreen plant which belongs to Aceraceae Family. It is widely distributed throughout South Asia, including the Philippines, Thailand, Vietnam, Bangladesh, Myanmar, India, and China. Many consumers feel that eating areca nut can help with digestion and have a euphoric (joyful/excited) effect, according to data from numerous research papers. (Tiwari S., & Talreja S., 2020). Palms are among the best known and most extensively cultivated plant families. They have been important to humans throughout much of history. Palms are among the most commercially significant plants since they are utilized in landscaping and the production of numerous everyday goods and foods. (Aranda-Jiménez Yolanda G et al., 2020). In many historical cultures, palms were symbols for such ideas as victory, peace, and fertility.

Material and Method

Collection and identification of plant material:

Fresh plant part of *Dypsis lutescens* were collected from the Botanical Garden of Vidya Bharati Mahavidyalaya, Amravati during the month of March. The collected plant materials were identified with the help of 'flora of Amravati District' (Dhore M. A. 1986).

Preparation of extract:

Leaves were dried in moisture free rooms and then dried and stored. After drying, it is grinded into powdered form after that it was subjected to successive extraction with Ethanol and Water by using homogenization method. This was done by adding powder to the solvent mixed for few minutes and kept in an orbital shaker for about 24 hours. The prepared extracts were tested chemically for detection of primary and secondary metabolites.

Qualitative Phytochemical Analysis for Primary Metabolites**Test for carbohydrates****1. Benedict's test**

About 0.5 ml of the filtrate was taken to which 0.5 ml of Benedict's reagent is added. This mixture was heated for about 2 minutes in a boiling water bath. The appearance of red precipitate indicates the presence of sugars.

2. Molisch's test

To about 2ml of the sample, 2 drops of alcoholic solution of α -naphthol was added and to the mixture after being shaken well. Few drops of conc.H₂SO₄ were added along the sides of the test tube. A violet ring indicates the presence of sugars.

Test for starch

To about 5 ml of distilled water, 0.01g of iodine and 0.075 g of potassium iodide were added and this solution was added to about 2-3 ml of the extract. Formation of blue colour indicates the presence of starch

Test for proteins

To about 2 ml of the extract, 2ml of miller's reagent was added white precipitate which turns red on heating will confirm the presence of proteins.

Test for amino acids

To 2ml of extract few drops of nitric acid were added along the sides of the tube the appearance of yellow colour indicates the presence of protein and free amino acids,

Test for fatty acids

1 ml of the extract was mixed with 5 ml of ether. These extracts were allowed to evaporate on a filter paper and the filter paper was dried. The appearance of transparency indicates the presence of fatty oils.

Miscellaneous compounds**Test for resins**

Precipitation test: about 0.2 g of extract was extracted with 15ml of 95% ethanol. The alcoholic extract was then poured into a beaker containing about 20ml of distilled water.

Test for fixed oils and fats

Spot test: small quantity of the extract was taken and pressed between 2 filter papers. The appearance of spots indicates presence of oils.

Test for gums and mucilage

To 1ml of extract, distilled water, 2ml of absolute ethanol was added with constant stirring white or cloudy precipitate indicates the presence of gums or mucilage.

Carboxylic acids

To 1ml of extract a pinch of sodium bicarbonate is added. The production of effervescence indicates the presence of carboxylic acids.

Qualitative Phytochemical Analysis for Secondary Metabolites**Test for alkaloids**

1. Mayer's test to a few ml of filtrate, 2 drops Mayer's reagent was added a creamy or white precipitate shows a positive result for alkaloids.

2. Wagner's test (iodine - potassium iodine reagent) To about an ml of extract few drops of Wagner's reagent were added. Reddish - brown precipitate indicates presence of alkaloids.

Test for glycosides

Borntrager's test: To 2ml of filtrate, 3ml of chloroform is added and shaken. The chloroform layer is separated and 10% ammonia solution was added. The pink colour indicates the presence of glycosides.

Test for phenol

Gelatine test: To 5ml of extract 2ml of 1% solution of gelatine containing 10% of NaCl is added. Appearance of white precipitate indicates the presence of phenol

Test for Terpenoids (Salkowski test)

3ml of the extract was taken and 1ml of chloroform and 1.5 ml of concentrated H₂SO₄, are added along the sides of the tube. The reddish-brown colour in the interface is considered positive for the presence of terpenoids

Test for anthraquinones

To 5ml of extract, few ml of conc.H₂SO₄, was added and 1ml of diluted ammonia was added to it. The appearance of rose pink confirms the presence of anthraquinone.

Test for tannins

To 5 ml of extract few drops of neutral 5% ferric chloride solution was added, the production of dark green colour indicates the presence of tannins.

Test for saponins

0.5 mg of extract was vigorously shaken with few ml of distilled water. The formation of frothing is positive for saponins.

Test for xanthoproteins

1 ml of extract is taken and to these few drops of nitric acid and ammonia are added. Reddish brown precipitate indicates the presence of xanthoproteins

Test for Flavonoids

1. To the aqueous solution of the extracts 10% ammonia solution is added and is heated. The production of fluorescence yellow is positive for flavonoids.

Test for quinones

To 1ml of extract, alcoholic KOH is added the presence of red to blue colour indicates the presence of quinones

Test for chalcones

2ml of ammonium hydroxide is added to 0.5 g of extract. The appearance of red colour indicates the presence chalcones.

Test for anthocyanins

2ml of aqueous extract was taken to which 2N HCl was added and it was followed by the addition of ammonia, the conversion of pink-red turns blue-violet indicates the presence of anthocyanins.

Test for Coumarins

To 2 ml of the extract, 3 ml of 10% aqueous solution of NaOH is added. The production of yellow colour indicates the presence of coumarins.

Test for polyphenols

To the 3ml of extracts 10ml of ethanol was added and were warmed in a water bath for 15 minutes. To this few drop of ferric cyanide (freshly prepared) was added. The formation of blue green colour indicates presence of polyphenols.

Observation**Table 1: Qualitative analysis of primary metabolites of leaf extract of *Dypsis lutescens***

Sr. No.	Constituents	Chemical Test	Extract	
			D/w	E
1.	Carbohydrates	Benedict's test	-	+
		Molisch's test	-	-
2.	Proteins	Million's test	+	+
3.	Resin	Precipitation test	+	-
4.	Fixed oil and fats	Spot test	+	-
5.	Carboxylicacid		-	+
6.	Starch		+	+
7.	Fattyacid		+	+
8.	Aminoacid		+	+
9. 9	Gumand mucilage		+	-

Table 2: Qualitative analysis of Secondary metabolites of leaf extract of *Dypsis lutescens*

Sr. No.	Constituents	Chemical Test	Extract	
			D/w	E
1.	Alkaloid	Mayer's test	+	+
		Wagner's test	+	+
2.	Glycoside	Bontrager's test	-	+
3.	Phenol	Gelatin test	+	+
4.	Terpenoids	Salkowski test	-	+
5.	Anthraquinones		-	-
6.	Tannin		+	+
7.	Saponin		-	+
8.	Xanthoproteins		+	-
9.	Flavonoid		+	-
10.	Quinones		-	-
11.	Chalcones		-	-
12.	Anthocyanin		-	-
13.	Coumarin		+	+
14.	Polyphenols		+	+

(Where, D/w= Distilled water, E= Ethanol)

Result and Discussion

The present study deals with the Qualitative Phytochemical Screening of aqueous and ethanolic extract of leaves of *Dypsis lutescens*. The detailed investigations of phytochemicals in both the solvents are shown in table no. 1 and 2. The investigation revealed the presence of Alkaloids, Phenols, Tannins, Flavonoids, Xanthoproteins, Coumarins and Polyphenols in aqueous extract whereas the presence of Alkaloids, Glycosides, Phenols, Terpenoids, Tannins, Saponins, Coumarins and Polyphenols in ethanolic extract. Studies done by Tiwari S. & Talreja S, 2020 supported our findings. Anthraquinone, Quinone, Chalcone and Anthocyanins were completely absent in both aqueous and ethanolic leaf extract. Suryaprakash D. V. et al., 2022 showed that *Dypsis lutescens* contains various phytochemicals especially secondary metabolites like tannins, phenolic acids, flavonoids, terpenoids, alkaloids, coumarins and saponins etc. These phytochemicals are played as medicinal properties and acts as anti-oxidants to control disorders and the plant exhibits a wide range of pharmacological properties, including anti-tumor, anti-platelet, atheroprotective effects, neuroprotective actions and fibrinolytic effects etc. Chiduruppa M. et al., 2018 also worked on Phytochemical Screening of *D. lutescens* (Golden cane palm) and revealed presence of flavonoids, tannins, lignans, triterpenes and steroids. Ali H. Abu Almaaty et al., 2022 reported that *D. lutescens* is widely used as an ornamental plant, which possesses strong antioxidant and anti-cancer activities.

Conclusion

Phytochemicals found in plants are a valuable resource for drugs and medical products. The present study concludes that the qualitative phytochemical analysis of aqueous and ethanolic leaf extract indicates the presence of alkaloids, flavonoids, saponins, phenols, Terpenoids, coumarins, polyphenols and tannins. The findings of our study show that the plant extract has antibacterial, antifungal, cytotoxic and antioxidant activity due to the presence of various phytochemicals in the plant extracts.

References

1. Ali H. Abu Almaaty, Sarah Keshk, Amira Galal, Osama A. Abbas, Mohamed K. Hassan (2022). Medicinal usage of some Arecaceae family members with potential anticancer effect. *Journal of Biotech Research*. Vol. 13: pp 55-63.
2. Aranda-Jiménez Yolanda G., Zuñiga-Leal Carlos, Fuentes-Perez Carlos A., Suárez-Dominguez Edgardo J., (2020). Physical Properties of the Stem of *Dypsis lutescens* and *Chrysalidocarpus lutescens* as a Vernacular Roofing Material. *Civil Engineering and Architecture* Vol. 8(4): pp. 641-645.
3. Aslam, F., Khalil-ur-Rehman, M.A., Sarwar, M., (2009). Antibacterial activity of various phytoconstituents of neem. *Pak. J. Agri. Sci.*, Vol. 46(3).
4. Balamurugan V., Sheerin Fatima. M. A., Velurajan S. (2019). A Guide to Phytochemical Analysis. *International Journal of Advance Research and Innovative Ideas in Education*. Vol. 5(1): pp 236-245.
5. Chiduruppa M, Opera BM, Nadu T. A detailed review on *Dypsislutescens* (Arecaceae). *WJPPS* 2018; 10(7): pp 1644–1650.
6. Dhore M. A. (1986). *Flora of Amravati District*.
7. Godghate A. and Sawant R., (2013). Qualitative Phytochemical Analysis of Chloroform Extract of Leaves of *AdhathodaVasica* Nees. *Rasayan J. Chem*. Vol. 6(2): pp 107-110
8. Ibrahim H. A., Elsharawy F. A., Elhassab M., Shabana S., Haggag E. G. (2020). Phytochemical Screening and Biological Evaluation of *Dypsis Leptocheilos* Leaves Extract and Molecular Docking Study of the Isolated Compounds. *International Journal of Pharmacy and Pharmaceutical Sciences*. Vol. 12(11): pp 106-113.
9. Surya prakash D. V., Vatsala Upadhyay, Akhil Dhar, Asad Khan (2022). Studies on Phytochemical analysis of Areca Palm Leaves. *International Journal of Chemical Separation Technology*. Vol. 8(1)
10. Tiwari S., and Talreja S., (2020). A Pharmacological and Medicinal Study of Areca Palm and Nuts: An Overview. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*. Vol. 11(5): pp 100-108

Preliminary Studies on Air Pollution Tolerance Index (APTI) of Some Plant Species in Amravati Region

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Abstract

In this modern world, the quality of air is getting decline day by day by vehicle emission, rapid industrialization, agricultural practices etc. and air pollution is a serious concern throughout the world. Air pollution has a negative effect on human health and it is responsible for physiological changes in plants as well. Plants have a vital role in reducing air pollution because they are capable of absorbing pollutants. In the present study, to calculate air pollution tolerance index (APTI) six plants i.e. *Saraca asoka*, *Ficus religiosa*, *Ficus benghalensis*, *Pongamia pinnata*, *Terminalia catappa*, *Alstonia scholaris* were collected from Urban and Rural areas of Amravati District region and analysed for different parameters. Among the plants studied, *Ficus religiosa* showed highest APTI value i.e. 19.93 while *Alstonia scholaris* showed lowest APTI value i.e. 11.68. The present study revealed that the assessments of above mention index with high APTI are significant in the reduction of urban air pollution and green belt designing.

Keywords: Air Pollution Tolerance Index, Ascorbic Acid, Chlorophyll Content, Relative Water Content, Amravati Region

Introduction

Air pollution levels are increasing day by day due to increasing population, industrialization, urbanization and the alarming increase in the vehicle fleet, etc. Although technology, society, and the provision of multiple goods and services all benefited greatly from the industrial revolution, it also brought about the production of massive amounts of airborne pollutants that are detrimental to human health. (Manisalidis et al., 2020). Air pollution has become a significant issue in the degradation of the environment because it raises concentration of gases and introduces suspended particulate matter into the atmosphere. (Panda and Aggarawal, 2018). Tree species provides an enormous surface area and effectively absorb air pollutants, acting as a sink for those pollutants. (Vyankatesh and Bosle Arjun, 2014). Decreasing air pollution through vegetation is one of the excellent natural method for clearing the atmosphere (Balasubramaniyan et al., 2018).

APTI is the intrinsic quality of plants to counter air pollution stress, which is currently a main concern, particularly in industrial environments. Therefore, the APTI needs to be monitored and varified in predominant species that are present in polluted and non-polluted areas (Rai et al., 2013). The Changes happening due to pollutants in the atmosphere is directly proportional to the change in the biochemical parameter such as pH, relative water content, ascorbic acid and total chlorophyll. The possibility of damage can be calculated as the overall effect of pollutants. Air Pollution Tolerance Index (APTI), can indicate to us the potential of vegetation and crops to encounter the changes occurring due to air pollution (Chaubey et al., 2021).

In the present study, four parameters (ascorbic acid, total chlorophyll content, relative water content, and active acidity) were identified and expressed together in one formula to evaluate the sensitivity of plants to air pollutants (Kotecha et al., 2007). Plant's reaction to air pollution is determined by the air pollution tolerance index (APTI) and APTI determines the

plant's ability to fight against air pollution (Vinita et al., 2010). Therefore, to improve air quality and minimize the pollution in the Amravati region, the APTI was evaluated, and the air pollution resistant species were identified (Gholami et al., 2016). The trees having higher tolerance index rate are tolerant towards air pollution and can be used as a source to control air pollution, whereas the trees having less tolerance index can be used as an indicator to know the rate of air pollution (Kaveri et al., 2023).

Material and Method

Study Area

The present study was carried out in Amravati which is the second largest city in the Vidarbha region and ninth largest city in Maharashtra, India. Amravati is located at 20.93°N 77.75°E. It has an average elevation of 343 meters (1125 feet). It lies 156 km (97 mi) west of Nagpur. Amravati has a tropical wet and dry climate with hot, dry summers and mild to cool winters. Summer lasts from March to June, monsoon season from July to October, and winter from November to March. The average ambient temperature remains 26.9 °C varies from 10.5 to 44.2. The average relative humidity remains around 57.8%, varies from 14.2% to 98.1%.

Sampling and analytical method

The present study was conducted on six plant species, namely, *Saraca asoka*, *Ficus religiosa*, *Ficus benghalensis*, *Pongamia pinnata*, *Terminalia catappa*, *Alstonia scholaris* to evaluate their APTIs. Six plant species were selected during summer season of 2023. This study conducted plant sampling in two areas: Urban and Rural. Samples were collected from selected trees. Samples were then mixed and transported to the laboratory. The active acidity of the leaf extract was measured by a digital pH meter; the amount of ascorbic acid was measured by titration method 2 and 6 dichlorophenolindophenol; the content of relative water of the leaf was measured by weight method; and the total chlorophyll content was measured by a spectrophotometer after extraction with 80% acetone (Amini et al., 2009). The APTI was calculated by the following formula (Sing and Rao, 1983).

$$APTI = \frac{A(T+P)+R}{10}$$

Where,

A= Ascorbic acid content (mg/g)

T= Total chlorophyll (mg/g)

P = pH of leaf extract

R = Relative Water Content of leaf (%)

Result and Discussion

Biochemical characteristics (pH, relative water content, total chlorophyll content and ascorbic acid) and Air Pollution Tolerance Index (APTI) of selected plant species from the Urban and Rural area of Amravati District are as shown in table:

Table no. 1 Biochemical parameters along with APTI of selected plant species from Urban area

Plant Species	PH	RWC (%)	Total Chlorophyll (mg/g)	Ascorbic Acid (mg/g)	APTI
<i>Saraca asoka</i>	8.0	89.82	5.60	4.12	14.59
<i>Ficus religiosa</i>	6.9	82.75	4.27	6.6	15.60
<i>Ficus benghalensis</i>	6.5	83.73	3.09	5.4	13.50
<i>Pongamia pinnata</i>	7.9	88.44	4.13	3.6	13.16

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<i>Terminalia catappa</i>	6.4	78.46	4.90	6.8	15.53
<i>Alstonia scholaris</i>	5.6	75.54	5.09	3.9	11.68

Table no. 2 Biochemical parameters along with APTI of selected plant species from Rural area

Plant Species	PH	RWC (%)	Total Chlorophyll (mg/g)	Ascorbic Acid (mg/g)	APTI
<i>Saraca asoka</i>	7.8	72.33	4.71	6.6	15.5
<i>Ficus religiosa</i>	6.3	89.87	5.86	9.0	19.93
<i>Ficus benghalensis</i>	6.2	91.75	4.93	5.8	15.6
<i>Pongamia pinnata</i>	7.3	86.43	5.40	7.2	17.8
<i>Terminalia catappa</i>	6.9	90.82	5.94	5.3	15.86
<i>Alstonia scholaris</i>	5.9	83.68	4.36	4.2	12.67

pH of leaf extract: There are so many factors controlling tolerance in plants. Plants with lower pH are more susceptible, while those with pH around 7 are more tolerant (Singh et al., 1991). *Saraca asoka* showed highest pH 8.0 and 7.8 in Urban and Rural region respectively while, *Alstonia scholaris* showed lowest pH 5.6 and 5.9 in Urban and Rural region respectively. Out of six selected plants, 4 plants showed acidic pH and 2 plants showed acidic pH.

Relative Water Content: RWC of a leaf is the water present in it relative to its full turgidity. High water content within the plant body helps to maintain its physiological balance under stress conditions such as exposure to air pollution when the transpiration rates are usually high. It also serves as an indicator of drought resistance in plants. (Kaur et al., 2021) The lowest water content observed in *Saraca asoka* i.e. 72.33% collected from Urban region and highest water content observed in *Ficus benghalensis* i.e. 91.75% collected from Rural region.

Ascorbic acid content: Ascorbic acid is an antioxidant that increases the resistance of plants against pollutant (Deepalakshmi et al., 2013). Tree species with high amount of ascorbic acid are considered to be tolerant to air pollutants (Kumar et al., 2018). In the present study, *Terminalia catappa* showed lowest amount of ascorbic acid content while *Ficus religiosa* showed highest amount of ascorbic acid content.

Total Chlorophyll content: The chlorophyll content decreases with increasing pollutant level because certain pollutants generally reduce the total chlorophyll content. Santosh et al. (2008) reported that a high amount of chlorophyll in plants increases air pollution tolerance. The lowest amount of total chlorophyll was observed in *Ficus benghalensis* (3.09) from Urban area and *Alstonia scholaris* (4.36) from Rural area while the highest amount of total chlorophyll was observed in *Saraca asoka* (5.60) from urban area and *Terminalia catappa* (5.94) from rural area.

Air pollution tolerance index (APTI): The APTI values were estimated using the four biochemical parameters in plant leaves, namely, RWC, total chlorophyll content, pH, and ascorbic acid value. They can be used as predictors of air quality. Plants with APTI value ≤ 11 are considered to be sensitive, while those with APTI value ranged from 12 to 16 classified as intermediate, and APTI value of ≥ 17 are known to be tolerant (Bharti et al., 2018, 1991). The APTI values calculated for each plant species are presented in table 1 and 2 for Urban and Rural study areas.

In the present study, APTI value varies from 11.68 to 19.93 and the maximum APTI was shown by *Ficus religiosa* in both Urban and Rural area. Similar observations were made by a study conducted by Kour and Raina, 2014; while observing the APTI values of various plant species, *Ficus religiosa* was found to be comparatively more tolerant and displayed the highest APTI value. Among the six plants studied, *Saraca asoka*, *Ficus benghalensis*, *Terminalia catappa*, *Alstonia scholaris* falls under the intermediate category as their APTI values range from 12 to 16 while *Ficus religiosa* and *Pongamia pinnata* falls under the tolerant category. Nayak et al., 2018 mentioned that the level of APTI varies from species to species depending on the capacity of plants to the effect of pollutants without showing any external damage.

Conclusion

Air Pollution Tolerance Index determination is crucial since the pollution load is rising due to an increase in small-scale industries, urbanization, and vehicle traffic. Vegetation naturally purifies the atmosphere by absorption of gases and some particulate matter through leaves. The present study was done to investigate tolerance of different plant species against air pollution in Amravati. From two different sites amongst 6 plants screened for Urban and Rural area *Ficus religiosa* shows highest APTI value and *Alstonia scholaris* shows lowest APTI.

In the present study it was found that, as per APTI value, the tolerant species are *Ficus religiosa*, and *Terminalia catappa*, hence these species can be cultivated along the road side as they are least effected by the pollutants. Tolerant plant species can help managing ecosystem services and enhancing the local urban ecology, along with minimizing and lowering the harmful health effects of ongoing exposure to air pollution.

References

1. Amini, H., M.M. Sadegheyan, M. Arajshiravani, and A. Banitaba (2009). Assessment of air pollution tolerable index for some plant species considered for green belt development in the city of Isfahan. Proc. natl. conf. of new ideas in agriculture, Isfahan, Iran. pp. 57-60.
2. Balasubramanian A, Prasath CNH, Gobalakrishnan K, Radhakrishnan S. (2018). Air pollution tolerance index (APTI) assessment in tree species of Coimbatore urban city, Tamil Nadu, India. Int J Env Clim Change Vol. 8: 27-38.
3. Bharti, Sushil Kumar, Arti Trivedi, and Narendra Kumar (2018) Air pollution tolerance index of plants growing near an indus trial site. Urban climate vol. 24 :820-829
4. Chaubey S., Palathingal Trisa and Bhagat S. S. (2021) Study of Air Pollution Tolerance Index (APTI) of Some Plants in Vasai-Virar location (Palghar district). Journal of Emerging technologies and Innovative Research. Vol 8(8): d563-d568
5. Deepalakshmi A.P., Ramakrishnaiah H., Ramachandra Y.L., Radhika R.N. (2013) "Roadside Plants as Bio-indicators of Urban Air Pollution". IOSR J. of Environ. Sci. Toxic. And Food Tech. (IOSR-JESTFT), Vol. 3: 10-14.
6. Gholami, A. Mojiri and H. Amini (2016) Investigation of the Air Pollution Tolerance Index (APTI) using Some Plant Species in Ahvaz Region. The Journal of Animal & Plant Sciences, 26(2): 475-480.
7. Ioannis Manisalidis, Elisavet Stavropoulou, Agathangelos Stavropoulos and Eugenia Bezirtzoglou (2020). Environmental and Health Impacts of Air Pollution: A Review. Frontiers in Public Health Vol. 8(14).
8. Kaur L. and Anuradha (2021). Preliminary Studies on Air Pollution Tolerance Index (APTI) of Selected Plant Species in Bikaner City. Environment & Ecosystem Science (EES) 5(2): 117-120.

9. Kaveri I and Jayalakshmi M (2023) Air Pollution Tolerance Index (Apti) of Selected Trees from Vimala College Campus. *International Journal of Creative Research Thoughts*. Vol 11(4): d400-d407.
10. Kotecha, M., K. Naik, and L. Abraham (2007). Study of Air pollution tolerable index (APTII) and distribution pattern by using importance value index (IVI) of plants in disturbed and undisturbed locality around Anand city (INDIA). *Carpathi. J. Earth and Environ. Sci.* 9(1): 115-120.
11. Kour, B. and Raina, A.K. (2014). Assessment of air pollution tolerance levels of some plant species of Jammu. *Environment Conservation Journal*, Vol. 15(1/2): 89-93
12. Kumar M., Alezona, Nandini N. (2018). Comparative Assessment of Air Pollution Tolerance Index of selected Tree Species of Bengaluru, India. *International Journal of Scientific Research and Multidisciplinary Studies*. Vol.4(11): 25-29
13. Nayak, Anjali; Madan, Sangeeta and Matta, Gagan (2018). Evaluation of Air Pollution Tolerance Index (APTII) and Anticipated Performance Index (API) of Some Plants Species in Haridwar City. *International Journal for Environmental Rehabilitation and Conservation*. Vol. 9(1): 1-7
14. Panda LRL, Aggarwal RK. (2018) Assessment of air pollution tolerance index and anticipated performance index of plants growing alongside the roads in sub- temperate condition of Himachal Pradesh, India. *Int J Cur Microbial App Sci* Vol. 7:79-93.
15. Rai, P.K., L.S.S. Panda, B.M. Chutia, and M.M. Singh (2013). Comparative assessment of air pollution tolerance index (APTII) in the industrial (Rourkela) and non-industrial area (Aizawl) of India: An Eco management approach. *African J. Environ. Sci. and Tech.* 7(10): 944-948.
16. Santosh, K., Prajapati B. and Tripathi D. (2008). Anticipated Performance Index of some tree species considered for green belt development in and around an urban area: A case study of Varanasi city, India. *J. Environ. Manage.* Vol. 88: 1343–1349.
17. Singh S.K., Rao D.N., Agrawal M., Pandey J., Narayan (1991) "Air pollution Tolerance index of Plants". *J. Environ. Manag.* Vol. 32: 45-55.
18. Singh, S.K. and D.N. Rao (1983). Evaluation of plants for their tolerance to air pollution. *Proc. Int. Symp. on air pollution control. IIT Delhi* pp. 218-224.
19. Vinita, P., B.D. Tripathi and V.K. Mishra (2010). Evaluation of Anticipated Performance Index of some tree species for green belt development to mitigate traffic generated noise. *UFUG-25195; No. of Pages 6.*
20. Vyankatesh B., Bosle Arjun B. (2014) "Air pollution tolerance index of various plant species around Nanded City, Maharashtra, India", *Journal of Applied Phytotechnology in Environmental Sanitation*, Vol.3(1): 23-28.

Effect of Gibberellic Acid on Seed Germination and Metabolism in *Brassica juncea* L.

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Abstract:

Gibberellic Acid Increases Secondary Metabolite Production in *Brassica juncea* seeds. Gibberellic acid (GA3) is reported to have diverse effects on seed germination and growth of *Brassica juncea*. Therefore, the effects of GA3 on the growth, germination, primary metabolite (protein), and secondary metabolite (chlorophyll) production. Three concentrations of GA3, ranging from 25 ppm to 75 ppm, as well as a control, were used for investigation. The moderate GA(3) concentration of 75 ppm and the control, resulted in the highest concentrations of germination in both the 7 and 14-day treatments. High shoot and root lengths were observed in the 75 ppm concentration of 14-day germinated seedlings. Additionally, carbohydrates, chlorophyll, and protein varied in 25 ppm, 50 ppm, 75 ppm, and control groups. This study demonstrates that supplementation with GA(3) may be an excellent strategy to optimize the production of secondary metabolites from *B. juncea*. However, GA(3) is a critical factor.

Keywords: *B. juncea*, GA3, germination, chlorophyll, carbohydrates, and protein.

Introduction:

The plant hormones abscisic acid (ABA), gibberellins (GA), ethylene, brassinosteroids (BR), auxin, cytokinins, and other signaling molecules have profound effects on plant development at vanishingly low concentrations. They are chemical messengers for communication among cells, tissues, and organs of higher plants. Seeds of higher plants contain an embryo surrounded by covering layers and function to ensure the establishment of a new plant generation. Plant growth regulators play an important role in plant development, improving yield, and enhancing the quality of seeds. Low temperature is an abiotic environmental factor that affects plant growth, geographical distribution, and crop yields. Gibberellic acid (GA3) is a PGR that enhances seed germination, growth, stem elongation, photosynthesis, flowering, and cell expansion due to its phytohormonal function [1, 2]. Studies have shown that gibberellic acid has the capability to improve growth, flowering, photosynthesis, nutrient transport, and yield of mustard [3, 4]. GA3 has been reported to increase seed germination percentage and seedling growth in *Cicer arietinum* under PEG-induced water stress (Kaur S et al., 1998 and Kaur S et al., 2000). GA3 pre-treatment affected the germination rate, germination potential, hypocotyl length, and radicle length. With an increasing GA3 concentration, these indices first increased and then decreased. For seedling physiology characteristics in hemp, GA3 pretreatment significantly increased the osmotic regulating substances (soluble sugar and soluble protein contents) and the activities of antioxidant enzymes (SOD, superoxide dismutase, and POD, peroxidase), while sharply decreasing the lipid peroxidation (malondialdehyde, MDA) in seedlings grown under PEG-6000-induced drought stress (5).

Indian mustard (*Brassica juncea* L.) is one of the most important oil seed crop belonging to the family Brassicaceae and the genus *Brassica*. Among the edible oilseeds

cultivated, mustard ranks second after groundnut in India, and its contribution to the total oilseed acreage and production is 23.7% and 26.0%, respectively. The present study investigates the effect of GA3 on Brassica for studying different parameters, including Such as:

1. Seed germination %.
2. Root shoot length.
3. carbohydrate content.
4. Protein content.
5. Chlorophyll content.

Materials and Methods: For this study, a laboratory experiment was conducted using a single variety of Brassica and varying concentrations of the plant growth hormone, gibberellic acid. The seeds were treated with varying concentrations of 25, 50, 75, and 100 ppm of GA. The seeds of Brassica were soaked in varying concentrations of GA3, 50, 75 and 100ppm. for 18 hours, the seeds were transferred for germination. After germination, plantlets were collected from the soil at 7 and 14-day intervals to study the germination rate, percentage, and secondary metabolites.

OBSERVATION AND RESULT

Effect of GA3 concentrations on the germination of *B.juncea*: In the 7-day time period, both germination and vigor index showed the maximum value in the control group, with 50, and 75 ppm concentrations showing an increase. In the 14-day time period, the germination percentage was highest in the control group, but there was a change in the vigour index, with the 25 ppm having the highest value. Table No. 1. Showing germination and vigor index.

Table No. 1 Effect of GA3 on the germination percentage and vigor index of Brassica

Concentration in ppm	Treatment duration	No. of seed sowed	No. of seed germinate			
			After 7 days of sowing		After 14 days of Sowing	
			Germination	vigor	Germination	vigor
25	18	50	27.00%	3.20	50.00%	17.50
50		50	30.00%	8.81	20.00%	119.51
70		50	31.00%	7.93	31.00%	5.07
control		50	45.00%	17.40	80.00%	17.62

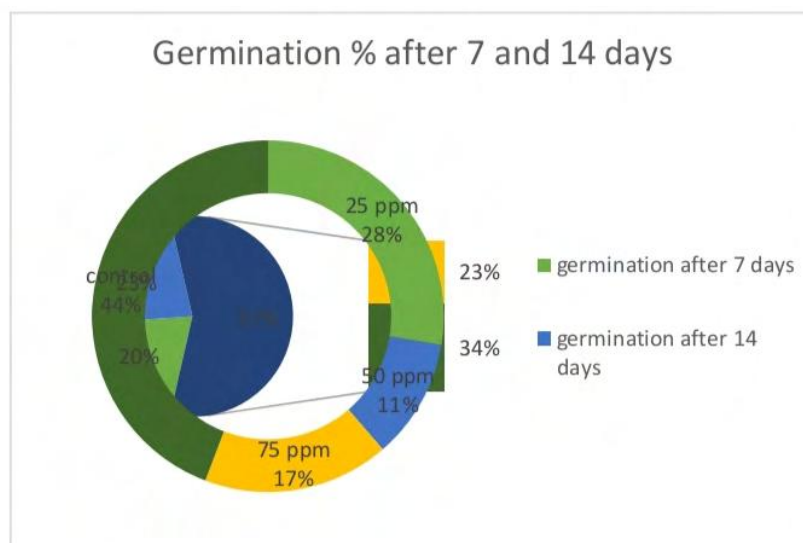


Fig1. Germination percentage of *B.juncea* seeds after 7 and 14 days

Shoot and root length of *B.juncea* after 7 and 14 Days :

Present study revealed that the shoot and root length of Brassica after 7 and 14 days varied. On 7 days germination, the highest root and shoot lengths were observed in 50ppm, which is 2.5cm and 4.2cm, respectively. after 14 days highest root length was observed in 50ppm, which is 4.8cm, and the highest shoot length was observed in 25ppm i.e. 2.1cm. Nearly similar results were observed by (Wareing et al., 1968). The increase in germination may be due to the antagonistic effect of gibberellic acid on germination, and endogenous gibberellins were reported to increase due to soaking (7). The minimum shoot and root lengths were observed in 75 ppm concentration on both the 7th and 14 days.

Table No.2 Shoot and Root lengthon 7 and 14 days

Concentration in PPM	7DAYS		14DAYS	
	Root	Shoot	Root	Shoot
25ppm	3.1cm	3.5cm	2.2 cm	2.1cm
50ppm	2.5cm	4.2 cm	4.8 cm	5.1cm
75ppm	3 cm	4.6cm	5.4cm	5.7cm

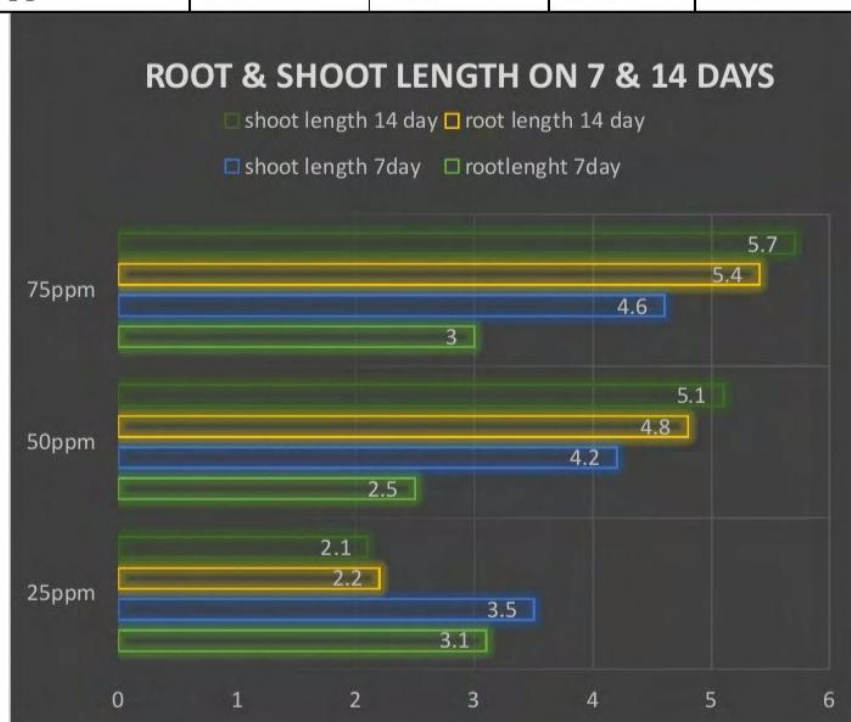


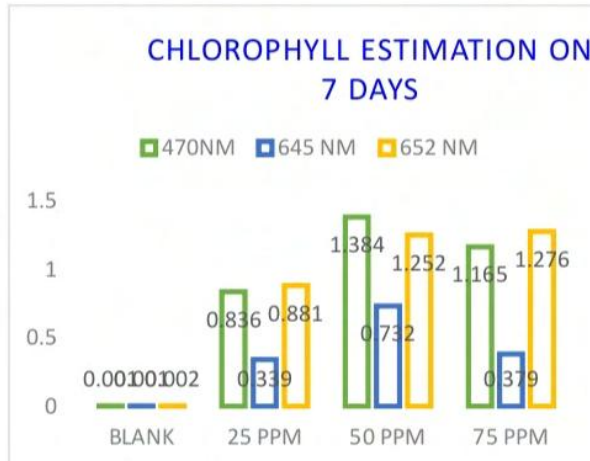
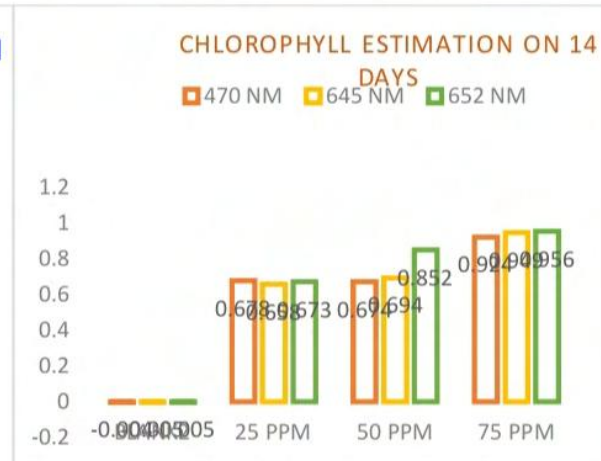
Figure 2: shoot and root lengths on the 7th and 14th days

Effect of GA3 concentration on chlorophyll content of *Brassica juncea* .

The seeds were treated with various concentrations of GA3 for 18 hours and then sown in soil after intervals of 7 and 14 days. Plantlets were collected, and several physiological tests were conducted, including chlorophyll analysis, carbohydrate, and protein tests (8). After 7 and 14 days intervals, chlorophyll estimation was observed at wavelengths 645 nm and 470 nm. And maximum absorbance recorded in 470nm i.e. 1.384nm in 50PPM concentration, which was recorded 1.384nm in control and 652nm on 7 days 0.881. The application of GA3 significantly increased the chlorophyll content compared to the corresponding treatments without GA3 application. The maximum increase in chlorophyll content was recorded by GA3P + GA3FS(Kashif Shahzad, Sadam Hussain *et.al.*2021)

Table No. 3: Estimation of chlorophyll on 7th and 14th days in *B.juncea*

Concentration in PPM	7 days			14 days		
	Wavelength			Wavelength		
	470nm	645nm	652nm	470nm	645nm	652nm
Blank	0.001	0.001	0.002	-0.004	-0.005	-0.005
25 PPM	0.836	0.339	0.881	0.678	0.658	0.673
50 PPM	1.384	0.732	1.252	0.674	0.694	0.852
75 PPM	1.165	0.379	1.276	0.924	0.949	0.956

**Fig.:3: Chlorophyll Estimation on Day 7 Days****Fig.:4: Chlorophyll Estimation on Day 14 Days****Effect of GA3 on the protein content of Brassica:**

Protein estimation was carried out using the standard method by Manickam and Sadashivam . On 7 days after seed germination protein estimation carried out which showing highest protein value in 25 PPM concentration at 645 nm i.e. 0.339 then after in 50 PPM that is 0.732 at 645nm and least value are observed in blank and 25 PPM and 75 PPM i.e. 1.165 and 0.379. Fayaz Asad1 , Naveen Dilawaret.al 2022 observed that Maximum proline content was observed for treatment 20ppm NaCl+20ppm GA3, while sugar records showed little variations between the treatments whereas higher value recorded for 10ppm NaCl+40ppm GA3. The lower value of Asad et al. 646 sugar content was recorded in 10ppm NaCl+40ppm GA3. After 14 days the maximum protein amount was found in 25 PPM and 75 PPM, with at 645 nm and 470 nm and absorbance are 0.339 and 1.165 and lowest readings were observed in blank (control) and 652nm 0.002. The total soluble protein significantly increased under GA3 application, with the maximum values recorded for GA3P + GA3FS indicating that the application of GA3 as seed priming and foliar spray effectively enhances soluble protein under salinity stress (Kashif Shahzad, Sadam Hussain *et.al.* 2021).

Table no.4: estimation of Chlorophyll from *B.juncea* on 7th and 14th days

Concentration in ppm	Treatment duration	Wave length of 7 days germinated seed				Wave length of 14 days germinated seed			
		470 nm	645 nm	652 nm	663 nm	470 nm	645 nm	652 nm	663 nm
Blank	18 hours	0.001	0.001	0.001	0.002	-0.001	-0.001	-0.002	0.002
25 ppm		0.836	0.339	0.881	1.114	-0.001	-2.444	2.500	2.570
50 ppm		1.384	0.732	1.252	2.108	0.117	0.917	0.942	0.112
70 ppm		1.165	0.379	1.276	1.31	1.309	0.851	1.260	2.109

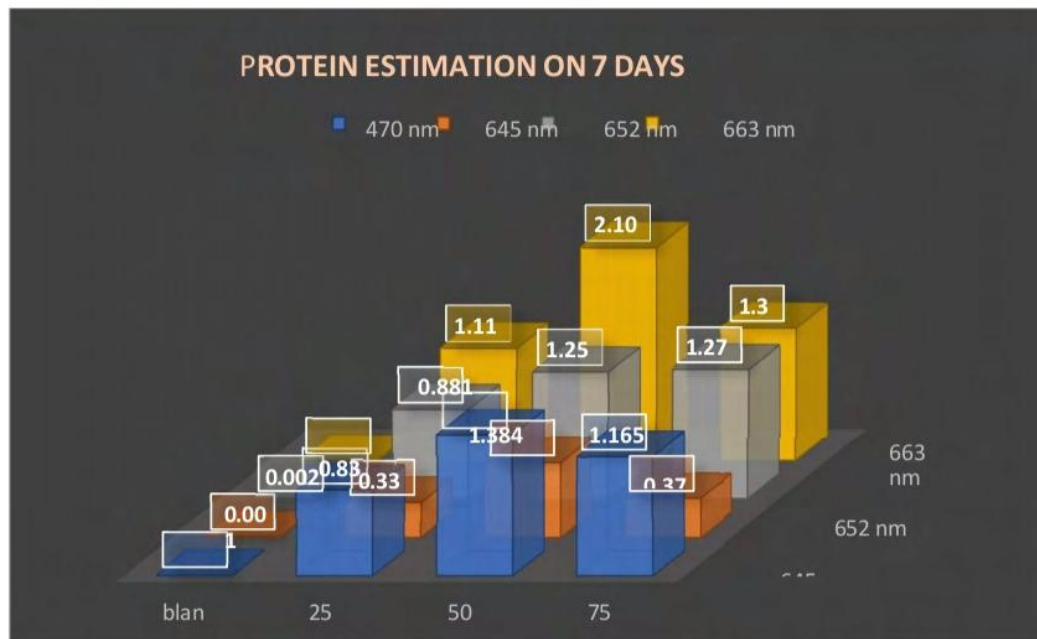


Fig:5 -Protein estimation on 7th day of germination

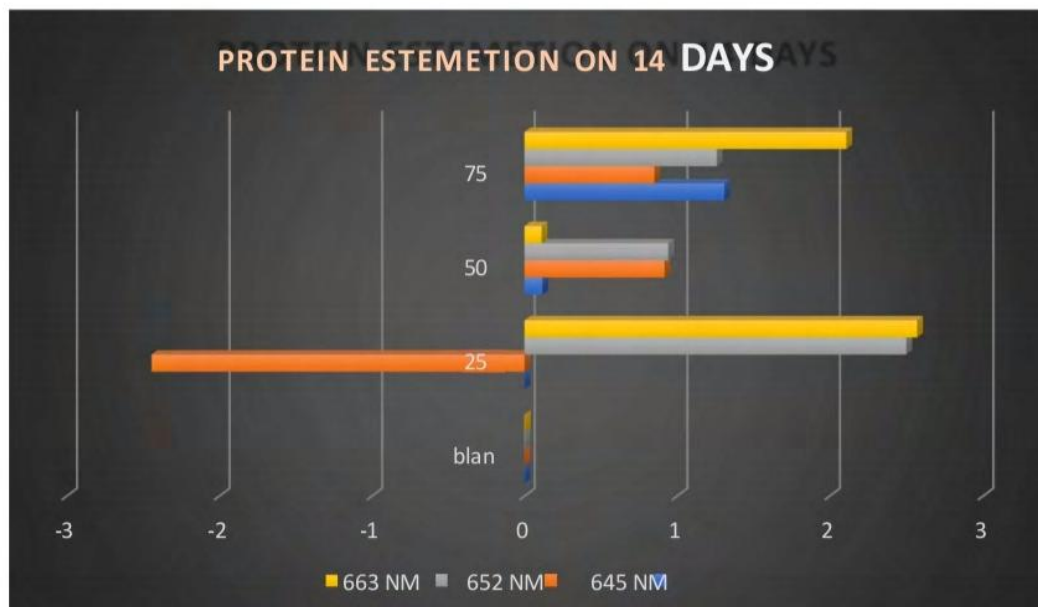


Fig: 6- Protein estimation on 14th day of germination

Effect of GA3 concentration on the carbohydrate content of *B.juncea*

In this investigation, seeds were soaked in GA3 for 18 hours. After germination, the estimation of carbohydrates was carried out. Absorbance was recorded at 630nm on the 7th and 14th days germinated seedlings by Manickam and Sadashivam. The maximum absorbance was recorded on concentration of 25 ppm, i.e. 0.954nm and the lowest absorbance was recorded in 75ppm i.e. 0.516nm, on 14 days germinated seed, the maximum absorbance was recorded in 50ppm concentration i.e. 0.517nm and the lowest absorbance was 0.419nm in 25ppm. (Abd El-Monem, A.A. (2007); El-Bassiouny, H. M. S.; Mostafa *et.al* 2008 and Hassanein R.A *et.al*. 2008) observed that The highest values of seeds mineral nutrients, carbohydrates, and total crude protein contents were gained by foliar spray with arginine at 300 ppm. These results could be supported by the results obtained by^(8,9,10) who indicated that arginine is the most effective compound for increasing soluble carbohydrates, polysaccharides, total carbohydrates,

proline, total amino acid and protein contents of wheat plants and grains under normal or stressed conditions.

Table no.5 : Estimation of carbohydrates on 7th days and 14th days

Concentration in ppm	Treatment duration	Carbohydrate estimation	
		On 7 days at 630nm	On 14 days at 630nm
blank	18 hr	-0.003nm	-0.001nm
25		0.954nm	0.419nm
50		0.692nm	0.517nm
75		0.634nm	0.516nm

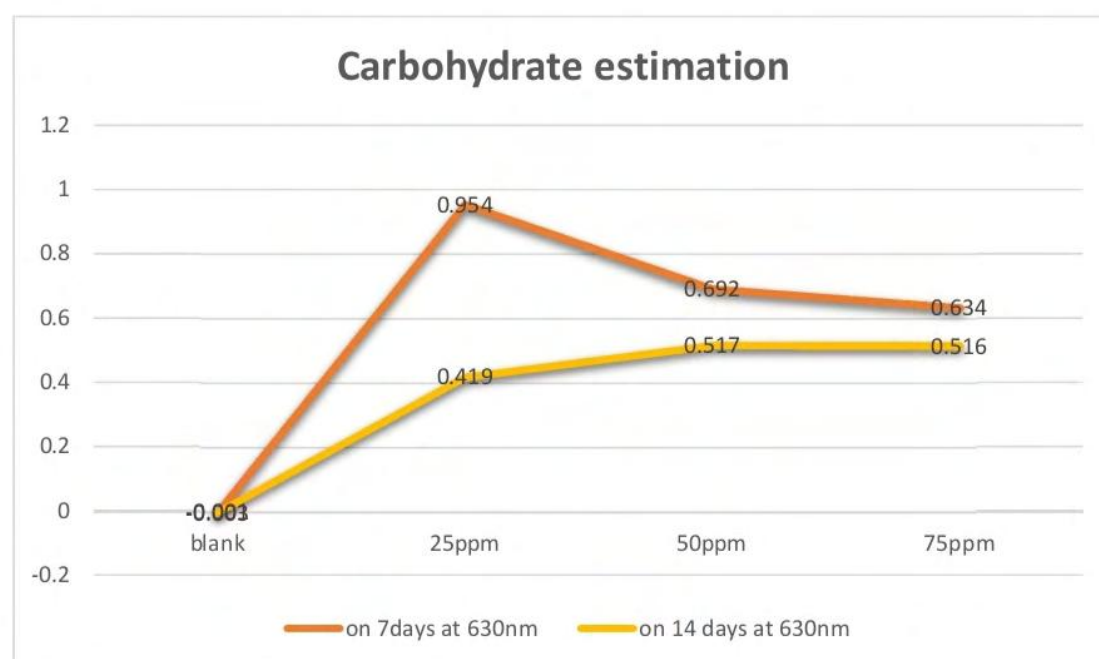


Fig: 7- Carbohydrate estimation on 7th and 14th day of germination.

Conclusion: Above investigation was carried out using phytohormones and observed their effect on plant growth and phytochemicals like carbohydrates, protein and chlorophyll and record was observed on 7 and 14 days interval period and it concludes that GA3 shows variation in growth and amount of metabolites.

Acknowledgement: I would like to express my deepest appreciation to the Head of the Department of Botany and all teaching and non-teaching faculty members of the department for their support.

References:

1. Taiz L, Zeiger E. Plant physiology. Sunderland, MA: Sinauer Associates 2010.
2. Yuan L, Xu DQ. Stimulation effect of gibberellic acid short-term treatment on leaf photosynthesis. Photosynthesis Research 2011;6:39-47.
3. Hayat S, Ahmad A, Mobin M, Fariduddin Q, Azam ZM. Carbonic anhydrase, photosynthesis and seed yield in mustard plants treated with phytohormones. Photosynthetica 2001;39(1):111-114.

4. Khan NA, Mobin M. The influence of gibberellic acid and sulfur fertilization rate on growth and S-use efficiency of mustard (*Brassica juncea*). *Plant and Soil*, 2005;270(1):269-274.
5. Effects of Gibberellin Pre-Treatment on Seed Germination and Seedling Physiology Characteristics in Industrial Hemp under Drought Stress Condition. *Life (Basel)*. 2022 Nov; 12(11): 1907. Published online 2022 Nov 16. doi: 10.3390/life12111907.
6. Mathur, M.M., 1971. Response of *Allium cepa*. L. transplants to different plant growth regulators. *Indian J. Hortic.*, 28: 296-300.
7. Biochemical Methods by A Sadasivam, S; Manickam, New age International Publication Exogenously Applied Gibberellic Acid Enhances Growth and Salinity Stress Tolerance of Maize through Modulating the Morpho-Physiological, Biochemical and Molecular Attributes Kashif Shahzad, Sadam Hussain, 2,3, † Muhammad Arfan, 1 Saddam Hussain, 2, * Ejaz Ahmad Waraich, 2 Shahid Zamir, 2 Maham Saddique, 1 Abdur Rauf, 4 Khaled Y. Kamal, 5 Christophe Hano, 6 and Mohamed A. El-Esawi, 7, *. *Biomolecules*. 2021 Jul; 11(7): 1005. Published online 2021 Jul doi: [10.3390/biom11071005](https://doi.org/10.3390/biom11071005)
8. Abd El-Monem, A.A. (2007). Polyamines as modulators of wheat growth, metabolism and reproductive development under high temperature stress. Ph.D. Thesis, Ain Shamas Univ., Cairo, Egypt
9. El-Bassiouny, H. M. S.; Mostafa, H. A.; El-Khawas, S. A.; Hassanein, R. A.; Khalil, S. I.; Abd El-Monem, A. A. (2008): Physiological responses of wheat plant to foliar treatments with arginine or putrescine. *Austr. J. of Basic and Applied Sci.*, 2(4): 1390- 1403.
10. Hassanein R.A., S.I. Khalil, H.M.S. El-Bassiouny, H.A.M., Mostafa, S.A. El-Khawas and A.A. Abd El-Monem (2008). Protective role of exogenous arginine or putrescine treatments on heat shocked wheat plant. 1st. International Conference on Biological and Environmental Sciences, Hurghada, Egypt, pp: 13-16.

Arbuscular mycorrhizal fungi diversity in coal mine soil of *Datura metal* at Chandrapur district

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ABSTRACT: An investigation was carried out on the species diversity of arbuscular mycorrhizal (AM) fungi in contaminated soils. Samples were analyzed for physicochemical parameters, including P^H, temperature, texture, sulfur, silica, and phosphorus, and it was concluded that AM fungi are known to enhance plant tolerance capacity in different stress conditions. A study was undertaken to assess the influence of coal mines on mycorrhizal colonization and revealed that mycorrhizal colonization and mycorrhizal spores are significantly positively correlated with various physicochemical properties in the contaminated soil. The results revealed that *Glomus* was the most dominant isolated mycorrhizal genus with 13 species, *Acualospora* having 06 species, *Scutellospora*-01 species, *Sclerocystis*-01 species, and *Entrophosphora*-01 species. This is because areas with heavy metallic elements in soil adversely affect the richness and diversity of AM fungal species.

Keywords: Contaminated rhizospheric soil, physicochemical analysis, AM isolation, AM spore species.

INTRODUCTION

AMF have played an important role in the evolution of land plants for more than four hundred million years ⁽¹⁾, AMF can enhance tolerance of abiotic stresses such as drought and metal toxicity ⁽²⁾. Therefore, it is evident that AMF are an important associate for crop plants in sustainable agriculture. Mycorrhizal fungi are known to affect the growth of most plant species in mine degraded areas, but in normal soil regions, plants, despite their ability to live independently, may increase nutrient uptake, growth, and reproductive success when associated with AM. Moreover, AMF improves soil quality ⁽³⁾ and enhances the ability of host plants to withstand abiotic stress and disease ⁽⁴⁾, thereby increasing plant performance ⁽⁵⁾. Coal is the most abundant fossil fuel on Earth and accounts for about 75 % of the total fuel resources ⁽⁶⁾. These mine-degraded soils are a man-made habitat that presents a wide range of problems for establishing and maintaining a vegetation cover ⁽⁷⁾. Mining activities exert lasting effects on ecosystems, both through structural changes and impacts on biodiversity. Mining activities produce wastes that may contain heavy metals as contaminants. These residues are generally deposited on the ground and often occupy large extensions. However, plants often have very limited development in contaminated areas. Due to their beneficial effects on plant growth under stressed conditions, AMF have been used to enhance the rehabilitation of contaminated soils through phytoremediation ⁽⁸⁾, and the beneficial role of vesicular arbuscular mycorrhizae in mine spoils is revegetation.

MATERIAL AND METHODS: The soil sample was collected from the coal mine spoil region at the Durgapur opencast coal mine site (E 20°, N 79°) at Chandrapur, Maharashtra State, India.

Fig.1- India, Fig.2-Maharashtra, Fig.3-Vidarbha, Fig.4-Chandrapur, Fig.5- Coal Mine Area



Fig.1



Fig.2

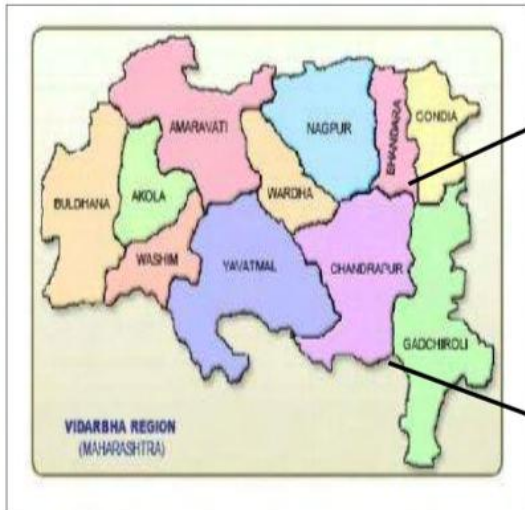


Fig.3



Fig.4

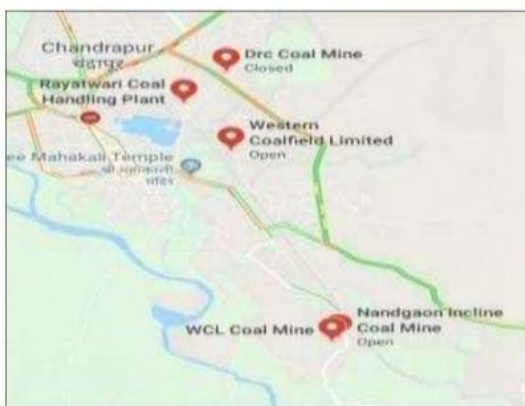


Fig.5

SAMPLING AND ANALYSIS:

The rhizosphere soil of *Datura metel*-contaminated region at Chandrapur were collected in sterile polythene bags. The collection was carried out from the Durgapur opencast coal mine region of Chandrapur district. The collected soil sample had different soil textures like sandy, sandy loamy, loamy, clay, and clay loamy. The rhizosphere soil sample was packed in clean sterile polythene bags, dried, and stored at room temperature.



Fig:6 A-Durgapur opencast mine-Chandrapur, B-Contaminated soil sample, and C-Rhizospheric sample

QUALITATIVE AND QUANTITATIVE ESTIMATION OF VAM FUNGI:

Different methods are used for counting AM fungal spores. The procedure described by Gaur and Adholeya 1994⁽⁹⁾ was used for counting AM spores as it is a simplified method for counting AM fungal spores. This method is used to count AM fungal spores in soil samples as follows. Various methods are used to isolate VAM spores from soil samples. In this study, the wet sieving and decanting technique was used ⁽¹⁰⁾. Photographs illustrating the different characteristic structures of VAM fungal species, such as the wall layers arrangement of spores in sporocarp, loose sporocarp, and other details, were taken using an electron microscope. An electron microscope with an attached Pentax thousand camera (magnification 40x and 10x). The VAM fungi are identified using the manual of Schenck and Perez 1990 ⁽¹¹⁾, keys of Morton and Benny 1990 ⁽¹²⁾ and the keys of Mehrotra and Bajjal 1994 ⁽¹³⁾.

MINERAL TESTS FOR SOIL:-

In the present work, different mineral tests were also carried out using polluted soil from the mine region at Chandrapur, including the Sulphur test ⁽¹⁴⁾, Silica test ⁽¹⁵⁾, and Phosphorus test ⁽¹⁶⁾.

OBSERVATIONS AND RESULTS:

The soil samples collected had varying textures, identified through the sieving technique, and their pH was measured using a pH meter. The collected data are in Table No.1.

Table No.1-Soil analysis of rhizospheric soil.

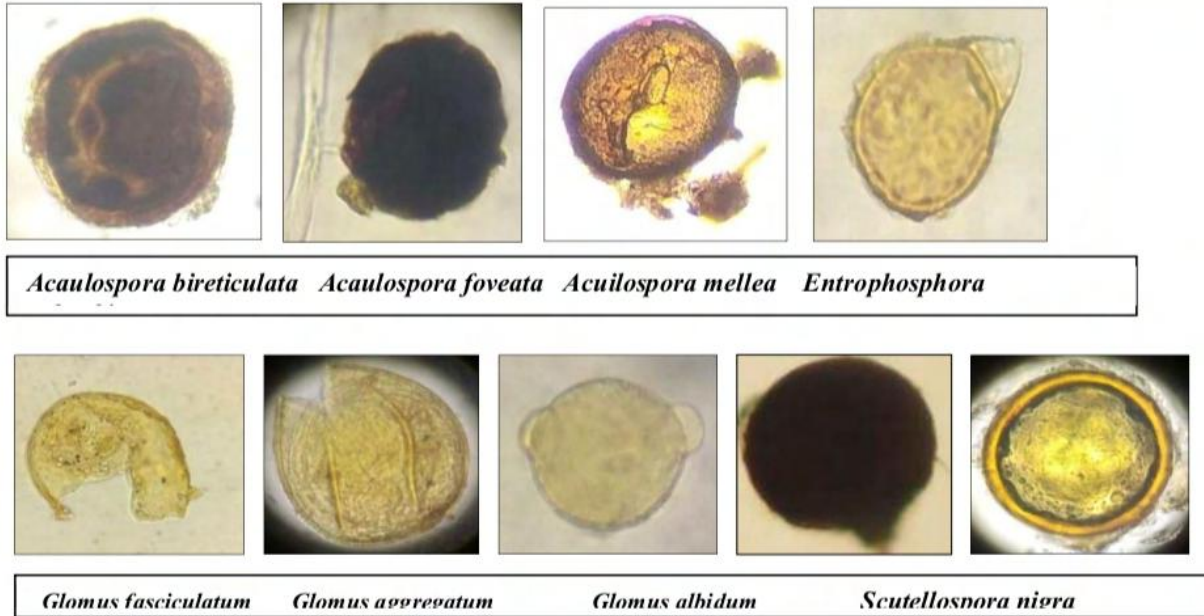
Sr.No.	Site Name	PH	Temperature	Soil Texture and			
				Sandy	Loamy	Clay	Fine
1	Chandrapur-coal mine area	7.4	25°C	1mm	0.600mm	0.090mm	0.053mm

QUALITATIVE ANALYSIS:

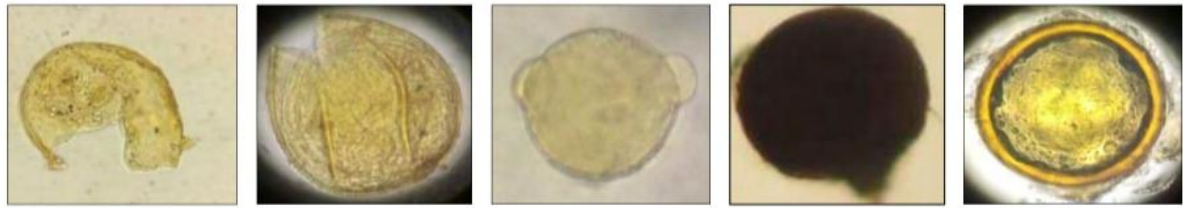
AM fungi stimulate plant growth by aiding in nutrient absorption. In the present study, plant samples were collected from the mining region of Chandrapur area, and the rate of AM fungi for plant growth and development was measured. The following data was recorded in Table No. 2

Table No.2 Identified species with diameters in μm in the coal mine area at Chandrapur.

Sr. No.	Slide No.	Identified species	Diameter μm	Number of species
1.	S1	<i>Glomus aggregatum</i>	82.63 μm	<i>Glomus</i> – 1 species
		<i>Scutellospora nigra</i>	57.31 μm	<i>Scutellospora</i> – 1 species
2.	S2	<i>Glomus reticulatum</i>	220.14 μm	<i>Glomus</i> – 1 species
		<i>Acaulospora foveata</i>	178.50 μm	<i>Acaulospora</i> – 1 species
		<i>Scutellospora nigra</i>	65.41 μm	<i>Scutellospora</i> – 1 species
3.	S3	<i>Glomus globiferum</i>	80.80 μm	<i>Glomus</i> – 2 species
		<i>Glomus reticulatum</i>	195.21 μm	
4.	S4	<i>Glomus fragilistratum</i>	56.08 μm	<i>Glomus</i> – 1 species
		<i>Scutellospora nigra</i>	60.02 μm	<i>Scutellospora</i> – 1 species
5.	S5	<i>Acaulospora taiwania</i>	70.24 μm	<i>Acaulospora</i> – 1 species
6.	S6	<i>Glomus halon</i>	141.21 μm	<i>Glomus</i> – 1 species
7.	S7	<i>Glomus aggregatum</i>	227.02 μm	<i>Glomus</i> – 1 species
		<i>Acaulospora mellea</i>	157.18 μm	<i>Acaulospora</i> – 1 species
8.	S8	<i>Acaulospora taiwania</i>	297.05 μm	<i>Acaulospora</i> – 1 species
		<i>Glomus aggregatum</i>	97.24 μm	<i>Glomus</i> – 1 species
9.	S9	<i>Acaulospora longula</i>	180.68 μm	<i>Acaulospora</i> – 1 species
10.	S10	<i>Glomus tenerum</i>	73.01 μm	<i>Glomus</i> – 2 species
		<i>Glomus fasciculatum</i>	69.42 μm	
11.	S11	<i>Glomus gerdimannii</i>	82.54 μm	<i>Glomus</i> – 1 species
12.	S12	<i>Sclerocystis coremioides</i>	79.33 μm	<i>Sclerocystis</i> – 1 species
13.	S13	<i>Acaulospora longula</i>	180.68 μm	<i>Acaulospora</i> – 1 species
		<i>Glomus albidum</i>	97.23 μm	<i>Glomus</i> – 1 species
		<i>Entrophospora</i>	26.24 μm	<i>Entrophospora</i> – 1
14.	S14	<i>Scutellospora nigra</i>	121.44 μm	<i>Scutellospora</i> – 1 species
15.	S15	<i>Acaulospora foveata</i>	104.98 μm	<i>Acaulospora</i> – 1 species
16.	S16	<i>Acaulospora scrobiculata</i>	115.67 μm	<i>Acaulospora</i> – 1 species
		<i>Glomus fecundisporum</i>	92.25 μm	<i>Glomus</i> – 2 species
		<i>Glomus diaphanum</i>	88.47 μm	
17.	S17	<i>Glomus fasciculatum</i>	89.26 μm	<i>Glomus</i> – 2 species
		<i>Glomus globiferum</i>	78.56 μm	
18.	S18	<i>Glomus fasciculatum</i>	125.36 μm	<i>Glomus</i> – 1 species
19.	S19	<i>Glomus criticola</i>	59.23 μm	<i>Glomus</i> – 2 species
		<i>Glomus globiferum</i>	86.48 μm	
20.	S20	<i>Glomus globiferum</i>	94.35 μm	<i>Glomus</i> – 2 species
		<i>Glomus aggregatum</i>	85.26 μm	
21.	S21	<i>Acaulospora denticulatum</i>	76.94 μm	<i>Acaulospora</i> – 1 species
22.	S22	<i>Glomus clarum</i>	48.67 μm	<i>Glomus</i> – 2 species
		<i>Glomus albidum</i>	125.47 μm	
23.	S23	<i>Acaulosporadenticulatum</i>	52.87 μm	<i>Acaulospora</i> –1 species
		<i>Glomus citricola</i>	78.16 μm	<i>Glomus</i> – 1 species
24.	S24	<i>Glomus citricola</i>	68.15 μm	<i>Glomus</i> – 2 species
		<i>Glomus fasciculatum</i>	49.32 μm	
25.	S25	<i>Glomus fasciculatum</i>	73.45 μm	<i>Glomus</i> – 1 species



Acaulospora bireticulata *Acaulospora foveata* *Acaulospora mellea* *Entrophospora*



Glomus fasciculatum *Glomus aggregatum* *Glomus albidum* *Scutellospora nigra*

Fig 6: Observed and identified Am spores:

QUANTIFICATION:

Quantitative analysis revealed that the number of isolated spore species varies according to their tolerance capacity in polluted regions. This study, it was revealed that *Glomus* species were dominant in the mine region compared to others, as observed in Table No.3.

Table No.3 Quantitative analysis of identified species in coal mine soil

Sr. No.	Name of Species	Number of species in coal mine soil
1	<i>Glomus</i>	13
2	<i>Acaulospora</i>	06
3	<i>Scutellospora</i>	01
4	<i>Sclerocystis</i>	01
5	<i>Entrophospora</i>	01



Fig 07: Quantification data of AM species in coal mine soil and normal soil.

MINERAL ANALYSIS:

Soil analysis is very important for plant growth and productivity, in the present work mining soil are used for various mineral test viz. Sulphur test, Silica Test and Phosphorous test for observing their amount in soil and growth rate of plant are as follow.

Table No.4 Mineral analysis of both collected soil samples

Sr.No.	Name of site	Mineral test Analysis		
		Sulphur Test	Silica test	Phosphorus Test
1	Coal Mine soil	21.77 mg/L	At 650 nm =0.011	33.045 ppm.

CONCLUSION:

Opencast mining, which is the main form of coal mining in India. In this area, plant growth is generally futile due to high temperatures and P^H, water shortages, and a lack of minerals. AM fungi play an important role in plant growth. Several environmental variables affect the occurrence and distribution of AM spore density in different soil profiles and their root infection status.

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REFERENCES:

1. Remy W, Taylor TN, Hass H, Kerp H. Four hundred million-year-old vesicular-arbuscular mycorrhizae. USA. 1994; 91: 11841±11843. PMID:11607500.
2. Meharg A.A., and J.W.G. Cairney., 2000. Co-evolution of mycorrhizal symbionts and their hosts to metal-contaminated environments. *Advances in Ecological Research*. 30: 69-112.
3. Smith SE, Read DJ (2008) *Mycorrhizal symbiosis*. 3rd ed. New York: Academic Press
4. Singh LP, Gill SS, Tuteja N. Unraveling the role of fungal symbionts in plant abiotic stress tolerance. *Plant Signal Behav*. 2011; 6: 175±191.
5. Berruti A, Lumini E, Balestrini R, Bianciotto V. Arbuscular mycorrhizal fungi as natural biofertilizers: Let's benefit from past successes. *Front Microbiol*. 2016; 6: 1559. doi: 10.3389/fmicb.2015.01559. PMID:26834714
6. Elliott MA. *Chemistry of coal utilization: second supplementary volume*. New York, United States: John Wiley and Sons; 1981
7. Maiti, S. K. 1997. Importance of VAM fungi in coal mine overburden reclamation and factors affecting their establishment on overburden dumps. *Environment and Ecology*. 15(3): 602-608.
8. Mathur N, Bohra JSS, Quaizi A, Vyas A. (2007) Arbuscular mycorrhizal fungi: a potential tool for phytoremediation. *J Plant Sci.*; 2:127-140.
9. Gaur A., Adoleya; (1994). Estimation of VAMF spores in soil Mycorrhiza. A modified method. *Mycorrhiza News*. 6: 10-11.
10. Gerdemann, J.W. 1968. Vesicular-arbuscular mycorrhizae and plant growth. *Ann. Rev. Phytopathol*. 6:397-418.
11. Schenck and Perez; (1990). *A manual for identification of vesicular arbuscular mycorrhizal fungi*. 3rd Edn. Synergistic Publication, Gainesville. Florida. USA: p. 286.
12. Morton, J. B. & Benny, G. L. (1990). Revised classification of arbuscular mycorrhizal fungi (Zygomycetes) : A new order, Glomales, two new suborders, Glomineae and Gigasporineae, and

- two new families, Acaulosporaceae and Gigasporaceae, with an emendation of Glomaceae. *Mycotaxon* 37, 471±491
13. Mehrotra, V.S. and Bajjal, U. 1995. Effect of single and mixed inocula of VAM fungi on the growth and field of sunflower (*Helianthus annuus* L.). *Philippina J. Sci.*, 124(2): 183-201.
 14. Experiment Plant Ecology book by Pratima Kapur / Sudha Rani Govil.
 15. Book of Analytical Chemistry by Gurdeep R. Chatwal.
 16. Chandak Nisha, Maiti Barnali, Pathan Shabana, Desai Meena, and Kamlesh Shah; 2017. Analysis of Soil Samples for its Physico-Chemical Parameters from Kadi City. *NEWEST INTERNATIONAL REFERRED JOURNALS* ISSN:2349-3372, Researchgate.
 17. Dhritiman Chanda, G.D.Sharma, and D.K.Jha; 2014. Isolation and identification of some Arbuscular Mycorrhiza (AM) fungi for phytoremediation in soil contaminated with paper mill effluent.
 18. Khalid Lubna P1 and Pulate P. arbuscular Mycorrhizal biodiversity associated with *Citrus aurentifolia* from Amravati region. *Int. J. of Life Science*, 2019; 7(2):229-235 ISSN:2320-7817(p) | 2320-964X(o).
 19. Jasper, D. A., Robson, A. D., and Pulate P. K. (1987). The effect of surface mining on the infectivity of vesicular-arbuscular mycorrhizal fungi. *Australian Journal of Botany*, 35, 641–652.
 20. Jasper, D., Abbott, L., and Robson, A. (1989a). The loss of VA mycorrhizal infectivity during bauxite mining may limit the growth of *Acacia pulchella* R. Br. *Australian Journal of Botany*, 37, 33–42.
 21. Meharg, A. A., and Cairney, J. W. G. (1999). Co-evolution of mycorrhizal symbionts and their hosts to metal-contaminated environments. *Advances in Ecological Research*, 30, 69–112..
 22. Bhuiyan MAH, Parvez L, Islam MA, Dampare SB, Suzuki S. Heavy metal pollution of coal mine-affected agricultural soils in the northern part of Bangladesh. *J Hazard Mater.* 2010;173:384–92. The source of metals has been well explained. [Google Scholar](#).
 23. Technical Bulletin: Sulfur in Soils Fertiliser Technology Research Centre, the University of Adelaide Mosaic.
 24. Sahoo PK, Tripathy S, Equeenuddin SM, Panigrahi MK. Influence of different forms of acidities on soil microbiological properties and enzyme activities at an acid mine drainage contaminated site. *J Hazard Mater.* 2010;179:966–75. [CrossRefGoogle Scholar](#).
 25. Rashid H, Shanto MAS, Roy DR, Hossain MS, Islam MS, Hoque MMM, et al. Impact of coal mining on soil, water, and agricultural crop production: a cross-sectional study on Barapukuria coal mine industry, Dinajpur, Bangladesh. *J Environ Sci Res.* 2014;1(1):0000001. This coal mine has a significant impact on soil quality, mainly contamination of heavy metals.
 26. Zhang ZY, Abuduwaili J, Jiang FQ. Determination of occurrence characteristics of heavy metals in soil and water environments in tianshan mountains, central Asia. *Anal Lett.* 2013;46:2022–31
 27. Wuana RA, Okieimen FE. Heavy metals in contaminated soils: a review of sources, chemistry risks and best available strategies for remediation. *ISRN Ecology* (2011). ID 402647. [Google Scholar](#)
 28. Zhang ZY, Abuduwaili J, Jiang FQ. Determination of occurrence characteristics of heavy metals in soil and water environments in tianshan mountains, Central Asia. *Anal Lett.* 2013;46:2022–31. [Google Scholar](#)
 29. Nagajyoti PC, Lee KD, Sreekanth TVM. Heavy metals, occurrence and toxicity for plants: a review. *Environ Chem Lett.* 2010;8:199–216. [CrossRefGoogle Schol.](#)

Elemental Analysis of *Limonia acidissima*: Insights into Nutritional Composition and Potential Health Benefits

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Abstract:

Human civilization has been exploring and using various plants and plant products to cure various diseases. Wild foods and medicinal plants are essential components of the natural biodiversity. The wild vegetable *Limonia acidissima* (Rutaceae) is highly prized. It goes by the name "kavath (wood apple)" locally. Fruits are used as vegetables. Therefore, attempts have been made, as highlighted by the elemental analysis of the plant. Including this fruit in a regular diet may improve general health and well-being by offering a sustainable and natural way to fulfill nutrient requirements. *Limonia acidissima* is a rich source of essential minerals, with significant concentrations of calcium, magnesium, iron, and chloride.

Keywords: *Limonia acidissima*, Minerals, Elemental Analysis, wild vegetables.

Introduction:

Limonia acidissima, commonly known as wood apple or elephant apple, is a tropical fruit indigenous to Southeast Asia. Renowned for its unique flavour and cultural significance, this fruit has garnered attention not only for its taste but also for its potential nutritional benefits. As a staple in traditional medicine and culinary practices, *Limonia acidissima* has been a subject of interest for researchers exploring its elemental composition and associated health implications.

In recent years, there has been a growing interest in understanding the nutritional content of fruits, not only for their taste appeal but also for their potential contributions to a healthy diet. Essential minerals and trace elements present in fruits play pivotal roles in various physiological processes, influencing bone health, enzyme activation, and antioxidant defense mechanisms. *Limonia acidissima* with its widespread availability in diverse ecological niches, serves as a promising candidate for such investigations.

This study seeks to delve into the elemental composition of *Limonia acidissima*, employing advanced analytical techniques to quantify the presence of essential minerals and trace elements. The goal is to provide a comprehensive understanding of the nutritional profile of *Limonia acidissima* and shed light on its potential health benefits. As consumers increasingly prioritize natural and nutrient-rich food sources, exploring the elemental makeup of *Limonia acidissima* becomes crucial in elucidating its role in a balanced and wholesome diet.

L. acidissima is a deciduous, slow-growing, erect tree with a few upward-reaching branches bending outwards near the summit where they are subdivided into slender branches that droop at the tips. Its fruit is spherical with a 5–12.5 cm diameter. The rind is 6 mm thick and grayish-white in color. It has a woody and extremely hard outer shell (called a rind) which is very difficult to crack open. A hammer is used to crack the hard rind of fruit. The pulp is brown, mealy, aromatic, resinous, sour, or sweetish with many small white seeds embedded in it. Syrups, drinks, jellies, and jams can be prepared from its sticky pulp.

Through systematic elemental analysis, this research aims to uncover the concentrations of key minerals such as calcium, sulphur, and magnesium, as well as trace elements including iron, and chloride in *Limonia acidissima*. The findings from this study may contribute valuable insights into the potential health advantages associated with the

consumption of *Limonia acidissima*, guiding future research endeavours and potentially influencing dietary recommendations.

Materials and Methods

Study Area

Amravati is rich in biodiversity. It is in the Satpuda Hill ranges, with good forest cover and good sources of water. This is a rich habitat with a very wide variety of flora and fauna, and so it is ecologically important. Also located on the border of two states, Maharashtra and Madhya Pradesh, Amravati is located at 20.93°N, 77.75°E. It has an average elevation of 343 meters (1125 feet). The climate of the district is characterized by a hot summer and general dryness throughout the year except during the south-west monsoon season, i.e., June to September. The mean minimum temperature is 15.1 °C, and the mean maximum temperature is 42.2°C. The normal annual rainfall over the city varies from 762 mm. Two types of soil have been observed in the district: medium-to-deep black soil and deep brown-to-red soil (regular).

Collection of Plant Material

Sample Collection: The wood apple, *L. acidissima*, fruit was collected from villages and farms in Amravati district, Maharashtra, in March, which is identified by taxonomists. The fruit was then cleaned and thoroughly washed under tap water. All the clean samples were mechanically peeled away from the hard outer shell and blended with seeds. Some portion of the blended material was kept for the determination of moisture and ash content while it was dried in an oven at 40 °C. Then the dried wood apple was ground to a mesh size of powder by a grinder and stored in an airtight bottle for further investigation.



Fig 1:- A. Habit; B. sample separated mechanically peeled away from the hard outer shell

Sample Preparation

For the identification of elements we have used the method i.e Ash dissolved 20% hydrochloric acid

- 1) Preparation of Ash: - The analytical methods adopted by the AOAC (Association of Official Analytical Chemists) were used to determine moisture and ash content. For determination of moisture content and ash content wood apple sample was taken in a porcelain crucible, and the initial weight of the crucible with and without the sample was taken. The crucible was then kept in an oven at 105 °C for 2 hours. Again, the weight of the crucible containing the sample was measured which in calculation gives the percentage of moisture content. The crucible was further kept in the carbonite furnace at 700 °C for 4 hours, let stay overnight, and transferred to desiccators to cool. The final weight of the crucible containing the sample was measured which in calculation gives the percentage of ash content
- 2) For the sample preparation fruit sample of *L. acidissima* sample converted into ash. **This ash was transferred into a conical flask and to it aqueous hydrochloric acid (20%) was added. This reaction mixture was taken continuously and vigorously for 2 hours. It was filtered and filtrate was taken for the analysis of Mg, Ca, S, and Fe elements present in the ash of *L. acidissima*.**

Methods for the identification of elements

A. Identification of magnesium in ash content of fruit sample of *L. acidissima* .

Filtrate (1ml) was taken in a test tube to it excess ammonium oxalate solution was added. The reaction mixture was shaken vigorously. During shaking if a clear solution is obtained this means that the magnesium is absent in the ash content of the sample.

B. Identification of Calcium in ash content of fruit sample of *L. acidissima*.

Filtrate (1ml) was taken in a test tube excess of ammonium hydroxide (20%) and 2 ml solution was added. The reaction mixture was shaken vigorously and filtered. To the filtrate few drops of saturated solution of ammonium oxalate were added. If it gives a clear colorless solution indicating calcium is absent in the fruit sample.

C. Identification of sulphur in ash content of fruit sample of *L. acidissima*.

Filtrate (1ml) was taken in a test tube it barium chloride (1ml) solution was added. If the white crystals were obtained indicating sulphur is present in the fruit sample.

D. Identification of Iron in ash content of fruit sample of *L. acidissima*

Filtrate (1ml) was taken in a test tube it aqueous potassium ferrocyanide was added if a blood blue color color solution was obtained that indicated iron was present.

E. Identification of Chloride in ash content of fruit sample of *L. acidissima*

Filtrate (1ml) was taken in a test tube with it 2-3 drops of silver nitrate. If the white precipitate was obtained which indicated the presence of chloride.

Here also we have performed some extractive product tests from the fruit sample of *L. acidissima* in ethanol.

For extractive product yield: oven oven-dried sample (10gm) was packed in extraction thimble, made up of filter paper, and placed in a soxhlet extractor. The extraction was carried out with ethanol (200ml) for six hours at the rate of 6 cycles per hour on the water bath. The remaining ethanol was distilled off, remaining output for the evaporation afforded crystals of extractive product yield was found with the percentage.

Observation and Result:-

Elemental analysis and testing include identification and quantification of elements in a sample, determination of the elemental composition, and trace level elements.

Filtrate (1ml) was taken in a test tube it excess ammonium oxalate solution was added. The reaction mixture was shaken vigorously the observation is that **Magnesium is present** which is given in Table 1.1

Filtrate (1ml) was taken in a test tube excess of ammonium hydroxide (20%) and 2 ml solution was added. The reaction mixture was shaken vigorously and filtered. To the filtrate few drops of saturated solution of ammonium oxalate were added observation is **calcium is present** given in table 1.1

Filtrate (1ml) was taken in a test tube it barium chloride (1ml) solution was added observation is **Sulphur is absent** given in table 1.1

Filtrate (1ml) was taken in a test tube it aqueous potassium ferrocyanide was added observation is **Iron is present** given in Table 1.1

Filtrate (1ml) was taken in a test tube to it 2-3 drops of silver nitrate observation is **Chloride is present** given in table 1.1

Table 1.1 Elemental Analysis of Ethanol Extract of *L. acidissima* fruit

<i>L. acidissima</i>	Elements	Test
	Magnesium	+
	Calcium	+
	Sulphur	-
	Iron	+
	Chloride	+

For extractive product test from the fruit sample of *L. acidissima* in Ethanol

Oven-dried sample (10gm) was packed in an extraction thimble, made up of filter paper, and placed in a soxhlet extractor. The extraction was carried out with ethanol (200ml) for six hours at the rate of 6 cycles per hour on a water bath. The remaining ethanol was distilled off; the remaining output for the evaporation after the evaporation of remaining crystals was measured out Remaining product = 0.360 gm

$$\text{Percentage} = \frac{\text{Remaining value}}{\text{Total value}} \times 100$$

$$\begin{aligned} \therefore \text{Percentage} &= \frac{0.360\text{gm}}{10\text{gm}} \times 100 \\ &= 3.6\% \end{aligned}$$

\therefore The Extractive Product Yield 3.6

**Test for *L. acidissima*****DISCUSSION:**

In the elemental analysis, nearly all the parts of any plant show the presence of several elements. Quantification of the elemental constituents provides information on their micro-nutritional characteristics. Although it varies widely, particularly in plant samples, due to its strong relationship with cultivation factors, particularly soil, water, and fertilizers used, elemental analysis is still a useful tool. The results show that the elements sodium, potassium, calcium, magnesium, iron, and zinc are in abundance. Though the herb is not ingested in its crude form but rather in the form of aqueous, alcoholic, or hydro-alcoholic, The daily recommended value for individuals aged 4 and above for Na, K, Ca, Mg, Fe, and Zn levels is 2000mg Na, 3510mg K, 1000mg Ca, 400mg Mg, 18mg Fe, and 15mg Zn, and these values can be surpassed by supplementation with herbal preparations.

Conclusion:

The findings presented from the elemental evaluation of the *L. acidissima* fruit provide information on the nature of the phytochemicals present and quantify the micro-nutrients.

Wood apple is rich in nutrients and is considered an energy food by many. It has high levels of fiber and Iron, which makes it a great fruit to have *L. acidissima*.

Acknowledgement:

The authors are thankful to Dr. P. G. Bansod, Head, Department Of Botany, Vidya Bharati Mahavidyalaya, and Amravati for providing facilities during the tenure of Research Work.

References:

- Abbasi A.M., Khan M.A., Ahmad, M., Zafar, M., Khan, H., Muhammad, N. and Sultana, S. (2009). Medicinal plants used for the treatment of jaundice and hepatitis based on socio-economic documentation. *Afr. J. Biotechnol.*, 8(8): 1643-1650.
- Abdul, Sattar. Abdul, Baqi I. Muhammad Suleman., Muhammad Tahir Shah., and Samiullah. (2020) Elemental analysis of medicinal plants and their impacts on human health, *Pure Appl. Biol.*, 9(1): 249-255.
- Adesina, S. K. (2005). The Nigerian *Xanthoxylum*; chemical and biological values. *AJTCAM*, 2(3):282-301.
- Ajaiyeoba E.O. 2000. Phytochemical and antimicrobial studies of *Gynandropsis gynandra* and *Buchholzia coriacea* extracts. *Afr. J. Biomed.* 90(9): 31123119
- Ameh, P.O., Sani, U.M., Nwoye, E.E. (2015). Studies on some physicochemical and rheological properties of the plant gum exudates of *Albizia furriguinea* International Journal of Chemical Material and Environmental Research.
- Aubert and Pinta, M. (1977). "Trace elements in soils," in *Development in Soil Science*, vol. 7, pp. 43-95, Elsevier, Amsterdam, The Netherlands.
- Basgel, S. and Erdemoğlu, S. B. (2006). Determination of mineral and trace elements in some medicinal herbs and their infusions consumed in Turkey. *Sci. Total Environ*, 359: 82-89.
- Bhogaonkar, Prabha. Y., Marathe, Vishal. R. and Kshirsagar, Prachi, P. (2010). Documentation of Wild Edible Plants of Melghat Forest, Dist. Amravati, Maharashtra State, India. *Ethnobotanical Leaflets. China. J Ethnobiol Ethnomed.*
- Dey, P. & Khaled, K.L. (2015). Electrolytic Conductivity of Crystal Violet-Based Quaternary Ammonium Polyelectrolytes in Propylene Carbonate and Sulfolane. *J. Chem. Eng. Data*, 40 (1): pp 79-82.
- Endjo, D., and Hernani. (2004). Trace elements in some wild plants from the shores of the high dam lake and the adjacent desert, as determined by atomic absorption spectroscopy. *J. Arid. Environ*, 29: 185-197.
- Sharma, Ankita and Singh, Nimali (2015). A Multifarious Potent herb: *Plumbago zeylanica*, International Journal of Recent Scientific Research Vol. 6, Issue, 6, pp.4825-4829,
- Shukla, Babita., Saxena, Sumedha., Usmani, Shazia and Kushwaha, Poonam (2021). "Biological effects of heavy metals: an overview. *Journal of Environmental Biology*, vol. 26, no.2: pp.301-313.
- Wani, A. A., Sogi, D.S., Singh, P. and Wani, A. I. and Shivhare, Uma, (2011). Characterization and functional properties of watermelon (*Citrullus lanatus*) seed proteins *Journal of the Science of Food and Agriculture*, 91: pp. 113-121.
- WHO, Guideline: Sodium intake for adults and children. World Health Organization, Geneva, 2012.
- Zich, F.A., Hyland, B.P.M., Whiffen, T., Kerrigan, R.A. (2020). *Plumbago zeylanica*". Australian Tropical Rainforest Plants (RFK8). Centre for Australian National Biodiversity Research (CANBR), Australian Government.

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References:

- Abbasi A.M., Khan M.A., Ahmad, M., Zafar, M., Khan, H., Muhammad, N. and Sultana, S. (2009). Medicinal plants used for the treatment of jaundice and hepatitis based on socio-economic documentation. *Afr. J. Biotechnol.*, 8(8): 1643-1650.
- Abdul, Sattar. Abdul, Baqil. Muhammad Suleman., Muhammad Tahir Shah., and Samiullah. (2020) Elemental analysis of medicinal plants and their impacts on human health, *Pure Appl. Biol.*, 9(1): 249-255.
- Adesina, S. K. (2005). The Nigerian *Xanthoxylum*; chemical and biological values. *AJTCAM*, 2(3):282–301.
- Ajaiyeoba E.O. 2000. Phytochemical and antimicrobial studies of *Gynandropsis gynandra* and *Buchholzia coriacea* extracts. *Afr. J. Biomed.* 90(9): 31123119
- Ameh, P.O., Sani, U.M., Nwoye, E.E. (2015). Studies on some physicochemical and rheological properties of the plant gum exudates of *Albizia furriginea* International Journal of Chemical Material and Environmental Research.
- Aubert and Pinta, M. (1977). "Trace elements in soils," in *Development in Soil Science*, vol. 7, pp. 43–95, Elsevier, Amsterdam, The Netherlands.
- Basgel, S. and Erdemoğlu, S. B. (2006). Determination of mineral and trace elements in some medicinal herbs and their infusions consumed in Turkey. *Sci. Total Environ*, 359: 82-89.
- Bhogaonkar, Prabha. Y., Marathe, Vishal. R. and Kshirsagar, Prachi, P. (2010). Documentation of Wild Edible Plants of Melghat Forest, Dist. Amravati, Maharashtra State, India. *Ethnobotanical Leaflets. China. J Ethnobiol Ethnomed.*
- Dey, P. & Khaled, K.L. (2015). Electrolytic Conductivity of Crystal Violet-Based Quaternary Ammonium Polyelectrolytes in Propylene Carbonate and Sulfolane. *J. Chem. Eng. Data*, 40 (1): pp 79–82.
- Endjo, D., and Hernani. (2004). Trace elements in some wild plants from the shores of the high dam lake and the adjacent desert, as determined by atomic absorption spectroscopy. *J. Arid. Environ*, 29: 185-197.
- Sharma, Ankita and Singh, Nimali (2015). A Multifarious Potent herb: *Plumbago zeylanica*, *International Journal of Recent Scientific Research* Vol. 6, Issue, 6, pp.4825-4829,
- Shukla, Babita., Saxena, Sumedha., Usmani, Shazia and Kushwaha, Poonam (2021). "Biological effects of heavy metals: an overview. *Journal of Environmental Biology*, vol. 26, no.2: pp.301–313.
- Wani, A. A., Sogi, D.S., Singh, P. and Wani, A. I. and Shivhare, Uma, (2011). Characterization and functional properties of watermelon (*Citrullus lanatus*) seed proteins *Journal of the Science of Food and Agriculture*, 91: pp. 113-121.
- WHO, Guideline: Sodium intake for adults and children. World Health Organization, Geneva, 2012.
- Zich, F.A., Hyland, B.P.M., Whiffen, T., Kerrigan, R.A. (2020). *Plumbago zeylanica*". Australian Tropical Rainforest Plants (RFK8). Centre for Australian National Biodiversity Research (CANBR), Australian Government.

1**A Study on the Fog- Edge-Cloud Computing based IoT (FECIoT):
Architecture, Security, and Privacy Issues****Prof .Ather Iqbal**Department of Computer Science
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sarvaiya.shilpa@gmail.com**ABSTRACT**

The Internet -of -Things (IoT) is the future of the Internet, where everything will be connected. Studies have revealed that Fog-Edge-Cloud Computing (FEC) –based services will play a major role in extending the cloud by carrying out intermediary services at the edge of the network. Fog-Edge-Cloud Computing-based IoT (FECIoT) distributed architecture enhances service provisioning along the Cloud-to-Things continuum, thereby making it suitable architecture. Furthermore, the proximity of Fog-Edge devices to where the data is produced makes it stand out in terms of security and privacy issues. From the business perspective, FECIoT will lead to a boom and spring up of Small-to-Medium-Sized enterprises (SMEs), thereby encouraging inclusion for all. In this paper present a study on FECIoT.

Keywords— Fog-Edge-Cloud Computing (FEC), Internet-of-Things (IoT), Service Oriented Architecture (SoA), Cloud-to-Things (CoT), Attacks.

I. Introduction

Recent studies have shown the shortcomings of the cloud as regards handlings of big-data. By the year 2020,it is projected that about 50 billion things are expected to be connected to the Internet [1].To this point,IoT requires a robust and resilient architecture that will enable faster data processing, as well as storage. Several researchers have suggested the need to integrate the Fog-Edge Computing (FEC) with the IoT [2].FEC promises to run IoT-enabled applications for real-time control and analytics, with millisecond response time. Furthermore, FEC enables designing and building a scalable and adaptable IoT platform. A service-based architecture (SoA) is a component-based model that focuses on the systematic design of the workflow of coordinated services. Where and how to perform computation and storage along the Cloud-to-Things (CoT) continuum, and how decisions can be managed within heterogeneous systems is still a debatable issue [3].Localized data analytics coupled with control can provide some level of autonomy to devices close to the edge of the network (FEC devices), which may help in enhancing the performance of mission-critical IoT applications. This paper presents new challenges in emerging IoT and the bottlenecks faced in resolving these challenges using today's computing and networking models. The paper further discusses why the FECIoT architecture should be deployed to fill possible technological gaps with a view to enhancing new business opportunities. Furthermore, we discuss security features, as well as security challenges that exist within the FECIoT framework. The remainder of this work is organized as follows. In section II, we present the basic concepts. The FECIoT architecture framework is presented in section III.Security and privacy issues are presented in section V.

II. Overview of Basic Concepts

In this section, present basic concepts and provide comparisons amongst seemingly similar concepts.Thus, we provide an overview of Cloud computing, Fog Computing, Edge computing, similarities and differences [4].

A.Cloud Computing (CC):

With top multinational computing giants like Amazon web services, Microsoft Azure, Google Cloud platform, and IBM Cloud championing the adoption of the generic cloud computing model where big-data analytics, decision making, and computations all take place centrally in the distant cloud data-centres. The increase in Machine Type Communication (MTC) as observed in IoT will lead to massive amounts of data flow within the IoT ecosystem. As such it becomes difficult to manage traffic and congestion within the network using the CC model. Despite the emergence of FEC which promises better business prospects for SMEs, lower latency, and higher bandwidth efficiency, the cloud will continue to have a key role to play in the proposed FECIoT framework. Figure 3 shows the Cloud Computing model along with three generic services. These services are Platform-as-a-Service (PaaS), Infrastructure-as-a-Service (IaaS), and Software-as-a-Service (SaaS).

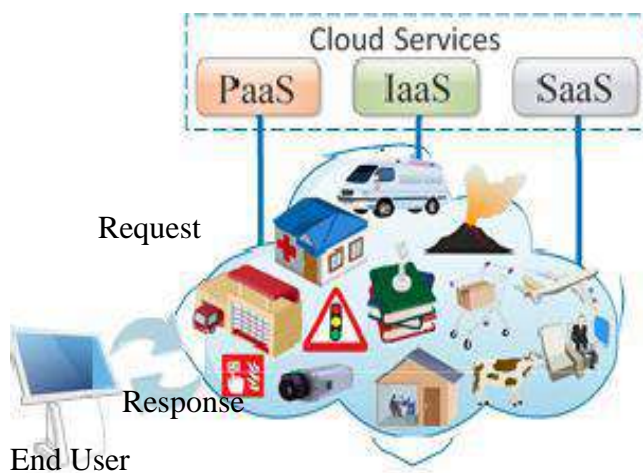


Figure1: Cloud Computing Model.

I) Platform-as-a-Service (PaaS): This is a customer-based Cloud Computing service that supports clients, by given them the flexibility of developing, running, and managing Web based without going through the rigour of building and maintaining infrastructures typically associated with developing and launching an application. The PaaS also supports the overall life-cycle management of cloud applications, including coding, testing, deployment and maintenance [5]. A good example is Apprenda, which is a provider of private cloud PaaS for .NET and Java.

II) Infrastructure-as-a-Service (IaaS): This service model is also known as Hardware-as-a-Service (HaaS), it is a cloud computing service model that provides computing infrastructure to enhance enterprise operations, usually based on outsourcing. In other words, IaaS manages computing, storage and networking resources and provides basic resource services to the PaaS or to users directly [7]. Generally, IaaS provides hardware (may include software), storage, servers, and data center space or network elements. Amazon Web Services (AWS), Cisco Metacloud (formerly Metapod), Microsoft Azure, Google Compute Engine (GCE), and Joyent etc. all fall within the IaaS category.

III) Software-as-a-Service (SaaS): This is a software distribution model which allows clients to have access to applications hosted by third-party providers over the Internet [6]. Good examples of SaaS used in everyday life are Twitter, Instagram, Facebook, and Google's suite of intelligent apps (formerly Google Apps).

B. Fog Computing (FC):

The concept of fog computing (FC) was first introduced in 2012 [7], working at Cisco Inc. The FC paradigm entails moving intelligence down to Local Area Network (LAN) level and data is processed at an IoT gateway. The main aim of its introduction was to extend services and functionalities offered by the cloud at the edge of the network. Such functionalities may include storage, processing, database operation, integration, security, and management to IoT end-devices, leveraging on its proximity to the edge of the network. With exciting benefits of minimizing network congestion, minimizing end-to-end latency, tackling connectivity bottlenecks, improving security and privacy, and enhancing scalability, FC is seen as the way forward. Furthermore, there are claims within the industry of the vast business opportunities that could be derived with the advent of FC. With the effective distribution of computing, storage, networking, and management service along the Cloud-to-Things continuum, it meets today's application requirements for local content, resource pooling, and real-time processing [8]. As such, FC has attracted interest from both the academia and industry. It is a fact that FC does not replace the CC, rather it complements by offloading data or service request that can be processed locally. However, we acknowledge the limitations of the CC-based model and stress the need for FC integration to allow for global applicability. Another emerging paradigm that can revolutionize IoT is Dew Computing (DC). In, DC is expected to depend on micro-service approach in a highly heterogeneous, vertical, and distributed hierarchy. It gives room for a centralized-virtualization-free computational horizon where data scattering into low-end devices is possible. Hence, allowing for data accessibility even without continuous internet access. The extreme scalability and self-adaptive attributes of DC makes it prime to the success of IoT [9]. With FC's intermediary role of deploying existing computing infrastructure in bridging the cloud to things, FC will be prime to the success of existing and emerging technologies like the smart grids, smart homes, smart cities, wireless sensor networks, mobile healthcare, manufacturing, vehicular networks, and lot more. Below are some advantageous features of FC:

- 1) Geographically dispersed.
- 2) Support for large-scale sensor networks and end nodes.
- 3) Provides better real-time response than the Cloud-based model.
- 4) Online analytics and interaction with the cloud.

C. Edge Computing (EC):

As the name implies, the edge computing (EC) entails computation that is carried out at the edge of the network EC aims at overcoming limitations associated with the cloud computing-based model. It serves as the intermediary between the end users/devices and the cloud, providing processing and storing functionalities to a large number of IoT end-devices. The proximity of edge devices will minimize computational load on data centers situated far away in the cloud. Real-time response will be enhanced, as well as reduced latency [10]. Another merit of EC is the distributed nature and support for device mobility within heterogeneous networks. According to edge layer can be implemented in three modes, the MEC, FC, and Cloudlet Computing (CC). Hence enabling cloud computing functionalities inside the Radio Area Network (RAN). Cloudlets is a smaller version of the cloud which uses dedicated devices that offer cloud like functionalities. Below are some advantages features of EC:

- 1) Geographically dispersed.
- 2) Improved security, as encrypted data moves further into the core network.
- 3) Provides better real-time response than the cloud based model.
- 4) Better scalability through virtualization.
- 5) Limits potential communication bottlenecks.

D.Fog-Edge Computing (FEC):

It is pertinent to note that FC devices may not necessarily be at the network edge, but reside close to the edge of the network. In contrast, edge devices often reside at the network edge, and are often the first point of contact to the IoT end- devices. In essence, FC devices and EC devices are both close to the IoT end-devices, but the EC devices are often closer. In many works, fog computing and edge computing have been used interchangeably. Some consider FC as a part of the EC and micro data center (MDC) paradigm for IoT. Both FC and EC have their services located close to the end users, however, EC is resident in edge devices, while FC resides in the network edge devices, usually a single or few network hops away from the edge. The EC platform has constrained energy and limited storage, and fall within the class of constrained devices. The increase in the number of IoT applications may result in higher contention for resources and additional latency [11]. In essence, the resource contention of EC is greater than FC due to proximity to IoT end-devices. Furthermore, EC focuses more on the things domain, while fog computing focuses more on the infrastructure domain. FEC has certain pillars, they include security, scalability, openness, autonomy, reliability, agility, hierarchical organization and programmability, which is inherent to both FC and EC. As such, the motivation for integrating both the FC and EC is based on the peculiarities between them.

- 1). They both use a virtualized IaaS platform and allow for multi-tenancy of applications at the edge of the network.
- 2) They both compliment functionalities offered by the cloud and are located between end users and data centers.
- 3) They both can be physically co-located with access points, roadside units, base stations, routers, switches, and gateways.
- 4) They both are mostly deployed wireless and provide low latency, low jitter, and cognition within the system.
- 5) They both provide computational services in distributed geographical locations in order to minimize the load on the cloud.

Figure 2. Shows a pictorial representation of the FECIoT model with various domains. In this paper, we arrive at a consensus that FC and EC are congruent [12].

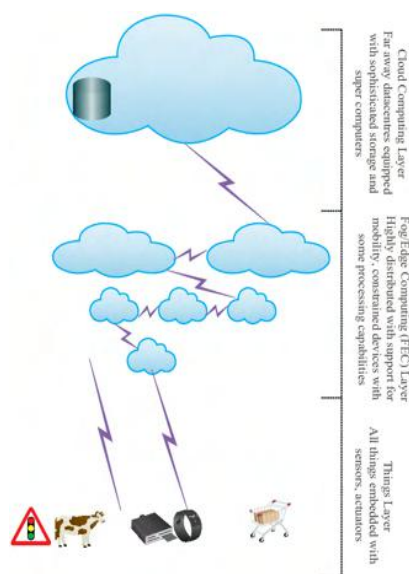


Figure 2: FEC Architecture and Interaction in the Cloud-To-Things Continuum

III. FECIoT Architecture:

The term "FECIoT" was first coined by Lin et al. in [13] with a motive to emphasize the immense potential that could be derived when the Fog-Edge computing paradigm is well integrated into the IoT architecture. In this section, present the FECIoT architecture framework. Fog-Edge devices may be linked to form a mesh to provide load balancing, resilience, fault tolerance, data sharing, and reduction in the Cloud-to-Things communication. Architecturally, this demands that Fog-Edge devices have the ability to communicate both vertically and horizontally within the IoT ecosystem. The FECIoT inherits the basic IoT architecture and delivers all IoT requirements in a more efficient way by leveraging on the distributed FEC paradigm. In this paper describe three different architectures that are Three-layer, Four-Layer and Five-Layer Architecture.

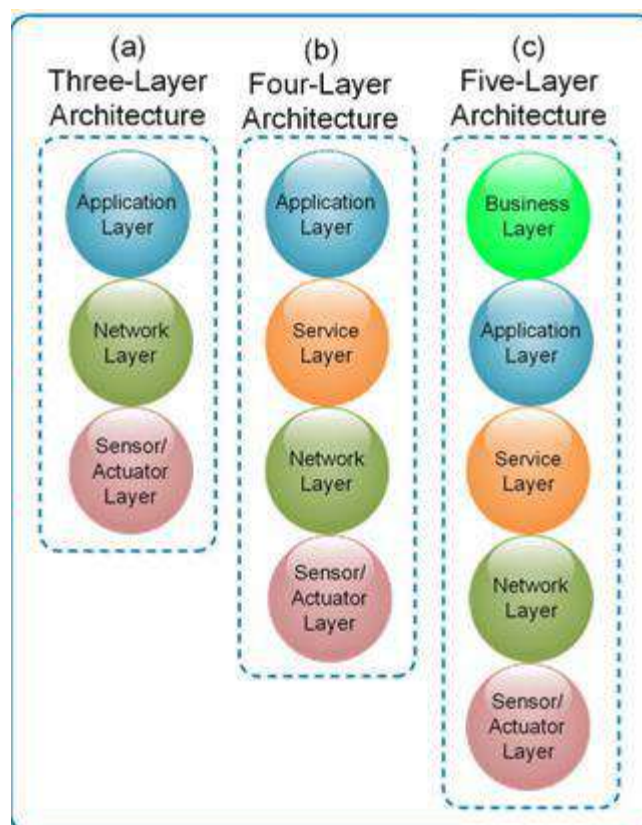


Figure 3: FECIoT (a) Three-Layer Architecture, (b) Four-Layer Architecture, (c) Five-Layer Architecture

A. Three-Layer Architecture:

This architecture is traditional in design and considers three basic layers. Figure 4 (a) shows the Three-Layer Architecture comprising of: (I) The Sensing Layer, (II) The Network Layer, and (III) The Application Layer.

(I) Sensing Layer: This layer is also known as the Perception Layer, acquires data through sensing using Radio Frequency Identification (RFID), Sensors. Nodes within radio range of each other may collaborate for the purpose ensuring ubiquitous data communication within the IoT network.

(II) Network Layer: This layer performs the task of routing data across diverse networks. Sensed information is received from the sensing layer and then routed to IoT hubs and devices over the Internet. This layer supports computing platforms such as Cloud Computing platforms,

Internet gateways. Which operate using state-of-the-art technologies like 5G/LTE, Bluetooth, WiFi. The Network Layer uses gateways to send data to and from applications or things across heterogeneous networks, and over multiple protocols and technologies.

(III) Application Layer: This layer provides services (Storage, Processing or Analysis) based on received data or request from the Network Layer. Several IoT applications exist in this layer with diverse requirements and deployed together with the Middleware functionalities. With emerging Fog-Edge deployments, Multivendor ecosystem applications need to be able to migrate and operate seamlessly despite system heterogeneity.

The Three-Layer Architecture looks simple, however, when taking a closer look at the Network and Application Layer, we observe complexities in grafting data services (Data Aggregation, Data Mining and Analytics) into this architecture. Thus, giving rise to a new layer called the service Layer.

B. Four-Layer Architecture:

This Architecture is also known as the Service-Oriented Architecture (SOA). The SOA is the application framework that allows establishments and enterprises to build, deploy and integrate these services independent of the technology systems on which they run. Here, the service layer is placed in between the Application and Network Layer in order to enhance data Services in IoT.

This Service-Oriented Architecture focuses on designing the work-flow of coordinated services, and allowing for hardware/software reuse because it supports the design, deployment, and integration of services, which are not dependent on the technology platform they operate on [18]. Figure 3 (b) shows the Four-Layer Architecture comprising of: (I) Sensing Layer, (II) Network Layer, (III) Service Layer, and (IV) Application Layer, which are briefly discussed with emphasis on the Service Layer.

(I) Sensing Layer: This Layer is at the base of this architecture, and responsible for data collection, measurement and extraction of physical devices. This data is passed on to the upper layers.

(II) Network Layer: This Layer provides support for data to be transmitted over multiple networks and topologies. Route decisions are made in this layer.

(III) Service Layer: This Layer as the name implies, provides a variety of services. This layer is also known as the Interface or Middleware Layer. The Service Layer can be further broken down into four components, namely:

- 1. Service Discovery:** This helps in discovering desired service request. In a global Service Discovery framework was introduced which allows users to register their own sensors into a common infrastructure, and discover the available services via a mobile device.

- 2. Service Composition:** A sub-layer in the SOA which provides functionalities for the composition of specific services offered by networked objects in building specific applications. Web of services also plays a vital role, in the sense that they allow for a precise definition of capabilities of interfaced objects and interaction with them.

- 3. Service Management:** This provides the primary functional requirements and management for each object. The functionalities in services may cut across QoS management, lock management, and semantics. In addition, newer services may be deployed at run-time, in order to meet application requirements.

- 4. Service Interface:** This interface serves as a bridge to connect all provided services. Interfaces are necessary for the reduction of complexities in business processes

(IV) Application Layer: This Layer is at the top of this architecture, providing overall support based on system's functionalities to end user. Unlike the traditional Three-Layer Architecture, the Application Layer is not part of the Middleware, rather it instructs the Service/Middleware Layer. This Layer provides an interactive interface via standard Web Service Protocols and

Service Composition Technology over heterogeneously distributed systems and applications. Examples of such applications include, smart homes, intelligent transportation, smart industry, smart health-care.

C. Five-Layer Architecture: This model has a Business outlook and is extracted from the traditional Application Layer to provide more complex services. The Five-Layer Architecture comprises of the following: (1) Sensing Layer,(2)Network Layer,(III) Service Layer,(IV) Application Layer, and (V) Business Layer.Here,we focus on the Business Layer, since previous Architecture has covered lower Layers.

(V) Business Layer: The main role of this Layer is to record and analyse all IoT CPS (Cyber Physical Systems) operations. The business Layer handles the entire IoT System, which includes applications, business and profit models and user confidential information. Figure 4 (c) shows the business Layer as an additional feature in the SoA.The SoA actually facilitates the creation of systems, which support the derivation of independent business solutions from technological constraints .The FEC Architecture will play an important role in reshaping the networking, server and software industry, with the convergence of routers,switches,storage and application servers into FEC devices.Furthermore,the distributed FEC Architecture supports the emerging Fog-as-a-Service (FaaS),where smaller business enterprise can also participate in delivering Private and Public services at diverse scales to end user.

IV. Security and Privacy in FECIoT

Security is important for the safe and reliable operation of connected IoT devices. With pervasive data emanating from heterogeneous systems, data confidentiality, integrity, privacy, as well as authentication to verify data source is very important. However, due to processing limitations of IoT devices, it is almost impossible to deploy full-fledged security suites. The FECIoT helps in overcoming some of the challenges encountered in existing IoT architectures that use the cloud computing-based model. In the aspect of security, FEC devices can be deployed as proxies for IoT end-devices. Despite the merits of FECIoT, there exist several security issues associated with this architecture. In this section, we present some security features of FECIoT and possible security attacks in FECIoT [13].

A.Security Features in FECIoT:

Security requirements impact different layers depending on the specific security principles. We briefly discuss some important security features in FECIoT.

1) Trust: Establishing communications between IoT devices, FEC devices, and infrastructures in the cloud requires some level of trust. Also, to effectively implement trust within the FECIoT architecture, devices need to be equipped with adequate security, making them trusted elements. When trusted devices are deployed, it provides the basis for a secure FECIoT ecosystem. Authentication and transparency play an important role in fostering prior relations between devices. Trust is not limited to communications among devices, rather covers the relationship between different IoT layers and applications. Several trust-management models have been applied in cloud computing domain, using artificial intelligence, fuzzy methods, game theory, and Bayesian estimation- based techniques.

2) Authentication: This involves entity identification. Before a device can become part of any given network, it is necessary that the device is first authenticated. However, the constrained nature of IoT devices makes it even more challenging when considering complexity in both registration and re-authentication phases. FEC-based authentication servers will be a better choice for the centralized cloud authentication servers, due to the distributed nature and proximity of FEC devices [14].

3) Integrity: Cannot be altered during the process of data transmission. Integrity is assured only when the intended and authorized entity receives data accurately as was sent.

Compromised data may cause serious disruption within the network and further cause harm to the operation of the IoT application. In, a sampling and signature scheme was presented, providing opportunity to relieve the burden of the network, where the local collector acts as the coordinator and periodically transmits the sampled packets to the global traffic analytic. This scheme was able to provide integrity and can be modified to suit the FECIoT framework. A Game-theoretic approach was adopted in to examine the best strategies to slowly corrupt the integrity of an IoT network. This approach can be used in designing better defensive measures in FECIoT.

4) Confidentiality: Confidentiality ensures that only authorized users/devices can have access to useful information or modify it, hereby keeping unauthorized users/devices away from interfering with data and services. Data in the FECIoT framework flows from the physical devices (e.g. sensors and actuators) through to FEC devices and then to/from higher layers. This increases the chance for this data to be accessed by malicious devices within the network. It is pertinent to address the access control mechanism and also the device authentication process.

5) Privacy: Privacy ensures that data is accessed only by the corresponding entity/device within the network. It is important to ensure that other users/devices may possess some specific controls based on received data, but should be unable to infer other useful information from the received data. Due to the huge number of IoT end-devices, and sheer volume of data flowing within the FECIoT ecosystem, privacy cannot be undermined

6) Availability: Availability is a very crucial security feature in FECIoT. It ensures that data and system resources should be available to authorized users/devices requesting for data or services. Most IoT applications are latency-sensitive, and as such, any downtime in system operations may have an adverse impact on end-users. Distributed denial of service (DDoS) attack is one that renders data and services unavailable to legitimate users/devices.

7) Access Control: Access Control is the process of determining whether user/devices can have access to system resources, this could be data, or services. This process involves denying or revoking access, especially to unauthorized users/devices. In, an access control system was developed which enables offloading of complex access control decisions to third, trusted parties. The design which is based on a simple communication protocol imposes minimal overhead. Thus, making it suitable for FECIoT applications.

B. Possible Security Attacks in FECIoT:

Here, we present possible security attacks in FECIoT [14].

1) Distributed Denial of Service (DDoS): One of the most lethal attacks in the FECIoT architecture is DDoS. The risk of malicious clients and coordinated group of clients (Botnets) mounting DoS attacks is still an issue of concern. DDoS attacks may emanate from IoT end devices. On the other hand, FEC devices may also be used to launch DDoS attack.

2) Man-in-the-Middle Attack (MitMA): The Man-in-the-Middle Attack is a prominent attack that could constitute a serious threat in FECIoT, especially in the area of privacy. The attack easily exploits this platform to disclose sensitive information such as location and identity of the FEC devices. This kind of attack is often successful, as devices cannot implement secure communication protocols due to resource constraints this attack still poses a serious challenge in FECToT.

3) Physical Attack: This type of attack involves physical compromise of hardware components. This hardware components could be RFID tags, sensor devices, FEC devices, or even more centralized infrastructure. Susceptibility of this kind of attack varies with respect to the location of deployment, level protection given to such devices.

V. Conclusion

FECIoT has the potential to add value to existing IoT systems by enabling real time response as well as providing storage and computational services in a distributed manner to IoT end devices. The proximity of FEC devices to where the data is produced makes it stand-out in terms of resource allocation, service delivery, and privacy. The FECIoT framework offers more responsiveness and eliminates the need for costly bandwidth additions by offloading gigabytes of network traffic from the core network. The proposed FECIoT service-based framework will greatly enhance service delivery to IoT end-users, hence, FECIoT should be considered as part of the overall Internet of the future, which will transform the Internet industry. In this paper, study the key aspect of the FECIoT framework and presented security and privacy issues. Also analyse FECIoT in a comprehensive form, especially for new entrants in the area of IoT. It should, however, be noted that the FECIoT framework may seem to have provided improvements on existing frameworks, numerous security and privacy issues abound. The FECIoT promises better service delivery to end users, and inspire novel business models. This is expected to be a prime focus for researchers in the next decade.

VI. References

- [1] Ms.S.B.Sarvaiya, Dr.S.E.Tayde, "Analysis of Security Mechanisms Based on IoT, Fog and Cloud Computing Paradigm." 7TH National Conference on Recent Trends in Computer Science & Applications (RTCSA-2018) 18 & 19 Dec 2018, ISSN: 2249-894X.
- [2] Dr.S.E.Tayde, Ms. S.B.Sarvaiya,"The Merger of Cloud Deployment Models Services With IoT.", NCETS "Research Journey" International E- Research journal, Impact Factor 6.261 ISSN: 2348-7143,February-2019.
- [3] Dr.S.E.Tayde, Ms.S. B.Sarvaiya," The Role of Just-in-Time Indexing Technique of IoT on Cloudlet-based during Interactive Data Exploration System", Recent Advances in Science and Technology (RAISAT-2019), 5 and 6 March-2019.
- [4] Dr.S.E.Tayde, Ms. S.B.Sarvaiya," EDGE CLOUD COMPUTING COMPLIMENTARY ROLE IN IOT ENVIRONMENT", 3rd National Conference Recent Development Science, Engineering and Technology (RDSET 2019), April 03, 2019.Vol.4, Issue 6, ISSN-2349-5162.
- [5]A.Chen, H.Wu, L.Tian, G.Luo," HCOS: A Unified Model and Architecture for Cloud Operating System", ZTE Communications Magazine, Vol.15, No.4, PP.23-29, NoV.2017.
- [6] W.Shi, J.Cao, Q.Zhang, Y.Li, L.Xu,"Edge Computing: Vision and Challenges", IEEE Internet of Things Journal, Vol.3, No.5, PP.637-646, OCT.2016.
- [7]J.Pan, J.McElhannon,"Future Edge Cloud and Edge Computing for Internet of Things Applications." IEEE Internet of Things Journal, Vol.5, No.1, PP.439-449, Feb.2018.
- [8]S.Chen, T.Zhang, W.Shi, "Fog Computing", IEEE Internet Computing, Vol.21, No.2, PP.4-6, Mar.-Apr.2017.
- [9]P.P.Ray,"An Introduction to Dew Computing: Definition, Concept and Implications", IEEE, Access, Vol.66, PP.723-737, 2018.
- [10]K.Dolui, S.K.Data," Comparison of Edge Computing Implementations: Fog Computing, Cloudlet and Mobile Edge Computing", IEEE Global Internet of Things Summit (GIoTS), Geneva, PP.1-6, 2017.
- [11] M.Aazam, E, N.Huh,"Fog Computing: The Cloud-IoT/IoE Middleware Paradigm", IEEE Potentials, Vol.35, No.3, PP.40-44, May 2016.
- [12]P.Hu, S.Dhelim, H.Ning, T.Qiu,"Survey on Fog Computing "Architecture, Key Technologies, Applications and Open Issues", Journal of Network and Computer Applications, PP.27-42, Nov.2017.
- [13]J.Lin,W.yu,N.Zhang,X.yang,H.Zhang,W.Zhao,"A Survey on Internet of Things (IoT) Architecture, Enabling Technologies, Security, Privacy and Applications",IEEE Internet of Things,Vol.4,No.5,PP.1125-1142,Oct,2017.
- [14]H.Kim, E.A.Lee,"Authentication and Authorization for the Internet of Things (IoT)", IT Professional, Vol.19, No.5, PP.27-33, 2017.



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3

Various Approaches for Content Extraction from Web Pages based on Factors

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Abstract-

With the huge development of the internet and web publishing techniques generally create numerous information sources published as HTML pages on World Wide Web. So Extraction of Information has become an important task for discovering useful knowledge or information from the Web Pages. However, there is lot of redundant and irrelevant information on web pages. Navigation panels, Table of content (TOC), advertisements, copyright statements etc. A search engine and crawler system is one of the fundamental necessities of Information Extraction. Search engine takes into account only the informative content for indexing. With the informative content, web pages commonly have blocks that are not the main content blocks and are called the non-informative blocks or noise. Content in noise blocks will seriously harmful for information extraction, web mining, web searching. Noise affecting the precision of search and the size of index of search engines. So identifying the main content block is a key issue. In order to improve the performance of extraction of information, cleaning of Web pages becomes critical. There are various factors that you can consider in segmentation of web pages for Content extracrion from web pages. The main objective of this paper is to study various factors for web segmentation and content extraction. In the paper we proposed techniques, methods and factors for content extraction in web pages.

Keywords-Search engine, information extraction, web content mining, web segmentation

I. INTRODUCTION

Web data mining tasks such as Web page clustering, classification, categorization, and information retrieval and information extraction [1]. Therefore these blocks are termed as the noisy blocks. Also, from the users' perspective only part of the information is useful for a particular application and the remaining information are noises. For improving the performance of traditional information extraction, it is necessary to differentiate valuable information from noisy content. Information contained in these noisy blocks can seriously hamper Web data mining task. Eliminating these noisy blocks is thus of great importance.

Now a day's World Wide Web (WWW) has become the main source of information for people, but the explosive growth of WWW has resulted in difficulties for individual user to process all these information. Search engines have been the various tools for users to find interested information on the web. Web contents such as multimedia data, structured i.e. XML documents, semi-structured i.e. HTML documents and unstructured data i.e. plain text [2] offer important information to the users and therefore be termed as informative contents. Other useful information on the Web is often accompanied by contents such as navigation bars, banner advertisements copyright notices etc [3] which can be termed as non informative contents.

In this paper, we present a various independent approach based on various factors for extraction of core contents from web pages. This approach extracts the data from each web page that are organised as well formatted XHTML documents. The different algorithms are

used based on various parameters for content extraction by filtering out the noise, and stores these contents into plain text form.

A web page usually contains various content such as contacts, information at the bottom, navigation bars, advertisements, or just some decoration components which are not related the topic of the web page. In information extraction, contents in these parts are all noise [4] information. Visitors to Web pages are only interested in the main content and have no use for the noisy content. Only the main content block of a web page contains the information we wants, we call this block *informative block*. So an accurate detection of informative block of a web page surely will improve the performance of information extraction. Content Extraction is a process of identification of what parts of a web page content the main textual content, thus ignoring the other irrelevant items of web page. Techniques belonging to the Web Content Mining such as classification and clustering, separation of block of web pages and removal of noisy blocks enable one to produce much better result for extracting useful information. Information retrieval or extraction applications consider all content on a Web page equally - e.g., with no differentiation between main and noisy content - there may be a decline in accuracy. It is necessary that such applications deal only with the main content of a Web page.

II. RELATED WORK

Web sites are main source of information. The information contained on web sites is often mixed with non-informative content, is one of the main issues on the web. Eliminating the non-informative blocks will help in improving the process of information extraction. One approach to identify the informative blocks is web page segmentation. This section presents a summary of the techniques used to identify informative blocks within a web page.

Lin and Ho [5] proposed a method named info discoverer in which they used <table> tag to divide the web page into blocks. Then they extracted features from blocks and calculated entropy value of these features. Then this entropy value is used to determine whether the block is Informative or not.

Kao and Lin [7] proposed a method in which they used HITS (Hyperlink Induced Topic Search) algorithm to get a concise structure of web site by removing irrelevant structures. On the filtered structure they performed info discoverer method. This method is better than info discoverer because instead of using the whole web page they experimented on the filtered structure.

Today, the most frequently used segmentation algorithm is Vision-based Page Segmentation (VIPS), proposed by [2] from Microsoft Research. The vision-based method utilizes visual clues in a Web page. Chen proposed a method that considers visual information such as height, length of node zone and separation information. Yang proposed the VIPS (Vision-based Page Segmentation) algorithm by considering vision information and heuristic rules to identify blocks [14]. VIPS utilizes many visual cues such as element size, background color, font size and *etc.* to build a visual partition tree of a web page. Each node in the tree is a visual block of the web page. Kao [7] proposed WISDOM (Web Intrapage Informative Structure Mining Based on Document Object Model) method. This method evaluates the amount of information contained in node of DOM (Document Object Model) tree with the help of information theory. It first divides the original DOM tree into subtrees and chooses the candidate sub trees with the help of assigned threshold. Then a top-down and greedy algorithm is applied to select the informative blocks and a skeleton set which consist of set of candidate informative structures. Debnath [8] gave four algorithms content extractor, feature extractor, k-feature extractor and L-extractor for separating content blocks from irrelevant content. Content Extractor algorithm finds redundant blocks based on the occurrence of the same block across multiple Web pages. Feature Extractor algorithm identifies the content block with help of particular feature. K-

Feature Extractor, algorithm uses a K-means clustering which gets multiple blocks as compared to Feature Extractor that selects a single block. L-Extractor algorithm combines block-partitioning algorithm (VIPS –Vision based Page Segmentation algorithm) [1] with support vector machine to identify content blocks in a web page. Content-Extractor and Feature Extractor algorithms identifies primary content blocks by i) looking for blocks that do not occur a large number of times across web pages and ii) looking for blocks with desired features respectively. They identify primary content blocks with high precision and recall, reduce storage requirements for search engines, and result in smaller indexes. Performance evaluation shows that content extractor significantly outperforms the entropy based algorithm proposed by Lin and Ho in terms of accuracy and run-time. In content-extractor algorithm Debnath used the same basic concept used by Lin, that a <TABLE> tag is used to design maximum web pages. They make use of some other html tags also while designing the algorithm. Similar blocks across different web pages obtained from different web sites can also be identified using this algorithm.

Kang and Choi [10] proposed algorithm RIPB (Recognizing Informative Page Blocks) using visual block segmentation. This method also partitions web page into blocks based on VIPS. Similar structure blocks are grouped into clusters. A linear weighted function is applied to determine whether the block is informative or not. Uzun[11] proposed hybrid approach which combines automatic and manual techniques together for extraction process. Machine learning methods are used which draw rules for extraction process.

Wang [7] proposed a method which is based on fundamental information of web pages. This method extracts information from each web page and thereby combining that information to get site information. The information extracted is text node i.e. the data present in the tags, word length, menu sub tree which is a sub tree having text node length less than 5, menu item information, and menu instance information. Huang proposed a method employing block pre clustering technology. This method consists of two methods- matching phase and modeling phase. In matching phase, it first partitions the web page into blocks based on VIPS (Vision based Page Segmentation algorithm) [1]. Nearest neighbor clustering algorithm is used to cluster these partitioned blocks based on similar structures. Importance degree is associated with each cluster and clusters with importance degree are stored in clustered pattern database. In modeling phase, when a new web page comes it is first partitioned into blocks and then these blocks are matched with clustered pattern database to get the importance degree of these new partitioned blocks. Entropy evaluation is done on these blocks to know whether they are informative or not.

III. APPROACHES, METHODS AND FACTORS FOR WEB CONTENT EXTRACTION

There are many methods proposed for the main content extraction. By using heuristic rules, determine whether an element of page is textual or not. Here we propose a wrappers language for extracting main content from web pages. The factors such as link density, Rules are considered. In this method the Vision based Page Segmentation algorithm considering for vision information and heuristic rules to identify blocks. [13]

A Novel approach for content extraction from web pages uses WLR. Word to leaf ration (WLR) combines with link attributes [12] of nodes for content extraction.

The popular Web page segmentation algorithms are DOM-based. In DOM-based segmentation, tag information is used to divide a Web page based on the Document Object Model (DOM). The DOM has a tree structure in which each node contains one of the components from an HTML tag. Web pages split using some relatively simple DOM nodes such as the <P>, <TABLE>, and nodes for further conversion or summarization.

We propose a web content extraction technique build on Entropy based Informative Content Density algorithm (EICD). The proposed EICD algorithm initially analyses higher text density content. Further, the entropy-based analysis is performed for selected features.

Here Text density, Content Ratio ,Page information density and Tag information density factors considering for content extraction.[14]

we proposed an algorithm for extracting the core contents of web pages using pattern matching approach that transforms the contents of web pages automatically in to plain text form. This approach deals with web pages of any size and extracts core contents with efficiency and high accuracy. The algorithm extracts high quality contents with efficiency and accuracy. Here we consider a Pattern as factors for content extraction.[15]

A simple but effective approach, named layout based detachment approach (LBDA). The proposed approach extracts the main content from the web page and removes the irrelevant information like header, footer contents, navigation bars, advertisements and other noisy images. This methodology uses tag tree parsing to get the analysis structure, block acquiring page segmentation method to remove unwanted tags, and data extraction to retrieve the necessary contents. It can eliminate noise and extract the main content blocks from web page effectively and display the essential content to the users. Here Time, Storage and accuracy factors consider for content extraction.[16]

The NEWSD (News Explorer for web Streaming Data) is a GUI text mining tool for the classification of web data is developed. In this tool feature extraction and classification apply on various news web sites for content extraction. Classifiers namely Naïve Bayes and J-48 are considering for results. Accuracy is main factors consider here.

IV.CONCLUSIONS

Informative Extraction of web content blocks from web pages is very important because web pages are unstructured and its number is growing at a very fast rate. Content Extraction is useful for the human users as they will get the required information in a time efficient manner.To extract the main content of a web page to prevent the treatment and processing of noisy, irrelevant and useless information is needed. We have presented some approaches for extracting main content from web pages and also studied a new approach for content extraction from web pages. In this paper we studied techniques for the extraction of content blocks based on the various factors for better and effective results. After implementation of various factors on Web page Segmentation and content extraction we get accurate and time efficient result.

REFERENCES

- [1] Lan Yi, Bing Liu, Xiaoli Li, "Eliminating Noisy Information in Web Pages for Data Mining," ACM SIGKDD, August- 2003.
- [2] XuhongZhang,Yanqing Zhang, and Frank "Vision based Web Page Block Segmentation and Informative Block Detection," International Conferences on Web Intelligence and Intelligent Agent Technology, pp. 265- 269,IEEE Computer Society,2013.
- [3] S.H. Lin and J.M. Ho, "Discovering informative content blocks from web documents," Proceedings of the eighth ACM SIGKDD international conference on Knowledge discovery and data mining, KDD ', pp. 588–593, 2002.
- [4] Christian Kohlschütter and Wolfgang Nejdl, "A Densitometric Approach to Web Page Segmentation," ACM SIGKDD, 2008.
- [5] S.Lin and J.Ho, "Discovering informative content blocks from web documents", Proceedings of ACM SIGKDD International Conference on Information Retrieval, pp. 450-453, 2002.

-
- [6] Stevina Dias and Jayant Gadge, "Identifying Informative Web Content Blocks using Web Page Segmentation," *International Journal of Applied Information Systems (IJ AIS)*, Vol. 7, no. 1, pp.37-41, April- 2014
- [7] H.Kao and J.Ho, "WISDOM: web intrapage informative structure mining based on document object model," *IEEE Trans. Knowledge and Data Eng.*, vol. 17, no. 5, pp. 614-627, 2005.
- [8] S.Debnath, P.Mitra, N.Pal and C.Giles, "Automatic identification of informative sections of web pages", *IEEE Trans. Knowledge and Data Eng.*, vol. 17, no. 9, pp. 1233-1246, 2005.
- [9] D.Cai, S.Yu, J.-R.Wen and W.-Y.Ma, "Extracting content structure for web pages based on visual representation", *Proceedings of Fifth Asia Pacific Web Conference*, pp. 406-417, 2003
- [10] J.Kang and J.Choi, "Detecting informative web page blocks for efficient information extraction using visual block segmentation", *International Symposium on Information Technology Convergence*, pp. 306-310, 2007
- [11] E.Uzan, H.Agun and T.yerlikaya, "A hybrid approach for extracting informative content from web pages," *Information Processing and Management*, vol. 49, no. 4, pp. 1248-1257, 2013.
- [12] S.Shen and H.Zhang, "Block-level links based content extraction," *Fourth International Symposium on Parallel Architectures, Algorithms and Programming*, pp. 330-333, 2011.
- [13] Ahmad Pouranmini and Shahram Nasiri, "Web Content Extraction using Contextual Rules," *2nd International Conference on Knowledge-Based Engineering and innovation*, pp. 1014-1018, IEEE Computer Society, 2015.
- [14] Aanshi Bhardwaj and Veenu Mangat, "A Novel Approach for Content Extraction from Web Pages," *Proceedings of 2014 RA ECS UIET Panjab University Chandigarh*, pp.978-980, IEEE Computer Society, 2014.
- [15] Sandeep Sirsat and Dr. Vinay Chavan, "Pattern Matching for Extraction of Core Contents from News Web Pages," *Second International Conference on Web Research (ICWR)*, pp. 13-18, IEEE Computer Society, 2016.
- [16] Dr. Anna Saro Vijendran C Deepa, "LBDA: A NOVEL FRAMEWORK FOR EXTRACTING CONTENT FROM WEB PAGES," *International Conference on Advanced Computing and Communication Systems (ICACCS -2013)*, Dec. 19 – 21, 2013, Coimbatore, INDIA.

Review Paper on Characteristics, Benefits and Challenges in Cloud Computing

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ABSTRACT: -

Cloud computing is a rapidly emerging technology that has significantly changed and opened up potential for many Indian industries. This ubiquitous computing paradigm has completely changed the way that information technology services and infrastructure can be provided. The use of cloud computing in the educational field is becoming more popular. The goal of the current study is to give a general overview of the cloud computing concept and its uses for student and academic collaboration. We suggested cloud computing for e-learning in this study, taking into account its advantages, disadvantages, work mode, services, and benefits. This essay examines cloud computing's potential educational applications, with a focus on management schools. A primary study was conducted with key players in the technical education infrastructures that are put into place for academic usage. The most recent research on cloud computing's application in education was carried out using a qualitative approach. Approximately eight research papers have been discovered and presented following a thorough study of the literature to demonstrate the significance and likely applications of cloud computing in the field of education. The primary stakeholders in education are identified, and the benefits and hazards associated with using cloud computing are analysed in this survey. According to a thorough examination, it is possible to offer more clarity on the benefits of cloud computing by integrating it into management education.

KEYWORDS: - Cloud Computing, Infrastructure-as-a-service (IaaS), Platform as a service (PaaS), Software as a service (SaaS), Data storage as service (DaaS), Public Clouds, Private Clouds, Hybrid Clouds, Community Clouds.

INTRODUCTION: -

When it comes to computing resources, cloud computing refers to on-demand network access that is typically offered by a third party and only needs minimal supervision. Networks, servers, storage, apps, and services are some of these resources. When combined with other technologies and design techniques, cloud computing offers a variety of designs and realistic models.

One of the top ten disruptive technologies for the upcoming years, according to Gartner, is cloud computing. It symbolizes the long-cherished goal of seeing computing as a service, wherein the principles of economies of scale significantly reduce the cost of computer infrastructure. Leading companies, including Sun Microsystems, Google, IBM, Amazon, and Microsoft, have started building new data centers for hosting cloud computing applications in various parts of the world in order to ensure consistency and provide redundancy in the event of a site failure or collapse.

Because all data and apps are stored online, cloud computing offers a number of benefits along with several drawbacks. Due to the real-time and online accessibility of cloud-based apps and data, it can be applied to a variety of daily tasks, such as teaching. A concept known as "cloud computing" makes it possible to have easy, on-demand network access to a

shared pool of resources (such as servers, storage, apps, and services), which can be quickly supplied and released with little administration labor. According to the adopted cloud model, its use forms the foundation of its monetizable worth.

Both instructors and students can access a wide range of cloud-based apps and services for both formal and informal education. Increased collaboration, communication, and resource sharing are made possible by cloud computing, which also offers more mobility and flexibility in the usage of resources for teaching and learning. It also generates virtual communities of teaching and learning or individualized learning environments.

HISTORY OF CLOUD COMPUTING: -

Cloud computing was developed by John McCarthy in 1960. "The use of computers as a subject of research may be arranged as a public utility eventually." According to Parkhill in The Computer Utility Challenges [1], the name "cloud" computing was introduced in the telecommunications industry as a virtual private network. . There was a waste of bandwidth using point-point data lines. Network utilization was balanced using a virtual private network. Servers and network infrastructure are now included. Cloud computing has been widely used by industry participants. Amazon introduced Amazon Web Services, and this has been of great help to their business. Furthermore, Google and IBM have both launched cloud computing research. Eucalyptus was the first open-source platform for private cloud deployment.

CLOUD COMPUTING ARCHITECTURE: -

There are three categories into which cloud computing services fall. the ends on the front and rear. The network, which is typically the network, connects the front end and back end[1]. A system's client, or user, sees its front end, while the system cloud is its back end. Many applications, such as web-based bulk processing systems for the back office, use cloud architectures. Here are a few examples.

- Processing pipelines for OCR-based document processing: This creates searchable raw text from millions of pages and images and converts thousands of Microsoft Word documents to PDF.
- Image processing pipelines capable of encrypting AVI or MPEG files. Constructing a web crawler index Data mining is used to sift through millions of documents.
- Batch processing systems are a kind of back-office program that are used in the retail, banking, and insurance sectors. Reports are produced on a daily and weekly basis using log analysis.

i. Infrastructure-as-a-service (IaaS):

Users of the cloud directly utilize the processing, storage, networks, and other computer resources and IT infrastructure that are made available by the cloud. Virtualization is widely employed in the (IaaS) cloud to mix and match physical resources as needed to satisfy the fluctuating resource requirements of cloud customers. The fundamental method of virtualization is building unique virtual machines (VMs) that are separated from one another and from the underlying hardware. The multitenancy paradigm modifies the software architecture of the program by enabling several instances (from different cloud users) to function on a single application. This strategy is different from that model. A few instances of infrastructure as a service include Google, App Engine, Microsoft Azure, Java, and developer tools[4].

ii. Platform as a service (PaaS):

Cloud users can create cloud services and applications by using a platform called "platform as a service," which supports the entire "software lifecycle." This

offers a development platform that hosts both completed and unfinished cloud applications, in contrast to SaaS, which only hosts completed cloud applications. Therefore, in addition to a hosting environment, PaaS provides development infrastructure, including tools, programming environments, configuration management, and other components. Examples of Platform as a Service (PaaS) include Java, Microsoft Azure, Google App Engine, and developer tools.

iii. **Software as a service (SaaS):**

Programs published in a hosting environment by cloud clients are accessible to a wide range of users with network access (such as web browsers). The SaaS cloud groups users of different cloud consumers' applications into a single logical environment to optimize speed, availability, disaster recovery, maintenance, and security, as well as to realize economies of scale. The cloud infrastructure is not controlled by the user and often uses a number of system architectures. Salesforce, Google Docs, and Google are a few examples.

iv. **Data storage as service (DaaS):**

Data storage services are now a distinct cloud service that offers virtualized storage that is made available on demand. A great data storage solution is available as a special kind of IaaS. This is because dedicated servers, software licenses, post-delivery services, and internal IT maintenance can sometimes come with costly upfront costs for on-premises enterprise database systems. Instead of getting a site license for the whole database, customers can utilize DaaS to pay only for the services they use. Some data storage service providers offer table-style abstractions that store and retrieve large amounts of data in very short times, in addition to more conventional storage interfaces like file systems and relational database management systems, which are often too big, too slow, and quite expensive.

CHARACTERISTICS OF CLOUD COMPUTING: -

The National Institute of Standards and Technology[2] lists five characteristics of cloud computing—such as resource pooling, broad network access, rapid elasticity, etc.—that make it appropriate for use in information technology services and applications.

i. **On-demand self-service:**

Cloud services can be automatically given to customers as needed, without the need for human interaction. These services include server time, storage, web applications, processing power, and networks.

ii. **Resource pooling:**

To serve numerous clients, cloud services combine their computing resources. Either "multi-tenancy," which lets several users share resources, or virtualization, which uses virtual computers to imitate physical hardware, are used to achieve this.[5]

TYPES OF CLOUDS: -

There are three types of cloud computing: private, hybrid, and public clouds[6].

- i. **Public Clouds:** Companies that use and control public clouds do so to provide other organizations and individuals with quick and reasonably priced access to computer resources. It is not necessary for consumers to buy hardware, software, or auxiliary infrastructure when using public cloud services because these are owned and maintained by the providers. A service provider that hosts the cloud infrastructure makes public clouds accessible to everyone. A few instances of public clouds are

- Google AppEngine, Sun Cloud, IBM's Blue Cloud, Amazon Elastic Compute Cloud (EC2), and Windows Azure Services Platform.
- ii. **Private Clouds:** Private clouds are data center architectures with provisioning, automation, monitoring, scalability, and flexibility that are owned by a specific company. The purpose of a private cloud is to obtain the advantages of cloud architecture without giving up control over your own data center maintenance, as opposed to selling "as-a-service" solutions to outside clients. Compared to public clouds, private clouds are more expensive but also more secure.
 - iii. **Hybrid Clouds:** A hybrid cloud is made up of two or more clouds—public, private, or community—that continue to exist as separate entities but are connected to provide the benefits of various deployment options. You can have complete or partial control over third-party cloud providers in a hybrid cloud, which increases computing flexibility. For example, specific apps or sections of applications can be moved to the public cloud during busy times.
 - iv. **Community Clouds:** The purpose of a community cloud is to serve its needs. These communities are made up of individuals or groups with similar interests. This covers groups for standards, industry, research, and so forth. A hybrid type of private cloud designed and run especially for a particular group is called a community cloud. These communities aim to collaborate in order to accomplish their shared business goals, and they have comparable cloud requirements. These clouds aim to provide participating enterprises with the extra privacy, security, and policy compliance typically associated with a private cloud while still enabling them to enjoy the benefits of a public cloud.

BENIFITS OF CLOUD COMPUTING: -

Users are encouraged to adopt cloud computing because of its many benefits. Using cloud computing has several advantages, the main ones being easy scalability, cost savings, and greater productivity.

- i. **Cost reduction:** By using software as a service, businesses can reduce the amount they pay for IT resources, which boosts their operations' productivity and profitability. Payments must be made by customers based on their usage.
- ii. **Increase productivity:** As a result of the quick development of technology, customers are expecting more from brands. Online or cloud-based computer systems must be able to access business applications for cloud computing. Availability of the programmers, which are always and everywhere available to consumers.
- iii. **Scalability:** On-demand business scalability is made possible by the scalable concept of cloud computing. SaaS, PaaS, and IaaS are a few examples. A company can always employ fewer virtual servers than it currently needs based on service demand. There is no set price that small businesses must pay for hosting in a dedicated data centre.

CHALLENGES OF CLOUD COMPUTING: -

There are many obstacles associated with cloud computing technology for various data and information handling sectors. Thus, in the event that you decide to implement cloud infrastructure services, you can run into the following challenges and risks[3]:

- i. **Security and privacy:** These include the technological and organisational challenges associated with preserving an adequate degree of data security and privacy in cloud services. This ensures that when government organisations use the cloud, major security and privacy issues pertaining to the security and privacy of sensitive or important data for a business, like banks, will surface.

- ii. **Data Management:** The demand for effective data management solutions has grown as a result of the greater number of data-intensive applications that cloud computing enables on the widest possible scale. Additional issues with cloud computing across several data centres include data processing and retrieval.
- iii. **Service Management:** The cloud-based IT approach presented a number of challenges for service management. Another challenge is the ability to provide more context-sensitive and customised services.

CONCLUSION: -

The architecture, types, and characteristics of cloud computing were covered in this study. Cloud computing is important to information technology since it lowers costs for businesses and facilitates file access. It also aids in lowering redundancy and data latency. The two main obstacles to cloud computing adoption for any firm are security and privacy.

REFERENCE: -

- [1] S. A. Sheik and A. P. Muniyandi, "Secure authentication schemes in cloud computing with glimpse of Artificial Neural Networks: A Review," *Cyber Security and Applications*, vol. 1, p. 100002, 2023.
- [2] P. mell and T. Grance, "The NIST Definition of cloud computing Recommendations of standards and Technology" Nat.l Stand. Technol.lab, Vol. 145, p.7, 2011.
- [3] VeritisAdmin, "Cloud computing trends, Challenges & Benefits," *Go to Veritis Group Inc.*, 12-Oct-2022. [Online]. Available:
- [4] "12 benefits of cloud computing and its advantages," *Salesforce.com*.
- [5] P. M. Mell and T. Grance, "The NIST definition of cloud computing," 2011.
- [6] <http://www.appcore.com/types-cloud-computing-private-public-hybridclouds/>

IoT Node Security Attacks on Device Layer: Attacks Detection Countermeasures and Solutions

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ABSTRACT

Node identity authentication is an essential means to ensure the security of the Internet of Things. If there is any attacks perform in IoT network then due to the authentication the intruders can be trap and system will not allow to change the network data. Trusted IoT node providing existing or new node authentication and authorization for network credentials, extract node data for extracting IP address, form packet to secret key generation for data privacy. Thus, secure authentication is a major requirement for managing and communicating with respect to the devices in the IoT environment. Currently most IoT devices use default login credentials and not secured with better configurations and protocols which paves way for various types of attacks. In this paper we address the physical node capture attacks, attacks detection on device layer or physical layer, corresponding countermeasure and finally suggesting their solutions for stability under these attacks in IoT network.

Keywords: Attacks, Authentication, Authorization, Countermeasures, Device layer, Internet of Things, IoT Network, IP address, packet generation, Trusted Node, secret key, Security.

1. Introduction

Figure 1 demonstrates IoT node enabled architecture is an important part of the IoT network. In order to protect the security of IoT extract node data approach provides a convenient way to secure end to end communication environments and allows numbers of nodes to establish a secure channel with the help of the trusted server [1, 2].

In figure 1 the dash line circle denoted the transmission range, the blue concentric circle denoted the regular node, and the red concentric circle denoted the new node. The black arrow line represented the message from one node to their neighbour node; the purple line represented the integration message for the data server, red dash line represented the secure key message for sensor node and the green arrow line represented key establishment request [3, 4].

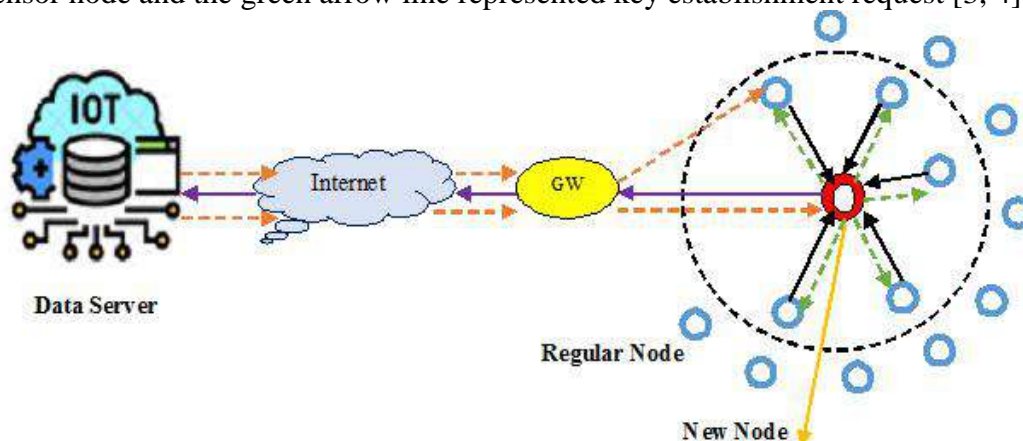


Figure 1: IoT Node Enabled Architecture

2. IoT Node Authentication Process

A secure communication mechanism is established by IoT nodes and devices; while their connection should be activated through the process of node and device binding in figure 2.

Our implementation given in figure 2 has following step by step approach to solving a task:

Steps 1: To create a node and add number of devices for every node with IP address to border router [5, 6].

Step 2: Perform device as well as node login in order that single authenticated user can see the password and connect with the device this procedure is called as IP based manual identification. [7, 8].

Step 3: Every node is configured with unique username and strong password.

Step 4: The particular node is going to be allotted with Node ID to particular device so, we can view the device [9, 10].

Step 5: The data will be considered for authentication of credentials.

Step 6: After that in authentication phase also checked the external or internal attacks present on device layer or physical layer of IoT network [11, 12].

Step 7: Further more stored the data in the cloud generated by the IoT device.

Step 8: Extract the IP address of IoT device form packets in a given node bind with the signal and send to receiver.

Step 9: The dashboard represent the list of nodes and its connected devices.

Step 10: The dashboard also help to control all nodes transmission and their data.

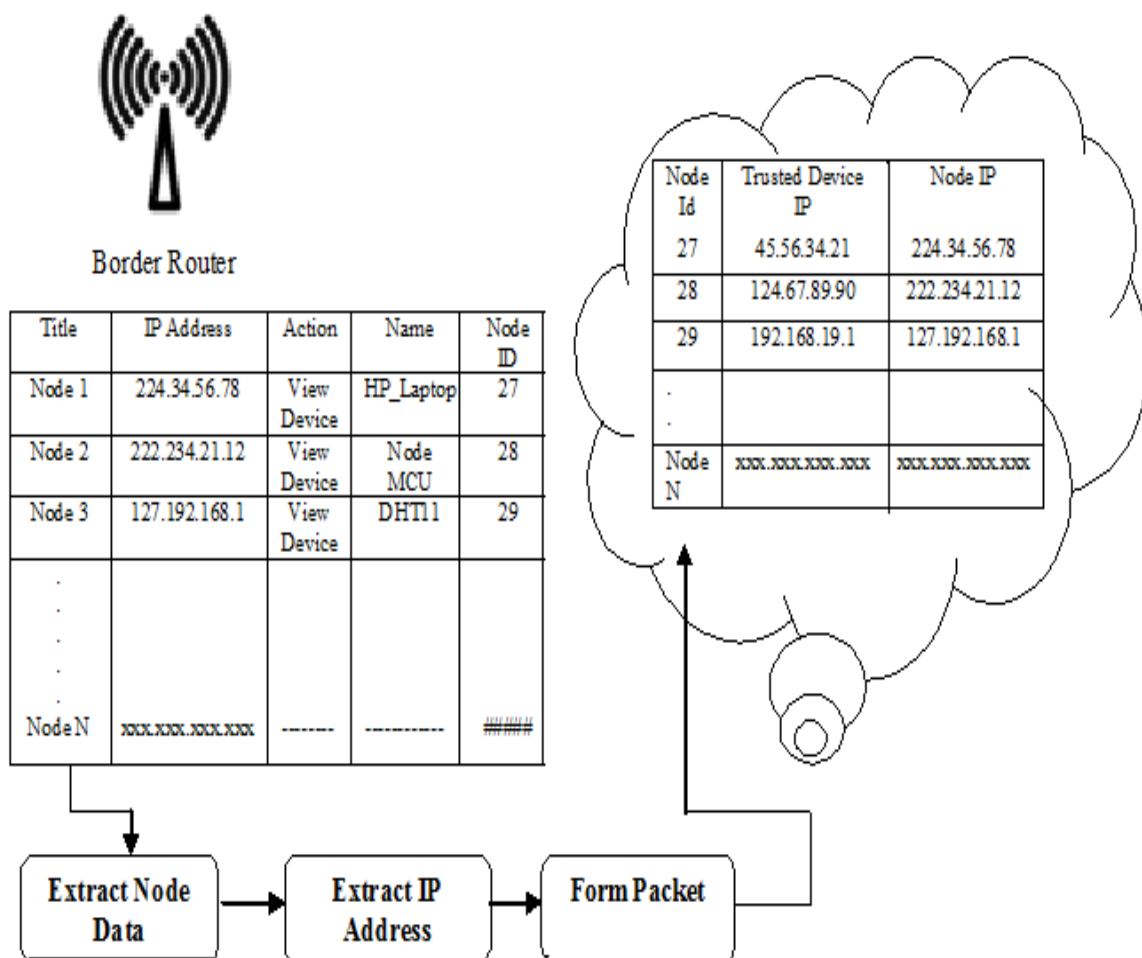


Figure 2: Secure IoT Node Schema

3. Attacks Detection and Problems formulation

Registered the IoT node for particular IoT device with unique node identification number in the process of heavy data streams are generally under security threats because of the following reasons [13, 14]:

- Unlatched Vulnerabilities.
- Lack of adequate Security Solution.
- Unchanged or Unsafe Passwords.
- Limited Memory.
- Limited Radio Bandwidth.
- Highly inefficient unsecured data transfer over the IoT devices network.
- Irregulars' updates and recovery.
- Undefeated Architecture.
- Insufficient memory with limited bandwidth.
- Poor network quality due to network congestion.

3.1 Basic Attack Model:

Figure 2 describes that the intention of an attackers is to find some IoT vulnerabilities from the underlying IoT network and takes benefits of it to steal sensitive data from an IoT device.

IoT devices and IoT nodes are gaining more attention in the perspective of security implementation since it became of urgent need due to unauthorized access to its sensitive data for personal benefits [15, 16].

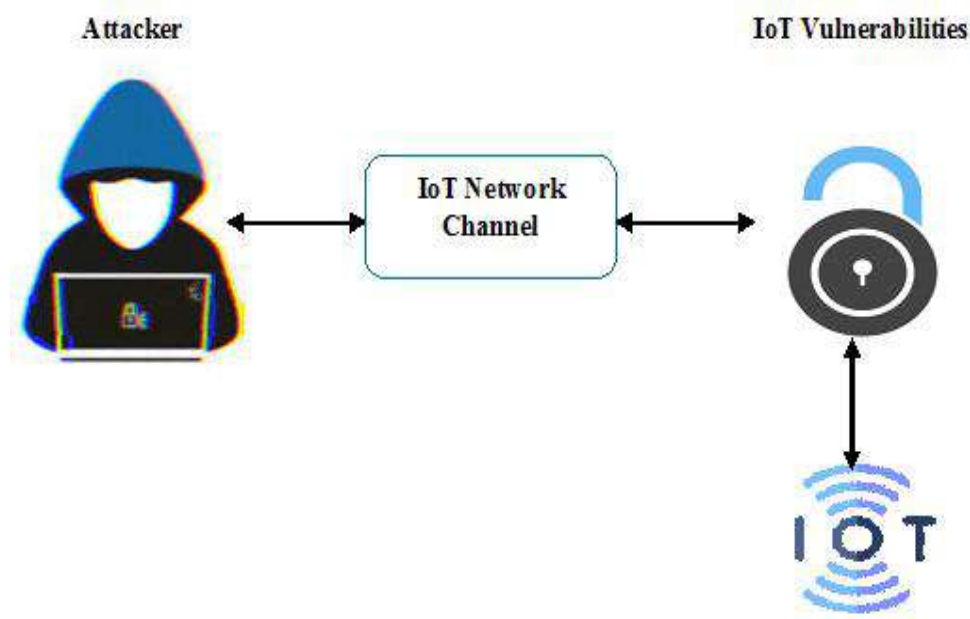


Figure 3: Basic Attack Model on IoT

3.2 Device and Node Capture Attack Model

Here discuss the problem of physical devices and nodes capturing attacks model on IoT network. Extract particular node data with corresponding device name to form a sender-receiver verification and encryption-decryption scheme. The data in IoT network is remain secured and will also check for the sender and receiver terminal. If the sender is right and receiver is also right the cross verification of sender and receiver done as well [17, 18].

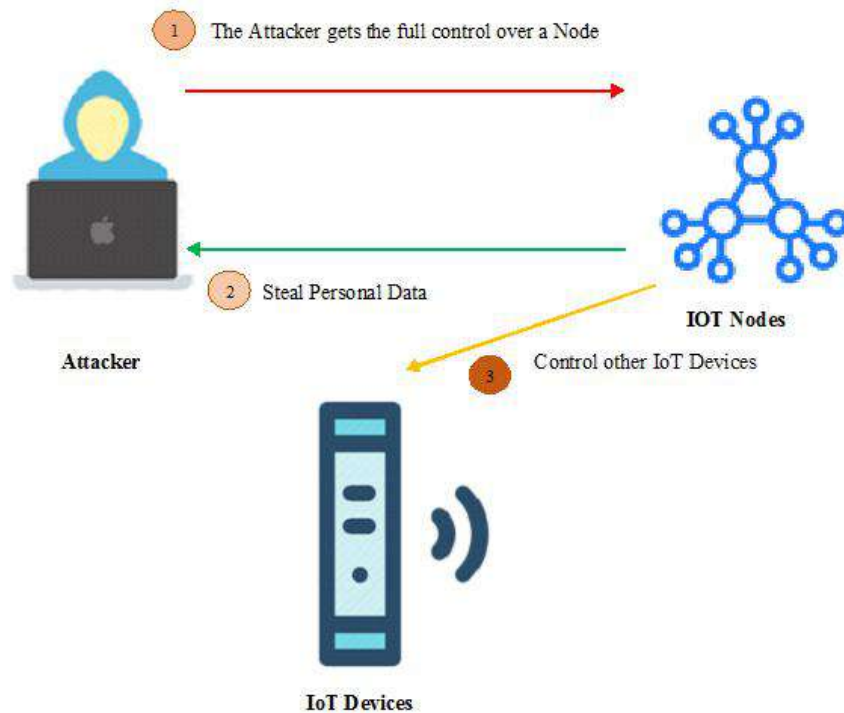


Figure 4: Devices and Nodes Capture Attack Model on IoT

4. Attacks Countermeasures and Solutions

Security is defined as a process to protect a resource against physical damage, unauthorized access by maintaining a high confidentiality and integrity of the useful information and making information about that object available whenever needed. IoT is relying on connectivity of infinite devices for its operation [19, 20].

Hence, the possibility of being exposed to a security attack is most probable. Here classified the IoT security attacks and the proposed countermeasures based on the current security threats, considering the Device layer or physical layer or perception layer. Table 1 summarizes the taxonomy of attacks and feasible solutions of IoT nodes and devices under device layer [21, 22].

Table 1: Taxonomy of attacks and solutions in IoT device layer

Layer/Component	Attacks	Countermeasure	Solutions
RFID Nodes	DoS, Eavesdropping, Spoofing.	Secure localization, Privacy protection.	Access Control , Cryptography Techniques.
Sensor Nodes	Node Subdivision, Node Failure, False Node.	Passive Information Gathering, Don't Form traffic Collision.	Device and Node Authentication Process.
Sensor Gateways	Protocol Tunneling, Man-In-The-Middle, Signal Lost.	Maintain Device and Node IoT Board Security.	Integration Security Message security, Sensor Privacy.

5. Conclusion

This research finding on security risks in IoT emphasize the extension of the attack surface of the IoT threats and Vulnerabilities rise robustly as the connected IoT devices and nodes. Here IoT nodes create dynamic topology and perform their tasks without human intervention against various attacks. IoT devices in all aspects of human life indicate the necessity of considering these security threats before the implementation of the countermeasures. This paper also highlights the proper attacks detection and their suitable solutions, which have proved to be effective in securing communication between IoT nodes and devices. The authenticated binding process can be able to tackle the various attacks in IoT nodes and devices make the IoT network to strong so that this mechanism will help in future to integrate with the various types of projects and the leakage found in the services can be identify and rectify as per the concerning security algorithms and protocols. This studied have limitation in only node failure cases but the occurrence of this is to very less. Therefore, the future work will focus on improvement in dynamic performance of IoT node environment and the behaviour prediction of attackers.

6. References

- [1] Shiqiang Zhang, et al., "A Heterogeneous IoT Node Authentication Scheme Based on Hybrid Block chain and Trust Value", KSII Transactions on Internet and Information Systems Vol.14, No.9, PP.3615-3638, ISSN:1976-7277, September 2020.
- [2] Mohamad Faiz Razali, et al., "TPAL: A Protocol for Node Authentication in IoT", Journal of Computer Science, Vol.14, No.10, PP.1401-1411, doi:10.3844/jcssp.2018.1401-1411, 26 October 2018.
- [3] Chun-Ta Li et al., "A Secure Three Party Node Authentication and Key Establishment Scheme for the Internet of Things Environment", Journal of Internet Technology, Vol.19, No.1, PP.147-155, doi:10.3966/160792642018011901014
- [4] Ilker Yavuz, et al., "End to End Secure IoT Node Provisioning", Journal of Communications, Vol.16, No.8, PP.341-346, doi:10.12720/jcm.16.8.341-346, 8 August 2021.
- [5] V.S. Saranya, et al., "An Intelligent IoT Attack Detection Framework Using Effective Edge AI Based Computing", Indian Journal of Computer Science and Engineering (IJCSE), Vol.13, No.4 PP.1156-1167 E-ISSN: 0976-5166, P-ISSN: 2231-3850, July-August 2022, doi:10.21817/indjcse/2022/v13i4/221304059.
- [6] K. Ravikumar, et al., "Detection of Node Capture Attack in Wireless Sensor Networks", International Journal of Scientific Research in Computer Science and Engineering, Vol.6, Issue 4, PP.56-61, E-ISSN:2320-7639, 31 August 2018.
- [7] C. Ramakrishna et al., "A Survey on Various IoT Attacks and its Countermeasures", International Journal of Engineering Research in Computer Science and Engineering, Vol.5, Issue 4, PP.143-150, ISSN: 2394-2320, April 2018.
- [8] Bichen Che et al., "KNEMAG: Key Node Estimation Mechanism Based on Attack Graph for IoT Security", Journal of Internet of Things, Vol.2, No.4, PP.145-162, ISSN: doi: 10.32604/jiot.2020.010035, 15 August 2020.
- [9] Nivedita Sharma, et al., "Novel Technique for Detection of Malicious Nodes in IoT", International Journal of Research In Electronics and Computer Engineering (IJRECE), Vol.7, Issue 3, PP.483-487, ISSN: 2393-9028(Print), ISSN: 2348-2281(Online), July-Sept 2019.
- [10] Moinul Hossain, et al., "Hidden Terminal Emulation: An Attack in Dense IoT Networks in the Shared Spectrum Operation", Vol.1, ISSN:6, ISSN:7281-0962, 2019 IEEE.
- [11] Xin Liu, et al., "Identifying Malicious Nodes in Multihop IoT Networks using Dual Link Technologies and Unsupervised Learning", Open Journal of Internet of Things(OJIOT), Vol.4, Issue 1, PP.109-125, ISSN:2364-7108, 2018.
- [12] K. Somasundaram et al., "IoT-Attacks and Challenges", International Journal of Engineering and Technical Research (IJETR), Vol.8, Issue 9, PP.09-12, 2454-4698(Print), ISSN: 2321-0869(Online), September 2018.
- [13] Rupali Sachin Vairagade et al., "A Study of various authentication mechanisms towards the secure Internet of Things networks", Control and Cybernetics, Vol.49, No.4, PP.393-418, January 2021.

-
- [14]Ms.K.Devipriya et al., "Enhancing Security in IoT Platform Using Secure Authentication Protocol", Turkish Journal of Computer and Mathematics Education, Vol.12, No.14, PP.5698-5708, 2021.
- [15]Gaurav Sharma,et al., "A Survey on Layer-Wise Security Attacks in IoT: Attacks, Countermeasures, and Open-Issues", Journal Electronics,PP.01-23,28 September 2021,Electronics 2021,10,2365.<https://doi.org/10.3390/electronics 10192365>.
- [16]Sher Ali et al., "Survey Paper on IoT Attacks and Its Prevention Mechanisms", Information Management and Computer Science (IMCS), Vol.3, Issue 2,PP.38-41,ISSN:2616-5961,doi:<http://doi.org/10.26480/imcs.02.2020.38.41,28> December 2020.
- [17] AArul,et al., "A Review on Intrusion Detection Systems to Secure IoT Networks", International Journal of Computer Networks and Applications(IJCNA),Vol.9,Issue 1,PP.38-50,ISSN:2395-0455,doi:10.22247/ijcna/2022/211599,January- 28 February 2022.
- [18] Ali Hamid Farea et al., "Enhancement Trust Management in IoT to Detect ON-OFF Attacks with Cooja", International Journal of Multidisciplinary Studies and Innovative Technologies, Vol.5, No.2, PP.123-128, 2021.
- [19]Ansam Khraisat et al., "A Critical review of intrusion detection systems in the internet of things: techniques, deployment strategy, validation strategy, attacks, public datasets and challenges", Cyber Security Springer Open Access, Vol.4, No.7, Issue 18, PP.01-27, ISSN: 42400-00077 <https://doi.org/10.1186/s42400-021-00077-7,2021>.
- [20] AKM Bahalul Haque, et al., "Security Threats and Research Challenges of IoT-A Review", Journal of Engineering Advancements, Vol.1, Issue 4, PP.170-182, 22 December 2020,<https://doi.org/10.38032/jea.2020.04.008>.
- [21]Anit Kumar et al., "Detection of Security Attacks on Edge Computing of IoT Devices through NS2 Simulation", 4th International Conference on Intelligent Circuits and Systems, PP.01-09, ISSN: 1742-6596,doi:10.1088/1742-6596/2327/1/012016.
- [22] Anca D.Jurcut, et al., "Introduction to IoT Security", ResearchGate, PP.01-37, 22 April 2020,doi:10.1002/9781119471509.w5GRef260.

4

Overview and Classification of Social Security Attacks using Online Social Networking for Rumour Blocking

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Abstract

The online social networking providers destine to secure their users; but the intruders and attackers are able to outsmart the security measures by exploiting user's privacy, identity and confidentiality using several techniques. An online social network(OSN) are permanent presence in today's personal and professional of a huge segment of the population. OSN also referred to as a virtual community is a website on the internet that serves as an ultimate location for people from different geometric locations to talk, share photos, ideas and interests, or make new friends. With the rapid increase in popularity and large number of user base, the online social networks also face an alarming rate of increase in security treats and rumors. On the other hand they become a cannel for the spreading of malicious rumors or misinformation. Most of the users in social networking sites might be unaware of the existence of these critical threats. We study different types of attacks to fight against rumors on social network. This paper highlights an overview and classification of Sybil, malware, Distributed Denial-of-service(DDOS), spam attacks.

Keywords: Attacks, OSN, DDOS, Social Security Network, Rumor Blocking

1. Introduction

With the increasing popularity of online social networks such as Twitter, Facebook, Renren and so forth. Rumors can spread farther, quicker and even with more terrible effect. An online social network have become a mainstream cultural phenomenon for millions of Internet users. In real world situation, Rumors exist in almost every domain of society. Example given, a Rumor generated in Twitter said that the president of Syria is dead, which hit the twitter greatly and was circulated fast among the population. We study different types of attacks to fight against rumours on social network. OSN services handle user's information and manage all user;s activities in the network. Being responsible for the correct functioning of its services and maintaining a profitable business model. Indirecting this translates into ensuring that their users continue to happily use their services without becoming victims of malicious actions. However attacks such as Sybil, Distributed Denile of service(DDOS) ,Spam and Malware. OSN's may translate into reputation damage. Service distruption or other consequences with direct effect on OSN.

These attacks are aimed at the service provider itself by threatening its core business. These attacks can be performed by number of ways. However attacks on the OSN exploit the social graph of the OSN and victimised more users by propagating rapidly. So, the priority of the service provider would be identify and stop the propogation we brifly discuss different types of attacks on OSN's.

2. Types of Attacks

2.1 Sybil Attack:-

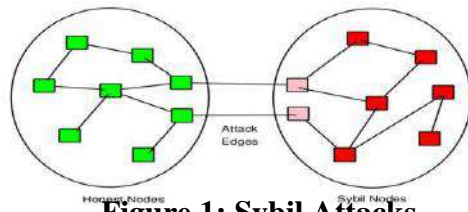


Figure 1: Sybil Attacks

In the Sybil attack, the malicious user claims multiple identities to compromise the whole network. Sybil attacks can be used to change the overall ranking in voting applications, access resources or to break the trust mechanism behind a P2P network. A P2P network is built on the assumption that each entity in the network holds a single identity. When an adversary introduces many bogus identities with a single entity or with no entity at all, a Sybil attack occurs. Using Sybil identities, an adversary may provide false opinions for his/her evil benefits, limit the amount of resources reaching each node, break the trust mechanism in a P2P network and may even cause a Denial-of-Service attack (DoS)[1]. In the initial researches to deal with Sybil attacks, network architectures were re-designed and secure mechanisms such as digital signatures and digital analyzers were used to mitigate the Sybil attacks[2]. Much effort has gone into the study of trust relationships in social networks [1][2][3][5] and community based schemes to reduce the influences of Sybil attacks [6][7].

2.1.1 Classification of Sybil attacks

(i) Direct vs. In-Direct communication

the attacker must consider the type of communication between honest nodes and Sybil nodes [2][5]. If the communication between honest node and Sybil node is direct, i.e. if the attacker can directly communicate with the honest node using fake identities, it is a case of direct communication. However, if the attacker has to use his legitimate identity to communicate with the honest node, and then divert the Sybil data to the honest node via the legitimate node, it is the case of indirect communication. It is easier for the attackers to launch Sybil attacks in case of direct communication and it is also more difficult to detect such attacks.

(ii) Busy vs. Idle: In a P2P network, normally, only few Sybil identities participate in the network while the others remain idle. The power of the Sybil attacker comes from the number of identities he or she holds. If an attacker could afford to get fake identities easily, he or she can make the identities appear more realistic by making them leave and join the network multiple times pretending as an honest node. However, if the number of the Sybil identities are limited, the Sybil identities must participate simultaneously to launch an attack[5].

(iii) Simultaneous vs. Non Simultaneous A simultaneous attack can be performed by involving all the Sybil identities simultaneously or a single physical node can change its identities in regular time slots to appear like all the identities are involved simultaneously. In non-simultaneous attack, an attacker may bring all his identities into the network slowly over a period of time involving only few identities each time. This can be done by pretending that one identity is leaving the network while the other identity is joining the network. As honest identities generally tend to leave and join the network number of times, the malicious node won't be suspected if they pretend to leave or join the network now and then using different identities[8].

(iv) Insider vs. Outsider The impact of the Sybil attack depends on whether the attacker is inside or outside the distributed network. If the adversary is part of the network and holds at

least one real identity, then the attacker is called an Insider, otherwise he or she is an outsider. An insider may introduce many fake identities, and pretend to communicate with other nodes using his fake identities. However, for an outsider, it is difficult to introduce Sybil identities into the network,

2.2 Distributed Denial-of-service:

A distributed denial-of-service (DDoS) attack is an attack in which multiple compromised computer systems attack a target, such as a server, web site or other network resource, and cause a denial of service for users of the targeted resource. The flood of incoming messages, connection requests or malformed packets to the target system forces it to slow down. Exploited machines can include computers and other network resources such as IoT devices. In a typical DDoS attack, the assailant begins by exploiting a vulnerability in one computer system and making it the DDoS master. The attack master system identifies other vulnerable systems and gains control over them by either infecting the systems with malware or through bypassing the authentication controls (i.e., guessing the default password on a widely used system or device). A computer or networked device under the control of an intruder is known as a zombie, or bot. The attacker creates what is called a command-and-control server to command the network of bots, also called a botnet[10]. The person in control of a botnet is sometimes referred to as the botmaster (that term has also historically been used to refer to the first system "recruited" into a botnet because it is used to control the spread and activity of other systems in the botnet). Botnets can be comprised of almost any number of bots; botnets with tens or hundreds of thousands of nodes have become increasingly common, and there may not be an upper limit to their size.

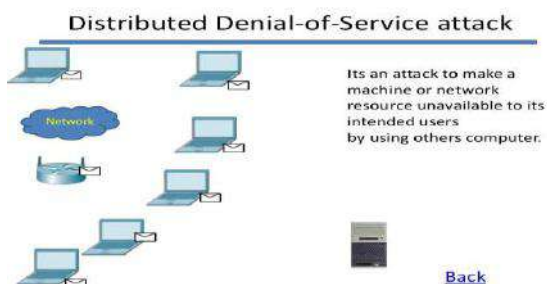


Figure 2: DDOS

2.2.1 Classification of DDoS attacks

There are three types of DDoS attacks. Network-centric or volumetric attacks overload a targeted resource by consuming available bandwidth with packet floods. Protocol attacks target network layer or transport layer protocols using flaws in the protocols to overwhelm targeted resources. And application layer attacks overload application services or databases with a high volume of application calls. The inundation of packets at the target causes a denial of service. While the things comprising the internet of things (IoT) may be useful to legitimate users, in some cases, they are even more helpful to DDoS attackers. The devices connected to IoT include any appliance into which some computing and networking capacity has been built, and, all too often, these devices are not designed with security in mind[9]. Devices connected to the IoT expose large attack surfaces and display minimal attention to security best practices. For example, devices are often shipped with hard-coded authentication credentials for system administration, making it simple for attackers to log in to the devices. In some cases, the authentication credentials cannot be changed. Devices also often ship without the capability to upgrade or patch device software, further exposing them to attacks that leverage well-known vulnerabilities. Internet of things botnets are increasingly being used to wage massive DDoS attacks.

2.3 Spam Attack

is an endless repetition of worthless text or image. Spam can spread out in any information systems like emails, web, social network sites, and blogs or in review platforms. The concept of web spam was introduced in 1996 [11] and it soon become key challenges for search engine industry [12]. Nowadays the major search engine companies have identified adversarial information retrieval [13] as top priority because of multiple negative effects caused by spam, and also the appearance of new challenges in the field of research. First spam spoils the quality of research and prevents the legitimate websites of revenue that might earn in the absence of spam. Second it weakens the trust of user in a search engine provider which is a notable issue since the user can easily continue his search form one search engine to other. Spam refers to the use of electronic messaging systems to send out unrequested or unwanted messages in bulk.



Figure 3:Spam Attacks

2.3.1 Classification of Spam Attack

i) Social network spam: In past few years the development of social networking sites is very high. The people communicate with their friends and chat or share multimedia contents with them. Sites like facebook, twitter are constantly among top 20 most viewed websites on the internet [13]. People spent more time on social network compared with other sites. The increase in popularity of social networks allows them to collect a huge amount of personal information about the users, their friends, habits and also their wealth information. In social network a person can reach any person which is attracted by the malicious parties.. As for Twitter, [12] ran an experiment on Twitter spam.Regarding the drawbacks in Bayesian spam filter an user-friendly spam filter called Social network Aided Personalized and effective spam filter (SOAP) is used.. social closeness spam filtering, social interest based spam filtering, and adaptive trust management.

ii) Email spam: The most common communication in the internet is using email communication. With the vast growth in email and its popularity unsolicited e-mail (spam) also emerged very quickly with almost 90% of all email messages. i.e., over 120 billion of these messages are sent each day [12]. The cost of sending these e-mails is very close to zero being easy to reach a high number of potential consumers [13]. In this context, spam consumes resources; time spent reading unwanted messages, bandwidth, CPU, disk, being also used to spread malicious content. The email system design can easily be exploited by spammers who send inaccurate information. All email on the Internet is sent via a protocol called Simple Mail Transfer Protocol ("SMTP").SMTP is designed to capture information about the route that an email message travels from its sender to its recipient. In actuality, the SMTP protocol provides no security, email is not private, it can be altered en route, and there is no way to validate the identity of the email source.

iii) Image spam :Recently, spammers have proliferated "image spam", emails which contain the text of the spam message in a human readable image instead of the message body. It consists in embedding the spam message into images which are sent as email attachments. Its

goal is to circumvent the Analysis of the emails' textual content performed by spam filters, including automatic text classifiers. Since attached images are displayed by default by most email clients, the message is directly conveyed to the user as soon as the email is opened. The simplest kind of image spam can be viewed as a screen shot of a plain text written using a standard text editor

iv) Click spam. Here the spammers generate fraud clicks and make the control function towards their websites. To achieve the goal spammers submit queries to search engine and click on the links point to the target pages [12, 13]. Online advertising is other incentive for spammers to generate fraudulent clicks [13]

V) Content Spamming : Content spamming involves changing the logical view that the search engine has over the page contents. An example of content spamming is keyword stuffing which involves placement of keywords within the webpage to raise the keyword count.

Malware Attack

Malware does the damage after it is implanted or introduced in some way into a target's computer and can take the form of executable code, Script, active content and other software[14]. The code is described as computer viruses, worms, Trojan Horses, Spyware[15]. The term malware comes from combining the two words malicious and software, and to be used to indicate any unwanted software. any code added, changed, or removed from a software system.[16].The purpose of Malware is to cause damage or penetrate users computer for the purpose of hacking personal data for illegal activity such as financial crimes. Many DoS viruses, and the Windows Explore Zip worm, are designed to demolish files on a hard disk, or to corrupt the file system by writing void data to them.

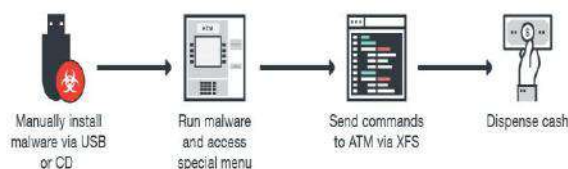


Figure 4:Malware Attacks

2.4.1 Classification of Malware Attack

Several malware classifications have been issued so far, depending on some of their characteristics. The purpose of such classifications is to facilitate the tracking of authorship, correlating information, identifying new variants [17]. However, The classification made, is to categorize the major common malware types into groups depending on the network and web usage.

i) Network-based Malware

Spyware is a kind of malware that is installed secretly on a user computer for the purpose of collecting information about users without their knowledge [17]. Even reputable vendors of software like Microsoft and Google, intentionally, collect information of their users using spywares [18].

Cookies are some information stored on user's computer by their web browsers. The main purpose of cookie is to authenticate users depending on the information stored in, storing site preferences and server-based session.

Trojan horse is a code that appears to be a useful program, but actually it steals information or corrupts data [17,18].

Botnet is a collection of infected computers (contains bot software embedded in it) that have been taken over by hacker and used to perform malicious functions, without the hackers having to log into the client's computer. Botnet can make DoS attack as many clients' bots, under control of hacker bot, having a role of attack [19, 20].

ii) Ordinary Malware

Virus is any software code that has the ability to replicate itself, during infection, into any other application software or a document. Viruses can do harmful functions on a user machine; it can make destruction to the whole system from infected device to uninfected one [18, 19, 20]. Worm is any software code that has the ability of self replicating on victim computer. Worms are independent; they don't need for a host program to start lifecycle[20].

3. Comparative Analysis of Online Social Security Attacks

Table 1: Comparison of Social Security Attacks:

Attacks Type	Sybil	DDoS	Spam	Malware
Layers	Network	Transport,Application	Application	Network
Techniques	Light Weight Sybil Attack Detection	Defence techniques	Rulr Based scoring system	Signature and Detection
Methods	Robust,Lightweig ht	Artificial Neural Network	Spammers	Pre-pending, Embedding,Post-pending
Virus Activated	Worm	Botnet	Worms	Trojan Horse
Mode of Attacks	Rumor(Bogus Identities)	Intruder	Repetition of worthless text or image	Intrusive Code
Protocol	P 2 P	UDP,TCP/IP,HTTP, SMURF	SMTP,VOIP	UDP,HTTP,SOCKS 4/5
Advantages	i)Efficient in large overhead ii)No clock synchronization	i) Detecting and stopping a DDoS attack at the Source providesr. ii) minimum damage is done on legitimate traffic .	i) it is essential to send as many messages as possible in a short period of time. ii) the transitional period as only one service needs to be maintained instead of two parallel running services	i) Protection from Phishing Attacks ii) Provides Robust Web Protection
Disadvantages	i) reliability is lesser ii) May encourage attackers economically	i)Detecting DDoS attacks at source end is difficult because sources are widely distributed across the network and a single source behaves like a normal traffic. ii)The difficulty of deploying system at the source end	i) Limiting the number of emails that can be send ii) Analyzing the messages to determine if they contain spam or no	i) Security defects in software ii)_Insecure design or user error

4. Conclusion:

In this paper, we study how social network security attacks occurs to fight against rumors on social network and their classification. In Sybil attack, an insider may introduce many fake identities and pretend to communicate with other nodes using his fake identities and for an outsider it is difficult to introduce sybil identities into the network. In DDoS, multiple compromised computer systems attacks a target such as server, website or other network resources and exploiting a vulnerability in one computer system and making it the DDoS master. Using SMTP, VoIP protocols, Spam is essential to send many messages in short period of time. There is an endless repetition of worthless text or images. spam can spread out in any information system like E-mails, Web, Social Network Sites. using malware attack any code added, changed or removed from a software system in order to intentionally cause harm or disturb the intended function of the system that encompasses viruses, Trojans and other intrusive code. The purpose of such classification is to facilitate the tracking of authorship, correlating information, identifying new variants.

References

- [1] H. Yu, M. Kaminsky, P.B. Gibbons, and A. Flaxman. Sybil Guard: Defending against Sybil attacks via social networks. In SIGCOMM, 2006.
- [2] H. Yu, M. Kaminsky, P.B. Gibbons, and A. Flaxman. Sybil Limit: A near optimal social network defense against Sybil attacks. In IEEE Symposium on Security and Privacy, 2008.
- [3] J. Newsome, E. Shi, D. Song, A. Perrig. The Sybil Attack in Sensor Networks: Analysis & Defenses, In Proc. of ACM IPSN, 2004.
- [4] W. Chang and J. Wu. A Survey of Sybil Attacks in Networks. In publications of computer and Information Sciences, Temple University, Philadelphia, 2013
- [5] G.V. Rakesh, S. Rangaswamy, V. Hegde, G. Shoba. A Survey of techniques to defend against Sybil attacks in Social Networks, In IJARSCCE, 2014.
- [6] W. Wei, F. Xu, C.C. Tan, Q. Li. SybilDefender: Defend Against Sybil Attacks in Large Social Networks, In Proc of IEEE INFOCOM, 2012.
- [7] L. Shi, S. Yu, W. Lou, Y. T. Hou. SybilShield: An agent-Aided Social Network-Based Sybil Defense among Multiple Communities, In Proc of IEEE INFOCOM, 2013
- [8] Manju V C "Sybil attack prevention in Wireless Sensor Network", IJCNWMC 2014.
- [9] A. Harrison, "The denial-of-service aftermath," Feb. 2000, <http://www.cnn.com/2000/TECH/computing/02/14/dos.aftermath.idg/index.html>.
- [10] www.academia.edu/2963956/A_Brief_Review_of_Denial-of-Service_Research_Papers
- [11] Wikipedia, "Spam" [http://en.wikipedia.org/wiki/Spam_\(electronic\)](http://en.wikipedia.org/wiki/Spam_(electronic))
- [12] <https://www.ijcaonline.org/archives/volume157/.../vairagade-2017-ijca-912633.pdf>
- [13] <https://ieeexplore.ieee.org/abstract/document/7226077/>
- [14] <https://ieeexplore.ieee.org/document/8094101/> Vinod, P., et al., Survey on Malware Detection Methods. 2009
- [15] McGraw, G. and G. Morrisett, Attacking Malicious Code: A Report to the Infosec Research Council. IEEE Softw., 2000. 17(5): p. 33-41.
- [16] Xufang, L., P.K.K. Loh, and F. Tan. Mechanisms of Polymorphic and Metamorphic Viruses. in Intelligence and Security In
- [17] Egele, M., et al., A survey on automated dynamic malware-analysis techniques and tools. ACM Comput. Surv., 2008. 44(2): p. 1-42.
- [18] Idika, N. and A.P. Mathur., A Survey of Malware Detection Techniques. 2007.
- [19] Nataraj, L., Karthikeyan, S., Jacob, G. and Manjunath, B. (2011) Malware Images: Visualization and Automatic Classification. Proceedings of the 8th International Symposium on Visualization for Cyber Security, Article No. 4.
- [20] Nataraj, L., Yegneswaran, V., Porras, P. and Zhang, J. (2011) A Comparative Assessment of Malware Classification Using Binary Texture Analysis and Dynamic Analysis. Proceedings of the 4th ACM Workshop on Security and Artificial Intelligence,

Big Data Analytics In Health Care: A Reviewpaper

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ABSTRACT

The application of big data in health care is a fast-growing field, with many discoveries and methodologies published in the last five years. Big data refers to datasets that are not only big but also high in variety and velocity, which makes them difficult to handle using traditional tools and techniques. Moreover, medical data is one of the most growing data, as it is obtained from Electronic Health Records (EHRs) or patients themselves. Due to the rapid growth of such medical data, we need to provide suitable tools and techniques in order to handle and extract value and knowledge from these datasets to improve the quality of patient care and reduces health care costs. Furthermore, such value can be provided using big data analytics, which is the application of advanced analytics techniques on big data. This paper presents an overview of big data content, sources, technologies, tools, and challenges in health care. It also intends to identify the strategies to overcome the challenges.

KEYWORDS *Big Data, Healthcare, Big data challenges, EHRs.*

1. INTRODUCTION

Nowadays there is increasing in the details and data presented through the advancements in technologies and the internet. Anything ranging from consumer names and addresses to products available, to purchases made, to employees hired, etc. has become necessary for day-to-

daycontinuity. Withtheimprovementinstoragecapacitiesandtechniquesofdatacollection,enormous amounts of data have become easily available. Every second, more and more data is being produced and needs to be stored and analyzed in order to obtain value. Furthermore, data havebecome cheaper to store, so business companies and organizations need to get as much value as possible from the huge amounts of data collected daily.

Data sets increase rapidly because they are frequently gathered by many information-sensing devices such as mobile devices, aerial (remote sensing), software logs and records, cameras, microphones, radio-frequency identification (RFID) readers, and wireless sensor networks [1]. Thus, big data is a field that explains methods to analyze, systematically obtain information from, and how to deal with data sets that are too large or complex to be dealt with by traditional data processing applications.

The health care industry is one of the most important industries. It is also one of the world's largest and fastest-growing industries it can produce and handles data at a staggering speed, but different electronic health records (EHRs) collect data in different structures: structured, unstructured, and semi structured. This variety can pose a challenge when seeking veracity or quality assurance of the data. The EHRs can provide a rich source of data, ready for analysis to improve our understanding of disease mechanisms, as well as better and personalized health care, but the data structures pose a problem to standard means of analysis. So, there is a need for converting the raw Data into significant and action able information by using big data analytics tools [2].

Big data in healthcare refers to electronic health data sets so large and complex that they are difficult (or impossible) to manage with traditional software or popular tools and methods [3]. Accordingly, big data in healthcare is overwhelming not only because of its volume of data sets but also because of the variety of data types and the speed at which it must be managed. The purpose of this systematic review is to provide a summarize of big data analytics in healthcare. First, we define and explain the definition of big data and the characteristics of big data analytics in the healthcare domain. Then we describe the big data types in healthcare. Third, we provide examples of big data analytics in healthcare. Fourth, we compile a list of challenges and opportunities faced by big data analytics in health care. Finally, we offer conclusions and future directions.

2. BACKGROUND

2.1. Defining Big Data

The concept of “big data” is not new, however, the way it is defined is continually changing. Many authors have provided big data definitions such as Zulkarnain et al. [4] define Big Data as “data sets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze”. Likewise, Kaislere et al. [5] say “Big data is data too big to be handled and analyzed bytr additional database protocols such as SQL”. Moreover, the authors in [6] present big data as a collection of data elements whose size, speed, type, and/or complexity require an attempt to use and discover new hardware and software tools to successfully store, examine, and visualize the data. Accordingly, Big Data points to large, complex datasets that are exceeding the capabilities of the traditional data management system to store , manage and process them.

2.2. Big Data Characteristic

As with all big things, if we want to manage them, we need to characterize them to organize our understanding. The three Vs (volume, velocity, and variety) are known as the main characteristics of big data. These features are key to understanding how we can measure bigdata. The volume of the data refers to its size, and how huge it is. While the velocity points to the rate with which data is changing, or how often it is created. Finally, the variety involves several formats and types of data, as well as the different kinds of uses and ways of analyzing the data [7]. The characteristics are described below in Fig.1.

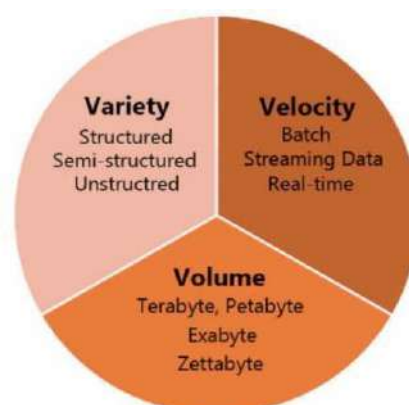


Figure1. The Big Data Characteristic

As shown in Figure.1. Big Data can be described by the following characteristic:

Data volume: This is the first and most important attribute of big data. Big data can be quantified by size in Tb soar PBs, as well as even the number of records, transactions, reports, or files. The volume of data used to play important role in storage and processing. However, many factors can contribute to the volume rise in data, it could amount to hundreds of terabytes or even petabytes of information generated anywhere. As displayed in [8], the number of data sources for an organization is growing day by day. And therefore, more data sources consisting of enormous datasets increase the volume of data, which needs to be analyzed. As noted in [8], Fig. 2 shows that the volume of data stored in the world would be more than 40 zetta bytes (10^{21} Byte) by 2020.

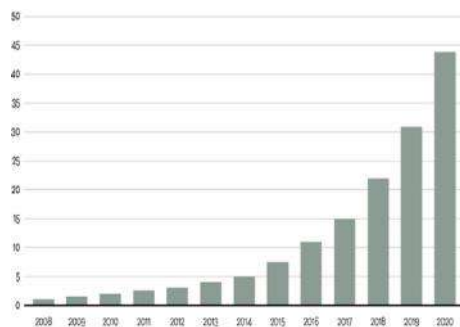


Figure2.Data volume growth by year in zetta bytes

- || **Data Velocity:** Points to the speed at which new data is generated and the speed at which data flows around, Hence, increasing speed in data processing, storage, and analysis by relational databases. Moreover, Velocity assists organizations understand their relative growth of their big data and how quickly that data reaches sourcing users, applications, and systems. Some activities are very important and require immediate responses, which is why quick processing maximizes effectiveness. For time-sensitive processes such as fraud detection, Big Data flows must be analyzed and used as they stream into the organizations to maximize the usefulness of the information. An illustration of data that is generated with great velocity would be Twitter messages or Facebook posts.
- || **Data Variety:** The next aspect of Big Data is its Variety. Which indicates the type of data that big data can contain. Big data is not always structured data. That means Big Data consists of any type of data, this data may be structured or unstructured such as text, sensor data, speech recordings, video, click streams, log files, and soon. Because Big Data contains data of different types and sources, Dealing with a variety of structured and unstructured data increases the complexity of both analyzing and storing Big Data. One of the goals big data is to employ technology to take this unstructured data and obtain an understanding of it.

2.3. Big Data in Health Care

In the healthcare field, the progress in information technology and the capability of storing more data have driven countries and governmental institutions to computerize health records and produced the Electronic Health Record (EHR) or Electronic Medical Record (EMR). Big data analytics in medicine and healthcare allows analysis of the large datasets from thousands

of patients, identifying clusters and correlation between datasets, Moreover improving predictive models using data mining techniques. As the health care industry focuses on improvements in order to save patients' lives, Big Data Analytics can play an important role in improving the services provided to health care by:

- Managing hospital performance
- Prevent epidemics, cure disease, and decrease costs.
- Increase transparency and efficiency in early disease diagnosis
- Enhancing clinical outcomes
- Engaging patients and family

3. RESULT

The literature included in this study contains essentially descriptive papers and studies. Based on the main research goals, the content from these studies was extracted and the papers were classified into many groups: Big Data analytics definition and concepts, sources of Big Data in healthcare, Big Data techniques for healthcare analytics, application and potential benefits of Big Data in healthcare and challenges in Big Data analytics in healthcare. The next section summarizes the conclusions in each of these categories.

4.1. Big Data Analytics Concept

With the evolving of technology and the increasing numbers of data flowing in and out of organizations daily, there has become a demand for faster and more efficient ways of analyzing such data.

The author sin [9] explained that Big Data is in effective in a vacuum. So, its potential value is only obtained when used in decision making. To enable an organization to acquire knowledge and use it indecision-making, organizations need effective methods to apply large amounts of fast-moving data of various types and forms to analyze and benefit from it. The analytics concept refers to techniques used to analyze and acquire knowledge from big data. Thus, big data analytics can be viewed as a sub-process in the overall process of 'knowledge extraction' from big data.

As discussed in[10], Big data analytics refers to using advanced techniques and tools for analyzing and examining very large and various data sets that combine structured, semi-structured, unstructured data from various sources and in different sizes from terabytes to zetta bytes in aimsto obtain helpful information included within the data and will also help identify the data that is most important to the business and future business decisions. Instead of: hidden patterns, associations, market trends, and consumer preferences.

4.2. Source of Health Care Big Data

Data that is obtained, collected, and stored in the healthcare industry may be are disorganized and distributed, coming from various sources and having different structures and forms. Health care Big Data involves data on physiological, behavioral, clinical, environmental illness, medical imaging, disease administration, medicine prescription records, nutrition, or exercise parameters [11]. However, most of the studies reviewed agreed on common sources of big data in the healthcare field, which are as follows:

- Electronic Health Records (EHRs):** An electronic copy of a patient's medical record thatismaintainedbytheserviceprovidervertime.TheEHRscanbecontainingdatarelatedt othe results of clinical and administrative meetings between the service provider (doctor,

□□□□□□□□ nurse, etc.) and the patient [12]. EHRs may include arrange of data including demo graphic Medical history, medication and allergies, immunization status, laboratory test results,

Radiology images, vital signs, personal statistics like age and weight, billing information, and Active medical problems [13].

Electronic Medical Records (EMRs): EMRs are similar to EHRs, they are digital records of patient health information; it is a digital version of a patient's information maintained in the formula chart, and it contains the patient's medical and treatment history from one clinic. Usually, this digital record stays in the doctor's office and does not get shared. If a patients witches doctors, his or her EMR is unlikely to follow. However, this paper chart is stored in clinician offices, clinics, and hospital data bases [14].

Patient- Reported Outcomes (PROs): Defined as a report coming directly from patients about their health condition and treatment which are based on a patient's perception of a disease and its treatment. This report includes arrange of outcomes such as symptoms, health status, and health-related quality-of-life [15].

Data collected from wear able sensors: The majority of wearable devices allow the collection of biochemical, physiological, and motion-sensing data such as (Heart rate, Steps walked, Blood pressure, etc.). So, it can collect patient health data and have data sharing capabilities [16]. The analysis of this type of data, when integrated with electronic health records, can support health monitoring and diagnosis for different chronic conditions.

Data extraction from social networking tools (social media): Patient posts on online social media such as Facebook, Instagram, Twitter, etc. can be extracted to obtain information about disease trends, patients' satisfaction, happiness, interests, and feelings. Twitter is a common example where data analytics methods have been used for disease monitoring and health-related trends (e.g. [17]).

4.1. Big Data Analytical Techniques and Tools in Healthcare

Different types of healthcare data are difficult to analyze due to their dynamicity and complexity, such as medical images (X-ray, Magnetic Resonance Imaging MRI images), biomedical signals (EEG, ECG, EMG, etc.), audio records, multi-dimensional health care data, written prescriptions and structured data from EMRs and EHRs [18]. Moreover, there is a lack of analytical approaches that can handle such unstructured data and help decision making [19]. In this review, we summarize the literature that considers some of the analytical strategies and tools which can apply to health care and medicine.

As reported by (Asante-Korang and Jacobs, 2016) [20], there are 4 types of Big Data Analytics: Descriptive, Diagnostic, Predictive, and Prescriptive Analytics. According to the literature, predictive analytics is the most popular in the healthcare industry as they are used to detect early signs of patient deterioration, predict high-cost patients, re-admission, what might happen (when the patient's condition worsens), adverse events, and treatment improvement for diseases affecting the multi-organ system as discussed in [21, 22,23]. Moreover, Healthcare organizations have observed improved quality of care after adopting several Big Data analytics techniques that helped enhance the ability of the healthcare sectors to predict epidemics and treat disease. Table 1. Summarizes some of the Big Data Analytical Techniques used in healthcare.

Table1. Summarizes some of the Big Data analytical techniques used in health care.

4.2. Big Data Analytics Challenges in Health Care

Big Data helps organizations, individuals, countries, and the world to create new growth opportunities, but it also poses significant challenges that could offset any potential gains, such as the loss of privacy and confidentiality, and the lack of appropriate IT infrastructure. Also, many of the big data tools are open source and free to use, which could provide the opportunity for intrusive operations, hackers, and data theft. Some literatures [32-38] discuss obstacles in the development of big data in health care applications. The key challenges are listed as follows:

1. **Privacy and Security:** Privacy and security are a key concern for individuals and corporations that hold information/data about people, products, activities, etc. Medical data obtained by healthcare providers from individuals and their medical records may contain private and confidential data [32]. Wherefore, protecting the patient's information must be handled with

enormous care from harm and hacker. When we use big data, many tools applied to analytics and data processes are open source and do not include all security measures [33]. Therefore, the primary justification for protecting personal privacy is to protect the interest of individuals. In order to overcome these challenges, some approaches are used to enhance the security level and obtain some confidentiality. First, Employing security measures, including strong encryption of data, validation of the source of data, access control, and authentication, where authentication is one of the measures for securing the data and maintaining confidentiality.

2. **Storage and Processing Issues:** Doubtlessly, the most obvious challenge associated with big data is simply storing and analyzing the huge amount of data. Nowadays, data grow significantly whenever a new storage technology is invented due to the huge amount of data collected and transferred by social media, healthcare providers, business transactions, and stock markets [34]. Moreover, this data is not just high on volume, but it also includes data of varied kinds that is generated periodically. With

Analytic Technique	Healthcare Application	Studies By
Cluster Analysis (CA)	-Identify cost change patterns of patients with end -stage renal disease(ESRD) who initiate dhemo dialysis (HD)by applying different clustering method.	ISMAIL etal., [21]
Data Mining	-Determination of epidemics; - Detection some diseases - Management of health care and measuring the effectiveness of certain treatments	Jothi etal., [22]
Graph Analytics	-Analysis of hospital performance across various quality measures	Nisar etal., [23]
Natural Language Processing (NLP)	-Extract clinical concept (e.g. diagnosis, procedure, and symptoms)from electronic medical record, patient discharge summaries, and lab report.	Gudivada etal., [24]
Neural Networks	-Prediction of patients future disease -Diagnosis of chronic diseases;	Wang etal., [25]
Machine Learning	-Microsoft's Inner Eye application employs machine learning to differentiate between tumors and healthy anatomy using 3D radiological images that assist medical experts in radio therapy and surgical planning, among other things.	Qiu etal., [26]

the rate of data explosion, the biggest challenge in dealing with is big data is that the present or traditional systems are unable to store and process data of this size and kind [35]. Therefore, the storage problem can be solved by making use of cloud computing. This would enable small and medium-sized hospitals and care organizations to eliminate cost and data storage issues.

3. **Data Ownership:** Data ownership represents a crucial and ongoing problem in big data applications in healthcare and other areas. Though peta bytes of medical records generally belong to the healthcare providers, governmental healthcare systems, or hospital in which they were created, but the information in it is not owned by them [36]. On the other hand, patients believe that they own the data. This dispute may be ended in the legal system to resolve the ownership issues unless healthcare providers receive written approval from patients before using data for experiences or research objectives.
4. **Skills Requirement:** A data analyst is a professional whose work involves collecting, cleaning, visualizing, and transforming or modeling raw data in to the blocks of information that are used by marketers, developers, and even healthcare providers[37]. One of the most important challenges in dealing with big data is the skills required for individuals to works in the big data field. A recent study [38] examined the required skills to deal with big data and concluded that the skills you need to work with big data will involve analytical capabilities.

CONCLUSION

The paper first defined what is meant by big data. We presented various definitions of big data, highlighting the fact that size is only one dimension of big data. Other dimensions, such as velocity and variety, are equally important. The studies reviewed showed that big data in the health care industry is obtained from several sources such as results of medical examinations, hospital records, medical devices, and records of patients. For better treat disease and diagnosis in medical, the role of big data is one where it can construct better predictive models using tools with the ability to analyze and process this vast amount of data. Finally, a discussion has been made of some challenges that face individuals and organizations in the process of utilizing big data in healthcare, such as data ownership, privacy and security, storage and processing issues, and skills requirements.

LIMITATIONS

While the proposed Review covers details about Big Data analytics and its applications in healthcare and medicine, however, we face a few limitations. First, the contents of this research consist of systematic review of the current state of Big Data technology in healthcare, but it does not get into consideration the technical details concerning the implementation and outcomes achieved in each of the studies reviewed. Second, there is heterogeneity in the documentation since

The literature includes various sources of information on the meaning of Big Data, methods of Big Data analytic, and their techniques and challenges in healthcare. Finally, despite the use of a Systematic strategy for review, the inclusion of studies on big data analytics in 'healthcare' for this Review was based on personal experience and knowledge, hence the cross-reference literature were also examined for this review.

FUTURE OUTLOOK

Big data analytics in medicine and healthcare is a very encouraging process of integrating, examining, and analyzing enormous amounts of complex heterogeneous data with different types: biomedical data, medical data, electronic health records data (EHRs), and experimental data. The combination of such various data makes big data analytics weave many fields, such as bioinformatics, medical imaging, sensor informatics, medical informatics, health informatics, and computational biomedicine. As further work, we plan to study the various improvements in big data analytic systems and databases. Also, we will attempt to produce a new high-performance data management system by depending on open source platform such as Apache Hadoop Map Reduce, which can assist heterogeneous datasets and uses memory and other hardware resources in a more efficient way to reveal hidden patterns.

REFERENCES

- [1] S. Singh, T. Firdaus, and A.K.Sharma,(2015)"SurveyonBigDataUsingDataMining",International Journalof Engineering DevelopmentandResearch, Vol.3, No.4, pp.135–143.
- [2] S. Dash, S. K. Shaky war, M. Sharma, and S. Kanshik, (2019) "Big data in healthcare: management, analysis and future prospects ",Journal of Big Data. Springer International Publishing, Vol. 6, No.1.
- [3] I. K. Subagja, N. Amaliyah, U. Hiermy, B. T. Rahardjo, E. L. Lydia, K. Shakar, and P. T. Nguyen,(2019) "Evaluation of big data analytics in medical science", International Journal of Engineering and Advanced Technology, Vol. 8, (6 Special Issue 3), pp.717–720.
- [4] N. Zulkarnain, M. Anshari, and A. Definition, (2016)"BigData :Concept, Applications, & Challenges", International Conference on Information Management and Technology, pp.307–31.
- [5] S. H. Kaisler, F. J. Armour, and A. J. Espinosa, "Introduction to the big data and analytics: concepts,(2016)techniques, methods, and applications minitrack", Proceedings of the Annual Hawaii International Conference on System Sciences, pp.1059–1060.
- [6] J. Amudhavel, V. Padmapriya, V. Gowri, K. Lakshmi priya, K. P. Kumar, and B. Thiagarajan, (2015)"Perspectives, motivations and implications of big data analytics. ", In Proceedings of the 2015 International Conference on Advanced Research in Computer Science Engineering & Technology, pp.1-5.
- [7] M. Pospiech, and C. Felden, (2012) "Big data - A State-of-the-Art", 18th Americas Conference on Information Systems 2012, AMCIS 2012, Vol.5, pp. 3918–3928.
- [8] S. Brown, (2020) "Data Characteristics", A multidisciplinary journal of global macro trends BIG, Vol.3, No.6, pp. 19–27.
- [9] M. I. Razzak, M. Imran, and G. Xu, (2020) "Big data analytics for preventive medicine", Neural Computing and Applications. Springer London. Vol. 32, No.9, pp.4417-4451.
- [10] G.Chen, and M.Islam,(2019)"BigData Analytics in Healthcare", Proceedings-2019 2nd International Conference on Safety Produce Informatization, IICSPI 2019, Vol.2015, pp.227–230.
- [11] S. G. Alonso, I. Torre-Diez, J. Rodrigues, S. Hamorioui, and M. L. Coronado, (2017) "A Systematic Review of Techniques and Sources of Big Data in the Healthcare Sector.", Journal of Medical Systems, Vol. 41, No.11, pp.183.
- [12] A. P. Ambinder, (2005) "Electronic Health Records By", Journal of Oncology Practice, Vol. 1, No. 2, pp. 57–63.
- [13] R. S. Evans, (2016) "Electronic Health Records: Then, Now, and in the Future", Yearbook of medical informatics ,pp. S48–S61.
- [14] Z.Liang et al.,(2014)"Deep learning for healthcare decision making with EMRs", Proceedings-2014 IEEE International Conference on Bioinformatics and Biomedicine, IEEE BIBM 2014, (Cm), pp.556–559.
- [15] M. Calvert et al., (2015) "Putting patient-reported outcomes on the Big Data Road Map", Journal of the Royal Society of Medicine, Vol.108, No.8, pp. 299–303.
- [16] M. Uddin, and S. Syed-abdul, (2020) "Data analytics and applications of the wearable sensors in health care: An overview", Sensors (Switzerland), Vol.20, No.5.
- [17] J. Zhang, N. Xue, and X. Huang, (2016) "A Secure System for Pervasive Social Network-Based Healthcare ", IEEE Access, Vol.4, pp.9239–9250.
- [18] A.Kankanhalli et al.,(2016)"Big data and analytics in healthcare: Introduction to the special section", Information Systems Frontiers, Vol.18, No.2, pp.233–235.

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- [19] B. Van Calster et al., (2019) "Predictive analytics in healthcare: how can we know it works?" *Journal of the American Medical Informatics Association*, Vol.26, No.12, pp. 1651–1654.
- [20] A. Asante-Korang, and J.P. Jacobs, (2016) "Big Data and paediatric cardiovascular disease in the era of transparency in healthcare", *Cardiology in the Young*, Vol.26, No.8, pp. 1597–1602.
- [21] A. ISMAIL, S. ABDLERAZEK, I.M. EL-HENAWY, (2020) "Big Data Analytics in Heart Diseases", *Journal of Theoretical and Applied Information Technology*, Vol.98, No.11, pp. 1970–1980.
- [22] N. Jothi., N. A. Rashid, and W. Husain, (2015) "Data Mining in Healthcare - A Review", *Procedia Computer Science*. Elsevier Masson SAS, Vol.72, pp.306–313.
- [23] M. U. Nisar, A. Fard, and J. A. Miller, (2013) "Techniques for graph analytics on big data", *Proceedings-2013 IEEE International Congress on Big Data*, Big Data 2013, pp.255–262.
- [24] V. N. Gudivada, D. Rao, and V. V. Raghavan, (2015) "Big Data Driven Natural Language Processing Research and Applications", *Handbook of Statistics*. Elsevier Inc, vol.33, pp.203-238.
- [25] Y. Wang et al., (2014) "Energy efficient neural networks for big data analytics", *Proceedings-Design, Automation and Test in Europe, DATE*, pp.2–3.
- [26] J. Qiu et al., (2016) "A survey of machine learning for big data processing", *Eurasip Journal on Advances in Signal Processing*. EURASIP Journal on Advances in Signal Processing, Vol.1.
- [27] M. R. Ghazi, and D. Gangodkar, (2015) "Hadoop, mapreduce and HDFS: A developers perspective", *Procedia Computer Science*. Elsevier Masson SAS, Vol.48, pp. 45–50.
- [28] A. B. Patel, M. Birla, and U. Nair, (2012) "Addressing big data problem using Hadoop and MapReduce", *3rd Nirma University International Conference on Engineering, NUI CONE 2012*, pp.6–8.
- [29] A. Alam, and J. Ahmed, (2014) "Hadoop architecture and its issues", *Proceedings-2014 International Conference on Computational Science and Computational Intelligence, CSCI 2014*, Vol.2, pp. 288–291.
- [30] K. Dwivedi and S.K. Dubey, (2014) "Analytical review on Hadoop Distributed file system", *Proceedings of the 5th International Conference on Confluence 2014: The Next Generation Information Technology Summit*, pp. 174–181.
- [31] I.A.T. Hashem et al., (2020) "MapReduce scheduling algorithms: a review", *Journal of Supercomputing*, Vol.76, No.7, pp.4915-4945.
- [32] A. L'heureux, K. Grolinger, J. F. Elyamany, and M. A. Capretz, (2017) "Machine learning with big data: Challenges and approaches", *IEEE Access*, Vol. 5, pp.7776-7797.
- [33] A. Ghazvini, and Z. Shukur, (2013) "Security Challenges and Success Factors of Electronic Healthcare System", *Procedia Technology*. Elsevier B.V., Vol.11, pp. 212–219.
- [34] M. Padgavankar, and S. Gupta, (2014) "Big data storage and challenges", *International Journal of Computer Science and Information Technologies*, Vol.5, No.2, pp.2218–2223.
- [35] J. Li et al., (2014) "The overview of big data storage and management", *Proceedings of 2014 IEEE 13th International Conference on Cognitive Informatics and Cognitive Computing, ICCI*CC 2014*, pp. 510–513.
- [36] P. Kostkova, "Who Owns the Data?", *Open Data for Healthcare*, vol.4.
- [37] R. Nambiar et al., (2013) "A look at challenges and opportunities of Big Data analytics in healthcare", *Proceedings-2013 IEEE International Conference on Big Data, Big Data 2013*, pp.17–22.
- [38] A. Gardiner et al., (2018) "Skill Requirements in Big Data: A Content Analysis of Job Advertisements", *Journal of Computer Information Systems*. Taylor & Francis, Vol.58, No.4, pp.374–384.

Internet Of Things: Applications and Security Challenges

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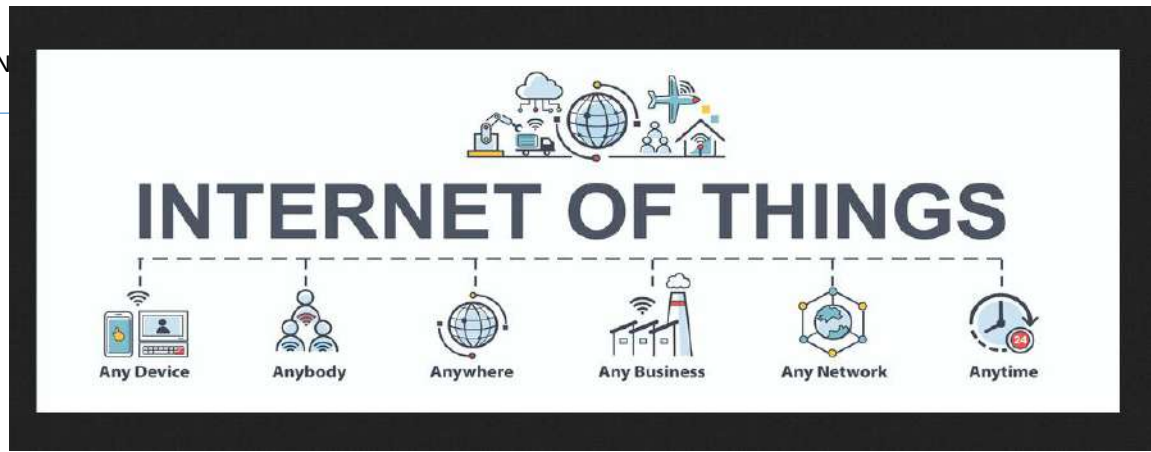
Abstract - A detailed examination of several Internet of Things (IoT)-based applications is provided in this paper. It highlights that, as opposed to individuals, items are connected via the internet. The Internet of Things (IoT) is a massive network of interconnected objects and people that gather and exchange data about their usage and their surroundings. Applications for IOT can be found in industries like agriculture, healthcare, supply chain management, and defense. Finally, the article addresses IOT-related challenges. Despite its benefits, IOT has some serious problems, such as security and privacy. It also offers an analysis of the Internet of Things and its uses in various scientific and technological domains. A literature study is included with the introduction of the Internet of Things. The paper also covers the IoT's components and architecture, in addition to its various uses.

Keywords – Internet of Things (IoT), Information about Iot, Characteristics of IoT, Application of Iot, Key features of IoT.

INTRODUCTION

The Internet of Things (IoT) has become a more viable platform for implementing this kind of innovative technologies. While cloud computing is not a novel concept in this industry, it has been utilized to symbolize the world of omnipresent computing. The seventh ITU Internet Report was first published in 1997 under the heading "Challenges to the Network." It was originally used in the RFID magazine in 1999 by Kevin Ashton. The term was modified to "Internet of things" in 2005. According to Kevin, the Internet of Things would allow networked devices to share information about real-world items via the internet. Most of the IoT architectures that have been suggested recently are utilized to broadcast information via social networks using web semantics.

INFORMATION- IOT, or the Internet of Things the internet of things, or IoT, is a network of connected computers, digital and mechanical devices, items, animals, and people that can transfer data over a network without requiring human-to-human or human-to-computer interaction. All of these devices are assigned unique identifiers (UIDs). Any natural or artificial object that can be given an IP address and be able to transfer data over a network, such as a person with an implanted heart monitor, a farm animal with a biochip transponder, an automobile with sensors to warn the driver when tire pressure is low, or any other combination of these, can be considered a thing in the internet of things[1][2].



ARCHITECTURE OF IOT

The best architecture design serves as the cornerstone for creating a privileged Internet of Things system. It addressed numerous challenges related to scalability, routing, networking, and other aspects of the IoT environment. Generally speaking, the three primary dimensions of the IoT architecture are: All items connected to the Internet of Things (IoT) can be classified into three categories: (i) information items, which include sensing, identifying, and controlling items; (ii) independent networks, which have multiple features like self-configuration, self-protection, self-adaptation, and self-optimization; and (iii) intelligent applications, which have intelligent behavior over the Internet in general. These applications can be classified based on their intelligent behavior, which can include data processing, intelligent control, and intelligent exchange methods through network items. All IoT-related applications can be categorized based on these dimensions. Connectivity between the physical, digital, and social realms is the aim of the IoT's future architecture. [3] These units of IoT are designed to mimic human neural networks and offer solutions for particular applications. Space-time consistency, cyber, physical, and social co-existence, connectivity and interaction, and multi-identity status are the primary features of the U2IoT concept.

CHARACTERISTICS OF INTERNET OF THINGS (IOT)

Some most popular characteristics of Internet of things are:

- Intelligence
- Connectivity
- Dynamic Nature
- Enormous scale
- Security

Intelligence –

The IoT is intelligent because it combines hardware, software, and algorithms. In the context of the Internet of Things, ambient intelligence improves its skills to help objects respond intelligently to a given circumstance and assist them in completing certain tasks. Notwithstanding the widespread use of smart technologies, intelligence in the Internet of Things is limited to the means of communication between devices; graphical user interfaces and conventional input techniques are the ways in which users and devices interact.

Connectivity-

The Internet of Things is made possible by connectivity, which connects commonplace objects. These things must be connected because even basic interactions between objects in an Internet of Things network can lead to collective intelligence. It makes the items compatible with and accessible over networks. The networking of smart objects and apps can open up new markets for the Internet of Things with this connectivity. In the Internet of Things, connectivity is more than just installing a Wi-Fi module and calling it a day. Network compatibility and accessibility are made possible by connectivity. Getting on a network is known as accessibility, whereas

sharing the capacity to create and consume data is known as compatibility. If this sounds familiar, it is because Metcalfe's Law applies to the Internet of Things.

Dynamic Nature -

The main function of the Internet of Things is data collection from its surroundings, which is made possible by the dynamic changes that occur in and around the devices. These devices' states vary on a dynamic basis; for instance, whether they are sleeping, waking up, connected, or not, and in what context—temperature, location, and speed, for example. The quantity of devices also varies dynamically with a person, place, and time, in addition to the device's status. The context of devices, which includes their location and speed, as well as their states—such as sleeping and waking up, connected or not—all fluctuate dynamically.

Enormous scale -

There will be a lot more gadgets than the ones currently connected to the Internet that need to be managed and communicate with one another. It becomes more important to handle the data produced by these devices and understand it for use in applications. In its estimation study, Gartner (2015) validates the massive scope of the Internet of Things, estimating that 5.5 million new items will be connected daily and that there will be 6.4 billion connected items in use globally in 2016, an increase of 30% from 2015. According to the research, there will be 20.8 billion linked devices by 2020. There will be at least an array of devices that require management and communication with one another.

Security -

Security risks are inherent to Internet of Things devices. It would be a mistake to ignore the security risks connected with the Internet of Things, as we enjoy increased productivity, new experiences, and other advantages from it. The IoT has a great deal of transparency and privacy concerns. Establishing a security paradigm is necessary in order to safeguard the networks, endpoints, and data that are moved between them [4].

APPLICATION OF IOT

IoT applications span a wide range of industries, including smart cities, agriculture, manufacturing, health, and emergency response, among many others.

SMART CITIES :-

In order to make cities smarter and improve general infrastructure, the Internet of Things is essential. When building smart cities, some IoT application areas include intelligent building practices, traffic congestion waste management, intelligent lighting, intelligent parking, intelligent transportation systems, and urban mapping. Installing sound monitoring equipment in sensitive areas of cities, keeping an eye on the number of cars and pedestrians, monitoring vibrations and the material state of bridges and buildings, and monitoring parking spaces available within the city are just a few examples of the various functions that may fall under this category. Smart cities can monitor, regulate, and lessen traffic congestion by utilizing IoT supported by artificial intelligence (AI). [5]

HEALTH CARE :-

The majority of healthcare systems throughout numerous nations are inherently slow, inefficient, and prone to mistakes. Given that the healthcare industry depends on a variety of activities and gadgets that technology allows for automation and improvement of, The healthcare industry would be significantly altered by more technology that might support a variety of tasks like record keeping, prescription distribution, and report sharing with numerous people and locations [6]. Tracking the flow of patients can greatly enhance hospital workflow. When IoNT is used in the human body, data from in situ body areas that were previously inaccessible for therapy can now be more easily accessible through the use of medical devices

equipped with large sensors. Therefore, IoNT will make it possible to gather fresh medical data, which will result in discoveries and improved diagnostics.

SMART AGRICULTURE AND WATER MANAGEMENT :-

The Internet of Things (IoT) would make it possible to manage and preserve the amount of vitamins present in agricultural products and to control microclimate conditions to maximize the yield and quality of fruits and vegetables. Additionally, monitoring meteorological data enables the forecasting of ice, drought, wind shifts, rain, or snow, allowing temperature and humidity levels to be regulated to avoid fungus and other microbiological pollutants. With regard to cattle, IoT can help identify animals that graze in open spaces, identify harmful gases from animal waste on farms, and regulate the growth circumstances of the progeny to improve.

IOT- KEY FEATURES

IoT basically turns everything "smart," enhancing life in all its facets through the use of networks, artificial intelligence algorithms, and data collection. This might be as easy as adding sensors to your cupboards and refrigerator to recognize when milk and your favorite cereal are running low and to place an order with your favorite grocery store accordingly.

Interconnectivity:

Networks are no longer only dependent on large suppliers, thanks to new enabling technologies for networking, and particularly for Internet of Things networking. Networks are still useful even at much lower and less expensive scales. These tiny networks are formed by IoT between its system devices.

Sensors:

Without sensors, IoT becomes indistinguishable. They serve as defining tools that turn the Internet of Things from a typical passive network of devices into an active system that can be integrated into the real world.

Engaging Actively:

A large portion of modern communication is linked to technology.

SECURITY CHALLENGES IN IOT

The defense against attacks on Internet of Things devices is known as IoT security. IoT device security is less of a known concern, and protection from it is all too frequently disregarded, despite the fact that most business owners are aware that they must use antivirus software on their PCs and phones. Devices using the Internet of Things are widely used. A growing number of items in our environment are being linked to the internet, ranging from refrigerators and cars to surveillance equipment on production lines. The rate of growth of the Internet of Things sector is astounding.

1. Accuracy of data:

Through the Internet of Things, billions of gadgets are part of a global ecosystem. Every piece of data that is communicated and transferred between the sensor and the main server can be manipulated, starting with just one data point. Implementing digital signatures and a decentralized distributed ledger is necessary to guarantee integrity [7].

2. Capacity to Encrypt:

It takes constant effort to encrypt and decrypt data. In order to process data, IoT network sensors are still lacking. Putting devices on separate networks and installing firewalls will stop brute-force attacks.

3. Concerns about Privacy:

Data sharing between platforms, devices, and users is at the heart of the Internet of Things. Data is collected by smart gadgets for several

4. Integration:

The number of IoT devices that businesses must manage will eventually increase. Managing such a massive volume of consumer data might present challenges. Undoubtedly, a solitary error or algorithmic infringement is sufficient to bring down the entire data infrastructure [8].

5. Revised:

Compliance is required for managing millions of devices' updates. Updates must be performed manually on devices because not all of them offer over-the-air updates. All of the different gadgets will require one to stay on top of the updates that are available. This becomes a laborious and intricate procedure, and any errors made during the process will result in weaknesses.

ETHICS

This Morals research report was written entirely on its own and wasn't accepted for publication in a journal or conference.

SUMMARY

The increasing number of Internet users and the development of the Internet of Things have led to a demand for data compression across the Internet as a critical function of data proliferation from sensors. Among these are textual data. A brief and clear summary can be produced from a single text or from a collection of texts using summarization, which is a useful method for data aggregation in natural language data processing. Multi-document summarization research is becoming more important in the IoT era because of the scattered location of documents [9]. Although the integration of IoT and summarization approaches has several benefits, this field is still relatively new and has few published studies. [10] Traditional methodologies contain a wealth of prior knowledge that would aid in the model optimization process, and deep neural models have significant non-linear mapping skills.

CONCLUSION

At every stage, the IoT framework is susceptible to attacks. As a result, there are several security risks and demands that must be addressed. The present status of IoT research is mostly focused on access control and authentication protocols; however, in order to achieve the progressive mash-up of IoT topology, new networking protocols like IPv6 and 5G must be consolidated due to the rapid advancement of technology. This chapter's primary goal was to draw attention to the significant security risks associated with IoT, with a special emphasis on security attacks and their defenses. Many IoT devices become soft targets as a result of security flaws, and even in these cases, the victim is unaware that their device is compromised.

REFERENCE

- 1) Sarfraz Alam, Mohammad M. R. Chowdhury, and Josef Noll (2010) SenaaS: An Event-Driven Sensor Virtualization Approach for the Internet of Things.
- 2) Daoliang Li, Yingyi Chen, Oct. 2010, Computer and Computing Technologies Huansheng Ning, Hong Liu, 2012, Cyber-Physical-Social-Based Security Architecture for Future Internet of Things, *Advances in the Internet of Things*
- 3) R. Neisse, G. Steri, and G. Baldini, "Enforcement of security policy rules for the internet of things," in *Int'l Conference on Wireless and Mobile Computing, Networking, and Communications (WiMob)*, 165–172, 2014.
- 4) Mirza Abdur Razzaq and Muhammad Ali Qureshi, "Security Issues in the Internet of Things (IoT): A Comprehensive Study," *International Journal of Advanced Computer Science and Applications*, Vol. 8, No. 6, 2017.
- 5) M. Zorzi, A. Gluhak, S. Lange, and A. Bassi, "From today's intranet of things to a future internet of things: a wireless-and mobility-related view," *Wireless Communications, IEEE*, vol. 17, no. 6, pp. 44–51, 2010.
- 6) C. Hong Song, F. Zhongchuan, and Z. Dongyan, "Security and trust research in m2m systems," in *Vehicular Electronics and Safety (ICVES)*, 2011 IEEE International Conference on. IEEE, 2011, pp. 286–290.
- 7) Cha, Y. Shah, A. U. Schmidt, A. Leicher, and M. V. Meyerstein, "Trust in m2 communication," *Vehicular Technology Magazine, IEEE*, vol. 4, no. 3, pp. 69–75, 2009.
- 8) C. Ma, W. E. Zhang, M. Guo, H. Wang, and Q. Z. Sheng, "Multi-document Summarization via Deep Learning Techniques
- 9) Y.-K. Ji, Y.-I. Kim, and S. Park, "Big Data Summarization Using Semantic Future for IoT on the Cloud," *Contemporary Engineering Sciences*
- 10) S. Nithyakalyani and S. S. Kumar, "Data Aggregation in Wireless Sensor Networks Using Node Clustering Algorithms: A Comparative Study," in *Proc. of the 2013 IEEE Conference on Information and Communication Technologies (ICT 2013)*, Bandung, Indonesia, 2013.

A Review on Big Data Challenges and Hadoop Technology

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Abstract

Big Data refers to the huge volume of data which is being processed on a daily basis and needs to be stored, distributed and managed. It can be structured, semi-structured or unstructured. Parallelism is used to process this data in an efficient manner. Big Data demands a platform and a technique which can analyse this data and extract hidden knowledge from it. Hadoop is an open source software, a core platform to structure Big Data. It offers a distributed file system known as HDFS (Hadoop Distributed File System) and MapReduce structure to deal with large data and provide a high degree of fault tolerance. This paper aimed at study and analysing big data concepts and Hadoop technology. This study designed about big data concepts, its issues and challenges. This paper also consists of Hadoop concepts and its framework. This paper mainly explains the Big Data, its issues and challenges. Along with this an introduction to Hadoop and its components and characteristics is also in this paper.

Keywords : Big Data, Types of Data, Issues and Challenges, Hadoop, Hadoop Framework

Introduction

Big Data

In digital world, data are generated from various sources and the fast transition from digital technologies has led to growth of big data. It provides evolutionary breakthroughs in many fields with collection of large datasets. In general, it refers to the collection of large and complex datasets which are difficult to process using traditional database management tools or data processing applications.[1]

This proliferation of data is primarily driven by advancements in technology, the widespread use of the Internet, social media platforms, mobile devices, and the Internet of Things (IoT). The data generated from these sources include structured, semi-structured, and unstructured data, creating a massive volume and variety of information.



Fig.1: Big Data

Types of Big Data

1 Structured Data: Structured data refers to organized and well-defined data that fits into a fixed schema or format. It can be easily stored, managed, and processed using traditional relational databases. Structured data includes information such as numbers, dates, names, addresses, and categorical variables. Ex. customer transaction records, inventory databases, and financial statements.

2 Semi-structured Data: Semi-structured data possesses some organization but does not conform to a rigid schema. It contains metadata or tags that provide limited structure and enables better organization and search ability. Ex. XML files, JSON documents, and log files. This type of data is often encountered in web applications, social media feeds, and data exchanged between different systems.

3 Unstructured Data: Unstructured data refers to data that lacks a predefined structure and does not fit neatly into traditional databases. It includes textual data, multimedia content, social media posts, emails, sensor data, and more. Unstructured data is often challenging to analyse due to its complexity, large size, and lack of organization.

4 Quasi-structured Data: The data format consists of unstructured textual data that lacks consistent formatting and requires significant effort and time to organize using specialized tools. For instance, web server logs are log files generated and maintained by servers, which contain a list of activities and events recorded on the server. These logs often include information such as IP addresses, timestamps, HTTP requests, and response codes[5].

Issues and Challenges

Challenges in big data can be broadly alienated into three types the first type is data challenges, the second type is data process challenges, and the third type are data management. Data challenges are the challenges that are associated with the characteristics of big data. Process challenges are the challenged that faced during the processing of data whereas management challenges pertaining to tackling the data such as providing security.

The characteristics of big data bring many challenges to it such as its high volume, variety, etc. Process challenges are related to data acquisition, pre-processing, data analysis, and data visualization whereas management challenges are related to privacy and security[4].

1. Data Challenges Researchers have given many definitions of big data and based on their understanding towards they come up with several new characteristics of big data. researchers discussed the 3V's characteristics of data (Volume, Variety, and Volume), 4th V was introduced by IBM as veracity , researchers have discussed 5th and 6th V's as variability, and value. The 10 V's of big data are taken under consideration, there are many worth mentioning prominent challenges associated with the characteristics of data. Some of the prominent challenges are discussed as follow.

1.1. Volume Challenges. The unprecedented increase in data through internal and external sources has resulted in a massive amount of data. This high volume of data brings the challenges to the data itself such as the storage of the data for processing is not possible through traditional tools and thus more innovative methods should be developed to handle this data deluge.

1.2. Variety Challenges. The challenge associated with variety is related to its different forms. The massive data can be present in the form of structured, semi-structured, and unstructured.

Research studies show that 95% of the data is present in unstructured form. Therefore, converting it into a form so that the analysis can be performed is a big challenge.

1.3. Velocity Challenges. Velocity indicates the speed of the data generated through the devices. Data can be processed in two ways batch processing and real-time processing. In batch processing, the data is stored and then processed whereas real-time processing is continuous. In online shopping, real-time processing is required to generate value for customers.

1.4. Veracity Challenges. Data veracity indicates the quality and accuracy of data. It deals with the fabrications, imprecision, messiness, and misplaced evidence in data. It defines the trustworthiness of data when a significant decision needs to be taken. In social networking sites, user opinion can be classified as positive, negative, or neutral.

1.5. Value Challenges. Value is one of the most significant features of big data characteristics. Big data contains valuable information that needs to be extracted from the large datasets. This brings a big challenge to data as extracting the high information from data in a cost-effective manner and making use of it for business intelligence, health sectors, etc.

2. Process Challenges Process challenges are related to processing and analyzing large datasets. It brings a significant challenge to the process as the data is present in different forms and conversion of it into one form for analysis purpose is a challenging task. It can be divided into four parts: Data Acquisition and Storage, Data Preprocessing, Data Analysis and Modeling, Data Visualization.

2.1. Data Acquisition and Storage. Data acquisition is the process of acquiring and storing the data for the future utilizing some valuable information. The data is acquired from various sources such as from sensors, social networking sites, blogs, etc. and hence the data is present in different forms (structured, semi-structured, and unstructured) bring a significant challenge to data. The second challenge is associated with the storage because the data generated through various devices does not mean that whole data carry meaning to it therefore the smart filter must be applied for generating the relevant datasets. Storing this massive dataset can result in high-cost scalable systems to handle the data.

2.2. Data Preprocessing. Data preprocessing is the process to collect the quality data from large datasets as low-quality data leads to low-quality knowledge. Therefore, data preprocessing plays a significant role in knowledge discovery. In this stage noise, missing values, inconsistent and superfluous data, etc. are removed before applying the big data mining techniques to its data. In big data preprocessing most of the efforts are done in the Feature Selection method whereas some of the families of it are ignored such for instance reduction, missing value imputations, noise treatments.

2.3. Data Analysis and Modelling. Data analysis is the process that discovers the hidden information from the data and helps the organizations to make a better decision. To efficiently extract the knowledge from the large datasets extraordinary techniques are required. To generate the hidden pattern from the large datasets Wal-Mart's employs statistical and machine learning techniques.

2.4. Data Visualization. A big data visualization technique presents the analytical data visual form. It makes usage of various types of graph for representing the valuable information for decision making. As per the research studies, the visual report has a better impact on information seeker rather than the text reports. Visualization tools like Tableau and Qlik View are the tools used for visualization however according to the researcher these tools cannot be fruitful shortly where data is growing every second by each one of us.

3. Management Challenges Management challenges are related to those challenges encountered by an organization which is related to the privacy, security, governance of data. Management challenges are also faced because we have a lack of data for skilled professionals who know the latest tool and techniques to employ the correct method for dealing with each phase of data. Security and privacy will always be the major concerns as data are highly sensitive such as financial data, military data, insurance codes and contains different kinds of information that can ruin if the unauthorized user has access to it [4].

Hadoop

Hadoop has become a very popular platform in the IT industry and academia for its ability to handle large amounts of data, along with extensive processing and analysis facilities. Different users produce these large datasets, and most of data are unstructured, increasing the requirements for memory and I/O. Besides, the advent of many new applications and technologies brought much larger volumes of complex data, including social media, e.g., Facebook, Twitter, YouTube, online shopping, machine data, system data, and browsing history. This massive amount of digital data becomes a challenging task for the management to store, process, and analyse. The conventional database management tools are unable to handle this type of data. Big data technologies, tools, and procedures allowed organizations to capture process speedily, and analyse large quantities of data and extract appropriate information at a reasonable cost. Several solutions are available to handle this problems. Distributed computing is one possible solution considered as the most efficient and fault-tolerant method for companies to store and process massive amounts of data. Among this new group of tools, Map Reduce and Spark are the most commonly used cluster computing tools. They provide users with various functions using simple application programming interfaces (API)[9].

Hadoop Framework

Hadoop is open any one software used to process the Big Data. It is very famous used by administrations/researchers to analyze the Big Data. Hadoop is influenced by Google's structural design, Google File System and MapReduce. Hadoop procedures the large data sets in a spread calculating environment.

Hadoop contains of two main mechanisms:

1) Storing:

The(HDFS) Hadoop Distributed File System: These are dispersed file system which brings responsibility taking and measured to run on creation hardware. HDFS brings high amount entree to application data and is suitable for requests that have vast data sets. HDFS can stock data over thousands of servers. HDFS has master/slave construction . Files added to HDFS are separated into fixed-size masses. Mass size is configurable, but avoidances to 64 megabytes. [7]

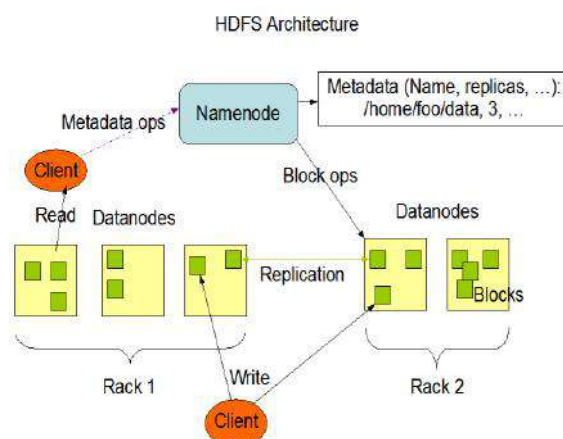


Fig-2: HDFS Blocks

2) Processing:

MapReduce : It is a software project classical presented by Google in 2004 for effortlessly writing applications which procedures enormous volume of data in equivalent on huge bunches of hardware in responsibility. This functions on huge data set, separations the problem and data sets and run it in equivalent way. Two utilities in MapReduce are as following:

a) **Map** –The Map function continually runs first naturally used to filter, transform, or parse the data. The outcome from Map develops the input to Reduce.

b) **Reduce** –The Reduce function is elective normally used to encapsulate data from the Mapfunction. [2]

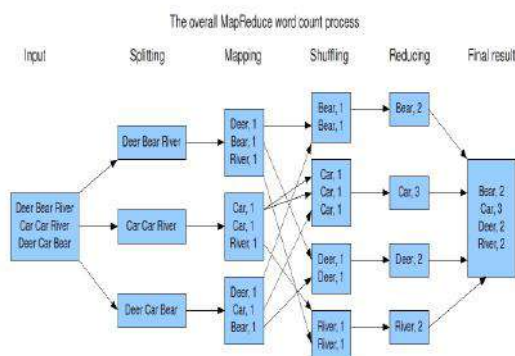


Fig-3: Map Reduce Processing

Hadoop Characteristics in Big Data

1. **Robust**: It can handle failures of hardware of data is stored in multiple data nodes.
2. **Scalable**: it can able to increase cluster size by add more and more nodes.
3. **Simple**: It focuses on code rather than data and is can write parallel wise so it's simple.
4. **Portable**: Because Structured (In table format), Semi structure- Not in well organized format (XML), Unstructured. It is no format (Text, Image, Videos).
5. **Cost Effective**: Hadoop uses commodity hardware to store the data so it is inexpensive and economic.

6. Fault Tolerance: the tasks are automatically redirected to another node if a node fails it is fault tolerance automatically stored multiple copies of all the data. If one node fails, same data is available on some other nodes is based on replication factor.[6]

Hadoop for Big Data

Effective storage, computation, and analysis of large volumes of data are major challenges of big data. Earlier due to the less advanced technology unstructured data is not handling by several organizations. So Hadoop big data changed that way and decision-making process is being used for unstructured data. Hadoop provides a reliable and scalable platform which is used to solve problems caused by massive amount of data. Hadoop big data is popular because of the properties like flexibility, scalability, performance, and cost effective. MapReduce is a programming framework which is used to processing and analyzing the big data in a cost-effective manner. Hadoop data analytics ecosystem includes data storage, data processing, data access, data management, privacy data protection[10].

Conclusion

Nowadays everyone has many data which is unstructured and collected from various sources. All this data is big data. In this review paper, we described the overview of Big data and Hadoop technology. We discussed the various problems of Big data and then we discussed about its solution (Hadoop). The paper describes Hadoop which is an open source software used for processing of Big Data, along with its features HDFS and MapReduce.

References

- [1] D. P. Acharjya, Kauser Ahmed P, A Survey on Big Data Analytics: Challenges, Open Research Issues and Tools, (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 7, No. 2, 2016
- [2] Rahul Beakta, Big Data And Hadoop: A Review Paper, <https://www.researchgate.net/publication/281403776>
- [3] Nikhil Madaan, Umang Kumar, Suman Kr Jha, Big Data Analytics: A Literature Review Paper, International Journal OF Engineering Research & Technology (Ijert)
- [4] R Rawat and R Yadav, Big Data: Big Data Analysis, Issues and Challenges and Technologies
- [5] 1Mohammad Nazmul Alam, 2Vakil Singh, 3Ms. Ripendeep Kaur, 4Md. Shahin Kabir, Big Data: An Overview with Legal Aspects and Future Prospects, Journal of Emerging Technologies and Innovative Research (JETIR) [www.jetir.org\(ISSN-2349-5162\)](http://www.jetir.org(ISSN-2349-5162))
- [6] N. Deshai1 , S. Venkataramana2 , Dr. G. P. Saradhi Varma, Research Paper on Big Data and Hadoop-Map Reduce Real Time Scheduling, International Journal of Advance Research in Science and Engineering [www.ijarse.com\(ISSN: 2319-8354\)](http://www.ijarse.com(ISSN: 2319-8354))
- [7] Vinayak Pujari1, Dr. Yogesh K. Sharma2 and Rohan Rane, A REVIEW PAPER ON BIG DATA AND HADOOP, International Journal of Advance and Innovative Research(ISSN: 2394-7780)
- [8] Pankaj Saraswat1 , and Swapnil Raj, A Review Paper on Hadoop Architecture, International Journal of Innovative Research in Computer Science & Technology (IJRCST),(ISSN: 2347-5552) www.ijrcst.org
- [9] N. Ahmed , Andre L. C. Barczak , Teo Susnjak and Mohammed A. Rashid / A comprehensive performance analysis of Apache Hadoop and Apache Spark for large scale data sets using HiBench / Ahmed et al. J Big Data (2020) 7:110 <https://doi.org/10.1186/s40537-020-00388-5>
- [10] Toshifa, Aniruddh Sanga, Shweta Mongia/ Big Data Hadoop Tools and Technologies: A Review/ International Conference on Advancements in Computing & Management (ICACM-2019)
- [11] WWW.Goglescholar.com

Role of Nanotechnology and Artificial Intelligence in aroma

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Abstract:

Artificial intelligence is most occupied concept in world of technology, its presence in almost any industry that deals with any huge volume of data are taking advantages in day to day operation. This technology can be applied to many different sectors and industries. There has been a tremendous use of artificial intelligence in nanotechnology research during last decades. Artificial intelligence is the simulation of human intelligence processes by machines, especially computer systems. The application of artificial intelligence and nanotechnology in cosmetics has been shown to overcome the drawbacks associated with traditional cosmetic and also to add tremendous development in this field. Aromatherapy is both an Art and a Science. Aromatherapy is generally used for treatment of common problems like headache, cough, cold, sleep related issues, stress, anxiety etc. Advanced practitioners are using aromatherapy in treating psychological as well as various physiological issues. The AI technology can be used to analyse the current data inferences, patterns and learning and use them to create new blends of flavours and fragrances which can then be used. Hence the industry and technology is leading us India should aim at developing its own technology which will help several small perfumery companies to utilize the new program in development of the new trends in fragrances. The aim of this paper is to create development in field of aroma with new technologies.

Keywords:

Artificial Intelligence (AI), Machine learning, Nano technology, aroma

Introduction:

Lifestyle is a way used by people, groups and nations and is formed in specific geographical, economic, political, cultural and religious text. Lifestyle is referred to the characteristics of inhabitants of a region in special time and place. In recent decades, life style as an important factor of health is more interested by researchers. According to WHO, 60% of related factors to individual health and quality of life are correlated to life style [1]. Today, wide changes have occurred in life of all people. Malnutrition, unhealthy diet, smoking, alcohol consuming, drug abuse, stress and so on, are the presentations of unhealthy life style that they are used as dominant form of lifestyle. Besides, the lives of citizens face with new challenges. Therefore, according to the existing studies, lifestyle has a significant influence on physical and mental health of human being.

Fragrance is a sweet or pleasant odor or scent, there are some natural ingredients having a pleasant fragrance. Nanotechnology has entered the production and application of various personal care and cosmetics products. Nano perfume ejectors are designed to mix nanoparticles with perfume and/or water particles and enable sterilization of air, absorption of unpleasant, and release of pleasant odors. Electronic noses are used to study the use of nanoparticles in fragrant products.

These days nanotechnology is small things such as an atom the "Size of the Nano scale" or basically, just how small is "nano?" and what can we imagine about the scale of from

Microscopic perspective. From metric MKS unit dimensional point of view or International System Units (ISU), the prefix “nano” means one-billionth or 10^{-9} ; therefore, one nanometre is one-billionth of a meter. It’s difficult to imagine just how small that is, thus, here we are presenting some examples to clear the matter better [2].

1. A sheet of paper is about 100,000 nanometres thick.
2. A human hair is approximately 80,000- 100,000 nanometres wide.
3. A single gold atom is about a third of a nanometer in diameter.
4. On a comparative scale, if a marble diameter were one nanometre, then the diameter of the Earth would be about one meter.
5. One nanometre is about as long as your fingernail grows in one second.
6. A strand of human DNA is 2.5 nanometres in diameter.
7. There are 25,400,000 nanometres in one inch.

Nano-science and nanotechnology involve the ability to see and to control individual atoms and molecules. Nanotechnology is the use of matter on an atomic, molecular, and supra molecular scale for industrial purposes, and it is the design, production, and application of structures, devices, and systems by manipulation of size and shape at the nanometre scale. Thus, when it comes to Nano science and nanotechnology, we can say that when and where, we are dealing with smallest scale size, “Small is Powerful”. However, when we are dealing with small, in particular at the scale of atom size, then for the purpose of all practical situations and applications, in particular in field medicine, we are encountering, with share volume of data that we need to collect and be able to analyse these data to the point of real-time speed. So requires a lot of data analytics and data mining, where such practice is beyond human capacities.

Artificial intelligence has been an increasingly growing area for many decades now, not just within itself where the areas of Machine learning, Deep learning and artificial neural network work simultaneously, but also in the number of fields and industries that they are now prevalent in. Nano-science and nanotechnology are the study and application of tiny things. There are some growing areas where AI converges with nanotechnology. [3] Perfumes are defined as products which give good odour to the product and person on/in which they have been used. But with increasing consumer expectations and awareness the demands from the perfumes have increased. The modern consumer demands are:

1. Multifunctional properties
2. Long lasting results
3. Convenient to use
4. Affordable price

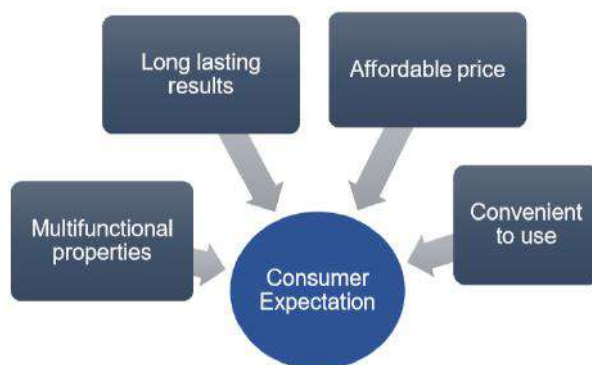


Fig:1 The modern consumer demands

With all these demands the expectations from a perfume company has increased 10 folds over the years. But these expectations have brought with them a challenge for creating an innovative product with best quality, maximum activity and best retentively at very low cost with high end popular expensive raw materials of best quality. Though these aspects look very lucrative from the marketing point of view but from a perfumer's view point they are nightmare as one must fit the best gems in a diamond encrusted platinum box at the price of a cardboard box. To maintain this balance a perfumer generally looks at various aspects like cheap raw materials or haggling on costs of ingredients or using less concentration of other expensive raw materials but forgets to look at increasing the availability of the expensive ingredients which helps in increasing the activity and also gives cost benefits. The potency and retentively of the perfumes can be increased by the modern technologies reason behind this is:

1. Achieve targeted & timed release of perfumes
2. Enhance efficacy in terms of retention and strength
3. Provide effective concentration
4. To preserve the stability of actives
5. Minimize irritation potential
6. Higher retentively of fragrances and clarity of product for aesthetically pleasing formulations.

Generally, in skin and other sectors Delivery Systems are commonly used. A delivery system is the method of delivering active payloads on to the surface, and then having them pass through the lipid barrier and finally reaching the targeted lower layers beneath.

Nanotechnology:

Nanotechnology is regarded as the most imminent technology of 21st century and is contemplated as a big boon in the cosmetic industry. The term nanotechnology is the combination of two words: namely, technology and the Greek numerical "nano" which means dwarf. Thus, nanotechnology is considered as the science and technology used to develop or manipulate the particles in the size range of 1 to 100 nm. Since 1959, nanotechnology has emerged in different fields like engineering, physics, chemistry, biology, and science and it has been virtually 40 years since nanotechnology has intruded into the field of cosmetics, health products, and dermal preparations.

There are several advantages of nanotechnology. Some of them are listed below:

- a) Nanotechnology allows for the controlled release of active substances by controlling the drug release from carriers by several factors including physical or chemical interaction among the components, composition of drug, polymer and additives, ratio, and preparation method.
- b) Nano cosmeceuticals make the fragrances last longer, for example, Allure Perfume and Allure Eau Perfume spray by Chanel.
- c) Nanotechnology based formulations are more effective and increase the lasting potential of fragrances by having very small size of the particles, the surface area is increased which allows the active transport of the active ingredients into the skin.
- d) Nanotechnology based cosmetics have high entrapment efficiency and good sensorial properties and are more stable than the conventional cosmetics. Most of the nanoparticles are suitable for both lipophilic and hydrophilic materials.

Global Industry Overview

The global perfumery market reached a value of US\$ 38.8 Billion in 2018. The global perfume market size was estimated at USD 32.50 billion in 2019 and is expected to reach USD 33.69 billion in 2020. The market value is projected to reach US\$ 48.0 Billion by 2024, at a projected CAGR of 3.6% over period of 2019- 2024. The market growth is attributed to the growing trend of personal grooming, coupled with increasing demand for luxury and exotic fragrances. Moreover, increasing consumer spending on premium and luxury fragrances due to the high income level, along with improving living standards, is driving the global market. In recent years, perfumes have evolved into a significant business in the cosmetics and personal care industry. Product diversification by manufacturers is also expected to expand the customer base. Product innovations based on customer needs are further augmenting the sales in the perfume market. For instance, Lauder's Jo Malone stores offer fragrance consultations so that shoppers can develop a customized product. Key players are also focusing on introducing natural fragrances in the premium category, primarily due to rising concerns over allergies and toxins in synthetic ingredients. Premium perfumes are expected to expand at the fastest CAGR of 3.9% from 2019 to 2025 owing to the growing preference for unique, handcrafted, and exotic fragrances.

Market size value in 2020 USD 33.69 billion
Revenue forecast in 2025 USD 40.9 billion
Growth Rate CAGR of 3.9% from 2019 to 2025

Though the predictions were made before COVID, after COVID it was seen that the Fragrances and Perfumes market in the U.S. is estimated at US\$11.8 Billion in the year 2020. The country currently accounts for a 27% share in the global market. China, the world second largest economy, is forecast to reach an estimated market size of US\$11.3 Billion in the year 2027 trailing a CAGR of 6% through 2027. Among the other noteworthy geographic markets are Japan and Canada, each forecast to grow at 0.9% and 2.4% respectively over the 2020-2027 period. Within Europe, Germany is forecast to grow at approximately 1.6% CAGR while Rest of European market will reach US\$11.3 Billion by the year 2027. At present several new technologies are being used in the global industry for the creation of long lasting, effective, retentive fragrances with longer shelf life. These are being done with use of new delivery systems like nanotechnology, micro-encapsulations, microsponges, liposomes etc.

Artificial intelligence and data-driven algorithms are heralding a new era for the fragrance industry, which is being transformed by machine learning.

1 Symrise's Philyra

Symrise's Philyra, created in partnership with IBM Research, analyzes thousands of formulas in order to identify patterns and discover innovative fragrance combinations. The system's algorithms accelerate the fragrance creation process by designing formulas that have never been seen before. This includes algorithms that learn and predict raw material substitutes and complements that can be used in a formula, appropriate dosing for a raw material based on usage patterns, 'likability' factor (whether the fragrance will be well received), and novelty of the fragrance when compared to commercially available fragrances. Philyra's data-driven approach also leverages data on fragrance families, historical data, and industry trends.

Philyra uses machine learning to discover whitespaces in the global fragrance market and create new formulas. Symrise's perfumers add the final touch by finetuning the creations, for example, by emphasizing a certain note or improving the long lastingness of the fragrance.

Philyra created two millennial fragrances that launched in 2019 for Brazilian personal care company O’Boticario.

2. Givaudan’s Carto

Givaudan’s Carto is an AI-powered tool that is designed to reinvent the way perfumers create, with the added benefit of accelerating perfume development. The AI program invites perfumers to imagine and create new fragrance accords using an interactive touch screen (creating their formulas differently from the traditional spreadsheet or olfactive pyramids). The program can cross-reference the fragrance house’s own market research, research and development, consumer data and historical formulas. Carto also includes an instant-sampling robot that accelerates the production of fragrance trials.

Carto enables perfumers to experiment with creative concepts by using the playful AI interface, which is supported by an extensive data library of fragrance formulations.

Carto is being used in Givaudan’s fragrance creative centers in all regions.

3. Scent bird’s Confessions of a Rebel

When direct-to-consumer Scent bird launched new gender-fluid sub-brand Confessions of a Rebel, it used AI, consumer data and reviews to create its four initial fragrances. (Confessions of a Rebel defines itself as a ‘next-gen fragrance brand, ready to push boundaries’). Scent bird leveraged over a million data points from its 300,000 subscribers to conceive the directions and fragrances. Instead of using typical fragrance categories such as floral, woody, or citrus, Scent bird asked consumers to select their own descriptors, that included ‘fresh’, ‘clean’ and ‘sexy’.

AI software gives Scent bird immediate access to patterns within its extensive subscriber data base, enabling it to create fragrances by way of user reviews, consumer preferences, and fragrance note preferences.

Confession of a Rebel’s four gender-fluid fragrances, including Get A Room, Love High, About Last Night, and Almost Single, launched in mid-July.

4. Sommelier du Perfume

Sommelier du Perfume is an AI-powered fragrance app that helps users find their ideal fragrance. Algorithms analyse responses to a questionnaire, learning about users’ tastes and lifestyles in order to make recommendations from its database of over 30,000 fragrances. After users select perfumes that they want to test in-store among the app’s shortlist, nearby retail stores are identified (consisting of both large beauty retailers and independent boutiques). Fragrance information includes olfactory notes, the perfumer and fragrance’s history, and ingredients, together with a toxicity assessment.

Sommelier du Perfume, as the name implies, educates consumers about the breadth of fragrances in the marketplace, and makes the selection accessible to them within a user-friendly app.

Sommelier du Perfume helps consumers find their next fragrance which they can buy in 8,000 stores in the US.

5. Algorithmic Perfumery

Algorithmic Perfumery invites users to create their own personalized fragrance made by artificial intelligence. The system uses AI software and a variety of data (together with a sampling robot) to create a personalized fragrance for each person who interacts with it. Algorithmic Perfumery is refined all the time as new users continue to train the creative sensibilities of the AI system, and it adapts and learns from every exchange. Dutch founder

Frederik Duerinck, who started the Netherlands-based company Scenonix, has presented Algorithmic Perfumery at film festivals and art exhibitions throughout 2019.

Duerinck's goal is to change how users interact with fragrance, and for every user to have their own unique fragrance. This includes fragrances with under-explored olfactive categories that are not typical of commercially successful fragrances.

Algorithmic Perfumery has been on tour this year throughout Europe and North America.

6. Coty's VR Experience

Coty's fragrance-focused, multi-sensorial virtual reality experience, launched in Argentina with retailer Julieraque, is powered by AI. The immersive experience uses touch, smell, sound and sight to help consumers find their perfectly fine fragrance match. Shoppers wear a virtual reality headset and pick up a scented stone which activates a short video. Each stone is tied to a broad fragrance category, such as 'citrus watery', 'floral fruity' or 'oriental spicy', up to six recommendations from eight Coty luxury brands based on their favourite fragrance concepts.

The VR technology can be scaled and adapted to suit a variety of markets and brands. The experience merges physical and digital worlds, and helps users navigate the world of fragrances.

Coty is planning on bringing the VR experience to additional markets, and tailoring the experience to specific brand universe. In a nutshell if we see these new tools help to

- a) Predict alternative raw material or substitutes to be used
- b) Human response
- c) The novelty of fragrance as well as the appropriate dosing of raw material, among other components.
- d) It also helps in understanding consumer preferences which in turn helps the company to focus on perfecting the final product rather than spending time searching for new fragrance combinations.

This data has been generated by a team of computer scientists who used a set of algorithms to predict the odour of different molecules based on their chemical structure. They labelled the smell with more than 19 descriptors, including "fish," "garlic," "sweet," or "burnt." They also created a massive database based on pleasantness and intensity of odour. While the immediate use of these programs was not sure, it can now find a way into the fragrance or perfume industry. New technology based on artificial intelligence could accurately predict future taste preferences among specific groups, allowing food and drink companies to get ahead of the next big trend and better target new product launches.

Application of Nanotechnology in perfumery is a very important aspect to be considered seriously to grow in the industry. Currently known applications of nanotechnology in perfume production and application are predominantly based on nano-encapsulation methods.

Application of nanotechnology enables:

- Reduction of costs of perfume compounds manufacturing,
- Manufacturing high quality ingredients,
- Manufacturing complete natural perfume compounds since they are derived from reaction catalyzed by enzymes from natural organisms,
- Compounds of low toxicity like using gold nanoparticles to replace toxic reagents that increases oxidation of aromatic primary alcohols to aldehydes,
- Manufacture of highly sensitive perfumery compounds.

Application of AI in Fragrance Industry in India

Today the Indian Fragrance market it is still lagging in terms of quality Fragrance creation. Indian fragrance industry is still looked down upon by the global industry as lacking in quality and substance. Especially the small companies dealing with the creation of fragrance blends. This is due to the aspect that Indian business owners in this field are still not well versed in this field and lack the advanced technical knowledge in creating these products. After looking at the global data in the fragrance industry we can say that if we bring in the Artificial intelligence technologies in India then they can be used in the Indian scenario to:

- a) Improve the standard of Fragrance Industry in India
- b) Help in improving the quality of fragrance blends
- c) Help the small and medium scale industries to upgrade themselves
- d) Aid the government in creating a tool for the upliftment of fragrance sector in India.
- e) Provide more employment.

Hence the industry and technology is leading us India should aim at developing its own technology which will help several small perfumery companies to utilize the new program in development of the new trends in fragrances. These systems will help in generating a new breed of entrepreneurs who can start selling their own perfume blends which have been created by AI technology and will also help the shopkeepers. The aid of AI technology Fragrance creation Kannauj and the area around it can be converted into a Tourist destination and Fragrance capital of India like Grasse is for France. Today Kannauj and the area is known for the perfumes but still there are no real fragrances and experiences which people can take back. So, with these technologies the small shop owners selling attars can also get help and can start selling the ethnic fragrances with a modern twist, created with the help of these technologies.

The technology can be divided into two parts:

1. E nose:-

Use of Artificial olfaction, i.e., e-nose, plays a critical function in robotics by mimicking the human olfactory organ that can recognize different smells. The e-nose through mimicking the olfactory receptors with the programmed algorithm of the artificial neural network helps in the recognition of the pattern of odors (i.e., their chemical profiles). Advantages of E Nose:

- Allows for monitoring of the shelf life of natural perfumery herbs by sensing the aromatic VOCs due to post-harvesting, respiration, fermentation, and phenolic oxidation.
- Detection of off notes in a perfume blend.
- Detection of perfumery compounds in a perfume blend.
- Detection of impact of factors on the stability of fragrance blends.
- Detection of Quality of Raw materials:
 - o Identification of raw materials used in perfumery.
 - o Detection of adulteration in perfumery raw materials.

2. Artificial intelligence Technology:-

The AI technology can be used to analyse the current data inferences, patterns and learnings and use them to create new blends of flavours and fragrances which can then be used by the entrepreneurs, Retailers and other small and medium companies to create new quality flavour and fragrances as per the choice of current consumers. The AI system can be created by using Python.

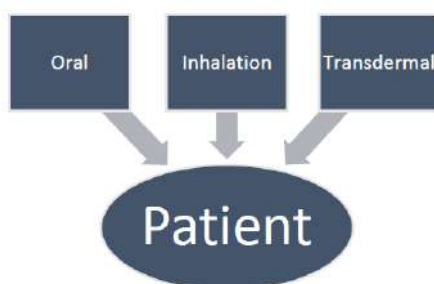
Advantages of AI in Fragrance Industry:

- Creation of new modern blends.
- Will help the entrepreneur in creating world class fragrances.
- Can Create Personalized fragrance and flavours for companies.

- Can help Kannauj to become the fragrance and flavour capital again.
- Can help several retailers to give the consumers exact fragrance and flavour of their choice.
- Cost effective as will help in saving Raw material and energy cost earlier used in trial and errors.
- Will bring in revenue for the government as companies can utilize the capabilities to create unique, personalized, quality fragrance blends.

Aromatherapy, AI and Nanotechnology

Aromatherapy is both an Art and a Science. It has for ages been considered as a holistic form of therapy. Aromatherapy is the use of essential oils for therapeutic or medical purposes (Buckle, 2003). It acts upon the holistic principles of awakening and strengthening energies and promoting self-healing. Buchbauer defined aromatherapy as – “therapeutic uses of fragrances to cure, mitigate or prevent diseases, infections and indispositions by means of inhalation.” The main component of aroma therapy is essential oils. Aromatherapy is generally used for treatment of common problems like headache, cough, cold, sleep related issues, stress, anxiety etc. Advanced practitioners are using aromatherapy in treating psychological as well as various physiological issues. Aromatherapy is generally administered in three ways to a patient:



- Oral route: The essential oils are generally administered orally in the form of oils or as seasoning in consumable products. The oils are Bitter tasting and may irritate mucosal lining. This mode of application is suitable only under supervision of experienced practitioners, as regular ingestion over a long period of time may lead to hepatotoxicity. Oils are often formulated into capsules and then consumed orally.
- Transdermal route: Lipid solubility of essential oils allows for better penetration in the skin. Easy penetration generally happens maximum behind ears, eyelids, inside the wrist followed by soles, palms, forehead, scalp, armpits, and the least in legs, buttocks, trunk and abdomen. The oils are often applied by rubbing or massaging. The oils are generally incorporated in carrier oils, gels or creams and then massaged on the skin.
- Inhalation: This is the most common and effective route of administration and is regarded as “true aromatherapy”. The incidence of adverse effects using this method is very rare.

Methods of administration include spraying on cloth and using an aroma diffuser, among others.

Essential oils: The main component of aroma therapy is essential oils, also sometimes referred to as volatile oils. Essential oils are aromatic oils extracted naturally from plant and animal sources and are used for treatments. Essential oils play a key role in plant metabolism and are also used in plants for communication. They are used by plants to attract certain beneficial insects and repel others. Essential oils allow plants to send and receive signals. Chemical communication requires specific signals that can be clearly recognized and interpreted. These chemicals are mostly in combinations, (like acetal and ester) or in enantiomeric forms e.g. α bisabolol has two enantiomeric forms - (+) α bisabolol and (-) α bisabolol.

Essential oils contain two main groups according to their biochemical origin :

1. Terpenes & Higher Monologues
2. Phenylpropane derivatives (cinnamic acid & aldehyde)

Oils whose main constituents belong to the same group exhibit similar effects, but again each oil exhibits different characteristics apart from these similar effects. Terpenes & Higher homologues (other molecules based on terpenes) - e.g. geraniol (terpinen alcohol-antiseptic and tonic), Farnesol (Sesquiterpene alcohol) etc. Essential oils contain mostly mono and sesquiterpenes. Mono terpenes are smaller molecules and their high oil content gives more clarity, less viscosity and more volatility e.g. eucalyptus oil. Sesquiterpenes have larger molecular weight and make the oil coloured (yellow/dark yellow/brown) and more viscous e.g. sandalwood, patchouli. Phenylpropane derivatives (cinnamic acid & aldehyde) - are by-products of the amino acid metabolism. These break down to form substances like anethol (antispasmodic, stabilizing effects), eugenol (stimulant, irritant & antiseptic property) etc.

Aromatherapy mechanism:

Two basic mechanisms are offered to explain the effect of aromatherapy.

1. First is the influence of the aroma in the brain, especially the limbic system through the olfactory system.
2. The other is the direct pharmacological effects of essential oils.

The efficacy of the aromatherapy remains unproven. Once the oils are circulating in the blood, they are carried to the target organ, where they exert a therapeutic effect on the specific tissues. e.g. Juniper oil targets the urinary tract and kidneys, with secondary effects on the Digestive, Respiratory and Reproductive Systems. Chamomile Oil targets the Nervous System via which it exerts a broad effect on body Systems, like Digestive Tract etc.

Examples of therapies applied and absorbed through the skin include stress relieving therapies and motion sickness patches. The global fragrance industry has shown affirmation that essential oils can affect the mood, boost productivity, help in restful sleep, alter psychological conditions of human beings and modify human behaviour on a regular and subconscious level.

Artificial intelligence can be used in aromatherapy for:

1. Evaluating and diagnosing the anxiety levels and problems in patients.
2. Evaluating the chemical constituents of essential oils.
3. Finding out the potential antimicrobial ability of essential oils.
4. Finding out the purity and level of adulteration by E-Nose and further finding out the ability of an oil in treating a certain health condition.
5. AI can be used in creating a shopping app for the customers to help them in selecting the correct oil or combinations of oils for the treatment of particular issue they are facing.

Conclusion:

With the progress and thriving of Artificial Intelligence (AI) and Nanotechnology curves are both on ascending slope, it seems these two curves have narrowed to each other to the point that we can recognize a separation span between them. This indicates that they have two complements each other and be the right partner and companion when it comes to both these industries. In today's technology of artificial intelligence and nanotechnology, it seems their integration of these is inevitable scenario. Aromatherapy is generally used for treatment of common problems like headache, cough, cold, sleep related issues, stress, anxiety etc. Advanced practitioners are using aromatherapy in treating psychological as well as various physiological issues. The AI technology can be used to analyse the current data inferences, patterns and learning and use them to create new blends of flavours and fragrances which can then be used. Hence the industry and technology is leading us India should aim at developing

its own technology which will help several small perfumery companies to utilize the new program in development of the new trends in fragrances.

Reference:

1. Ziglio E, Currie C, Rasmussen VB. (2004). The WHO cross-national study of health behavior in school aged children from 35 countries: findings from 2001–2002. *J School Health*, 74 (6): 204–206.
2. WHO (2001). Services for prevention and management of genetic disorders and birth defect in developing countries (Farhud DD. As committee member) (WHO/HGN/WAOPB-D/99.1).
3. Farahnaz Behgounia, Bahman Zohuri*. Artificial Intelligence Integration with Nanotechnology. *Op Acc J Bio Sci & Res* 6(3)-2023 DOI:10.46718/JBGSR.2020.06.000147.
4. Could an artificial intelligence be considered a person under the law? -<https://phys.org/news/2018-10-artificial-intelligence-person-law.html>
5. AI and human creativity go hand in hand - <https://phys.org/news/2018-10-ai-human-creativity.html>
6. Using AI to create new fragrances - <https://phys.org/news/2018-10-ai-fragrances.html>
7. Raj, S.; Jose, S.; Sumod, U.S.; Sabitha, M. Nanotechnology in cosmetics: Opportunities and challenges. *J. Pharm. Bioallied Sci.* **2012**, 4, 186–193. [CrossRef] [PubMed]
8. Kaul, S.; Gulati, N.; Verma, D.; Mukherjee, S.; Nagaich, U. Role of Nanotechnology in Cosmeceuticals: A Review of Recent Advances. *J. Pharm.* **2018**, 2018, 3420204. [CrossRef]
9. Ajazzuddin, M.; Jeswani, G.; Jha, A. Nanocosmetics: Past, Present and Future Trends. *Recent Patents Nanomed.* **2015**, 5, 3–11. [CrossRef]
10. Size, L.B.M.; Report, S.; Size, L.B.M.; Application, B.; Region, B.; Forecasts, S. Get Free, Instant, and Unlimited Access to a PDF Sample Report & Personalized Online Dashboard. 2021; pp. 2021–2028. Available online: <https://main.mohfw.gov.in/sites/default/files/Annual%20Report%202020-21%20English.pdf> (accessed on 15 January 2022).
11. Schneider, G.; Gohla, S.; Schreiber, J.; Kaden, W.; Schönrock, U.; Schmidt-lewerkühne, H.; Kuschel, A.; Petsitis, X.; Pape, W.; Ippen, H.; et al. Connect with Wiley. The Wiley Network. 2021, pp. 2–3. Available online: https://onlinelibrary.wiley.com/doi/abs/10.1002/14356007.a24_219 (accessed on 15 January 2022).
12. Cosmetics—Overview. Available online: <https://www.fda.gov/industry/regulated-products/cosmetics-overview> (accessed on 15 January 2022).
13. Tripathy, S.; Dureja, H. Cosmetics: Regulatory Scenario in USA, EU and India. *J. Pharm. Technol. Res. Manag.* **2015**, 3, 127–139. [CrossRef]
14. Kumar, N.; Kanchan, T.; Unnikrishnan, B.; Thapar, R.; Mithra, P.; Kulkarni, V.; Holla, R.; Bhagwan, D.; Radhakrishnan, Y. Characterization of *Rubia cordifolia* L. root extract and its evaluation of cardioprotective effect in Wistar rat model. *Indian J. Pharmacol.* **2018**, 49, 344–347. [CrossRef]
15. Haryanti, R. Krim Pemutih Wajah dan Keamanannya. *Majalah Farmasetika* **2017**, 2, 5–9. [CrossRef]
16. Search Worldwide, Life-Sciences Literature. 2021, pp. 1–2. Available online: <https://www.cosmeticsandtoiletries.com/regulations>

Artificial Intelligence: Advanced Analysis and Design

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Abstract:

Artificial Intelligence (A.I.) is a multidisciplinary field whose goal is to automate activities that presently require human intelligence. Recent successes in A.I. include computerized medical diagnosticians and systems that automatically customize hardware to particular user requirements. The major problem areas addressed in A.I. can be summarized as Perception, Manipulation, Reasoning, Communication, and Learning. Perception is concerned with building models of the physical world from sensory input (visual, audio, etc.). Manipulation is concerned with articulating appendages (e.g., mechanical arms, locomotion devices) in order to effect a desired state in the physical world. Reasoning is concerned with higher level cognitive functions such as planning, drawing inferential conclusions from a world model, diagnosing, designing, etc.

Introduction:

I have chosen this topic to spotlight on one of the most technological trend these days known as AI (Artificial Intelligent). Therefore; I will discuss some of the most important aspects related to AI in which it will help in a better understanding of Artificial Intelligent and both its advantages and disadvantages to be able to protect ourselves from the upcoming technological trend. This paper will also discuss some of the algorithms used in AI systems.

History of Artificial Intelligence:

Artificial Intelligence was first proposed by John McCarthy in 1956 in his first academic conference on the subject. The idea of machines operating like human beings began to be the center of scientist's mind and whether if it is possible to make machines have the same ability to think and learn by itself was introduced by the mathematician Alan Turing. Alan Turing was able to put his hypotheses and questions into actions by testing whether "machines can think"? After series of testing (later was called as Turing Test) it turns out that it is possible to enable machines to think and learn just like humans. Turing Test uses the pragmatic approach to be able to identify if machines can respond as humans. ("Smith", (nod))

Description Artificial Intelligence:

Artificial Intelligence is: the field of study that describe the capability of machine learning just like humans and the ability to respond to certain behaviors also known as (A.I.). The need of Artificial Intelligence is increasing every day. Since AI was first introduced to the market, it has been the reason of the quick change in technology and business fields. Computer scientist is predicting that by 2020, "85% of customer interactions will be managed without a human". ("Gartner", (nod)) This means that human's simple request will depend on computers and artificial intelligence just like when we use Sire or Galaxy to ask about the weather temperature. It is very important to be prepared for AI revelation just like UAE have by installing a state minister for AI in Dubai.

Pros and Cons of Artificial Intelligence:

AI offers reliability, cost- effectiveness, solve complicated problems, and make decisions; in addition, AI restrict data from getting lost. AI is applied nowadays in most fields whether business or engineering. One of the great tools in AI is called “reinforcement learning” which is based on testing success and failure in real life to increase the reliability of applications. Unfortunately, AI is limited with its capability and functionality. (“Sade”, (nod)) Although Artificial Intelligence made our lives much easier and saved us more time than ever, scientists are predicting that by the huge dependency on AI humanity could extinct. Scientists argue that by having an AI machines, people will be jobless and that will conclude in losing the sense of living. Since machines are learning and doing things more efficiently and effectively in a timely manner, this could be the reason of our extinction.

AI Algorithms and Models:

AI is mainly based on algorithms and models as a technique which is designed based on scientific findings such as math, statistics, and biology (Li& Jiang, (nod)). AI works based on several models such as: Ant Colony Algorithm, Immune Algorithm, Fuzzy Algorithm, Decision Tree, Genetic Algorithm, Particle Swarm Algorithm, Neural Network, Deep Learning and in this report, I will discuss some of the most known models which are: Support Vector Machine, and the Artificial Neural Network.

- Support Vector Machine (SVM) where it is used to build a classification model by Finding an optimal hyper plane based on a set of training examples as shown in (figure A-1) it is also has been used for pattern classification and trend prediction lots of Applications for instance: power transformer fault diagnosis, disease diagnosis and Treatment optimization (Li& Jiang, (nod))

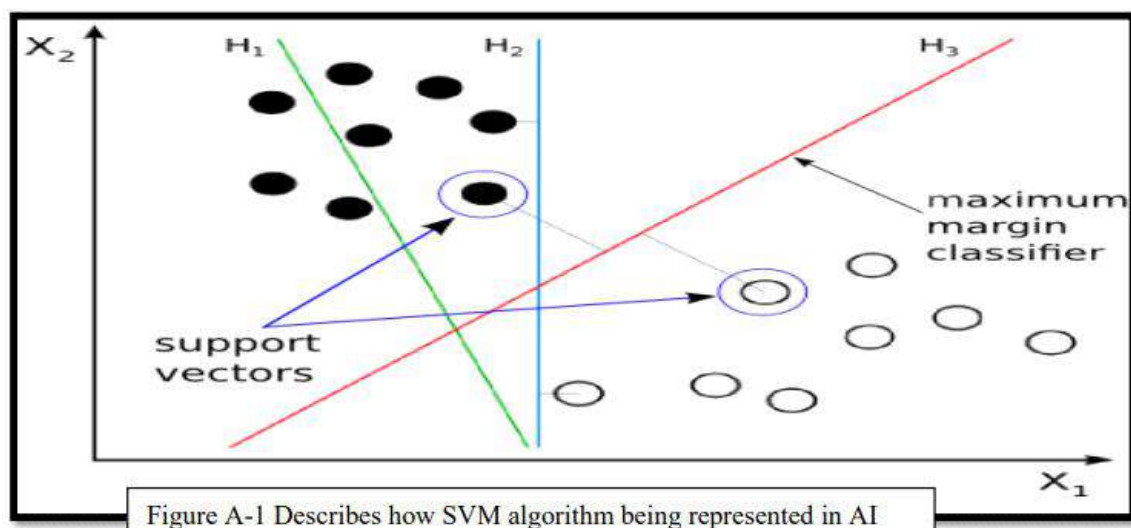
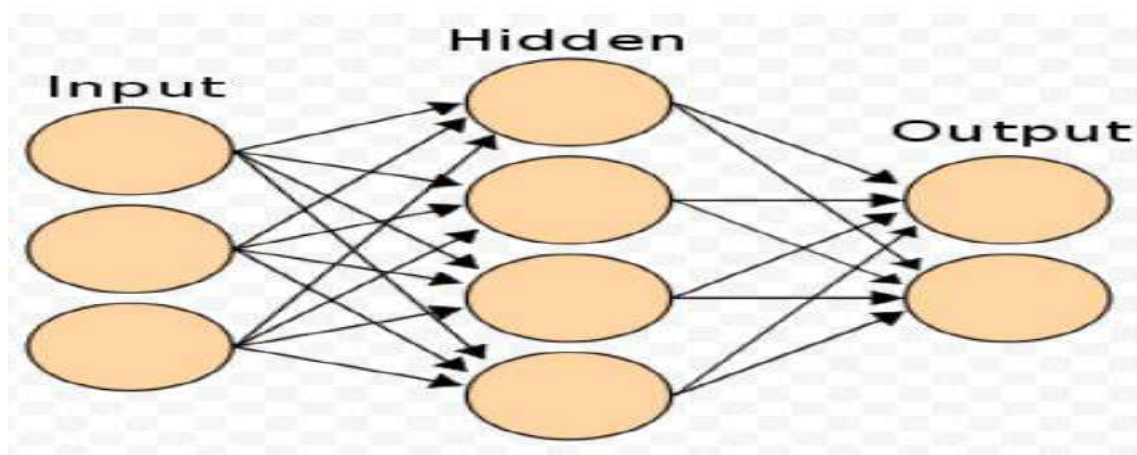


Figure A-1 Describes how SVM algorithm being represented in AI

- Artificial Neural Network (ANN) is a representative model of understanding thoughts And behaviours in terms of physical connection between neurons ANN has been used To solve variety of problems through enabling the machine to build mathematical Models to be able to imitate natural activities from brains perspective as shown in (Figure A- 2). By using this algorithm, the machine will be able to identify the Solution of any problem just like human’s brain



Some Applications on Artificial Intelligence:

AI can be designed using lots of algorithms. These algorithms help the system to determine the expected response which will basically tell the computer what to expect and work accordingly. Here are some of the greatest AI applications that we are probably using in our daily life without knowing:

- Voice recognition
 - Virtual agents:
 - Machine learning platform
 - Ai optimized hardware
 - Decision management
 - Deep learning platform
 - Bio matters
 - Robotic process automation
 - Text analytics and NLP
 - Adaptive Manufacturing :
- Machines that are “able to learn a multitude of tasks from demonstrations, just like their human counterparts can (“You”, 2017))

AI Design Models:

AI application are a lot around us and in this paper, I will discuss some of the most common application of AI that we always use nowadays which is Virtual Assistants such as Sire, Cortina...etc. Over the past few years smart assistants are becoming a very common technology in most of the smart devices and most importantly, that these assistants are getting smarter than ever. In addition to the awesome help they provide us with, is that every one of these apps has unique features. Artificial Intelligence works according to the following phases: getting the data, clean/manipulate/ prepare the data, train model, test data, and improve the data as mentioned in (figure A-3). Before accessing the data, a business must verify the quality of the data to ensure that it meets the requirement.

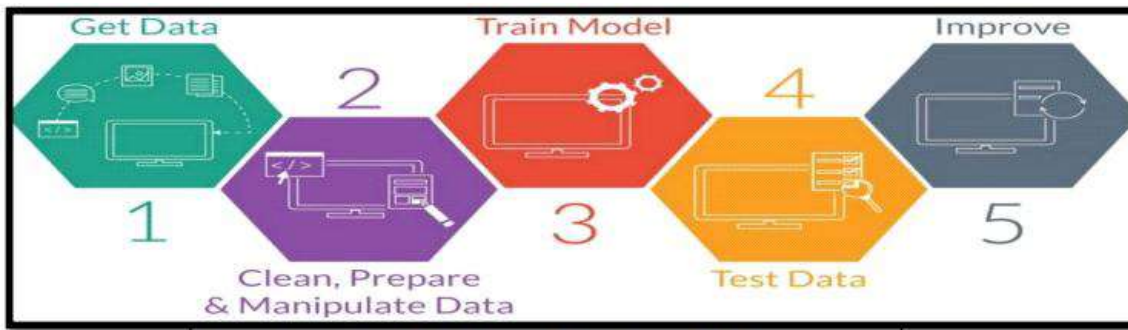


Figure A- 3 Describes Phases of Developing Artificial

Sire Virtual Assistant:

Sire is the well-known virtual assistant which uses voice recognitions and typed command in order to perform a certain task within a device. Sire is considered one of AI most used applications. The application simply takes the input from the user such as (e.g. Call dad) and try to find the most related keywords used in this command. Sire tries to eliminate inconsistent result through using the language pattern recognizer and from there to active ontology by searching through the contacts, then it tries to relate the contact named “Dad” and perform the task which is in this case is “Calling” and finally the output of this action will be “calling dad” and to consider all the possible situations refer to (figure A-4).

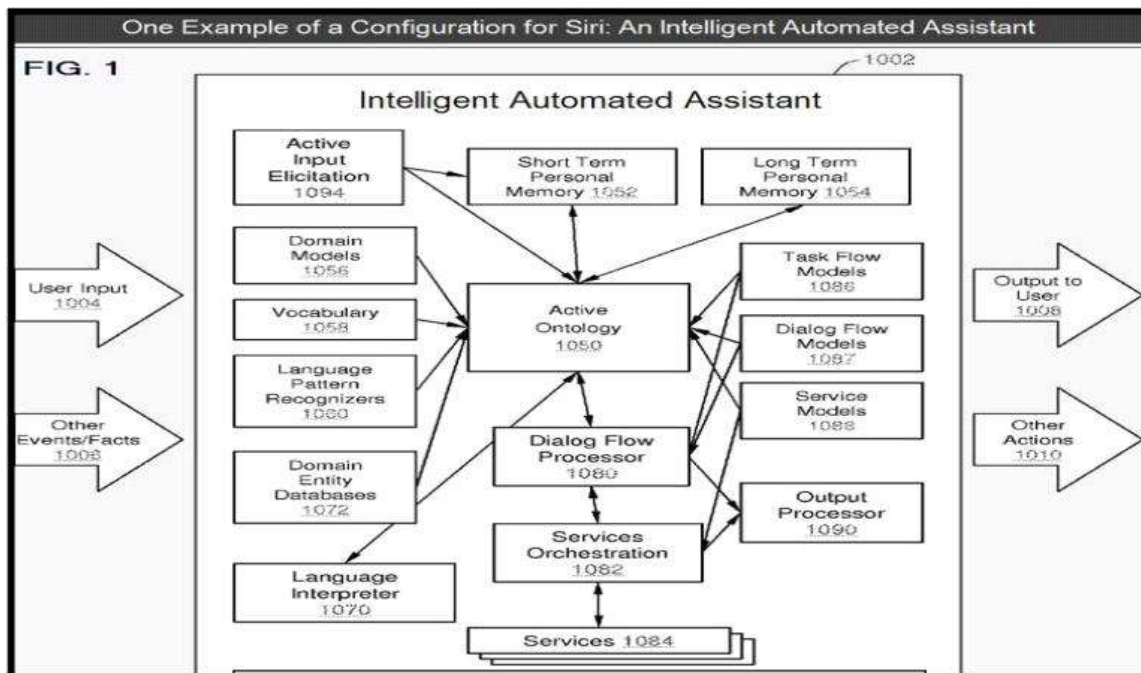


Figure A- 3 Describes one Example of configuration for Siri

In another scenario the architecture of the virtual assistant is shown in (figure A – 5) as we can see the flow of the system starts by taking the input from the user, after that the system decide the conversation strategy module to be used which is a respond from the dialog management module, meanwhile a classification module response to an NLP module. Finally, using the conversation history database is used to analyse the knowledge base construction module

which will response back to the domain knowledge based as explained in detail in (figure A-5)

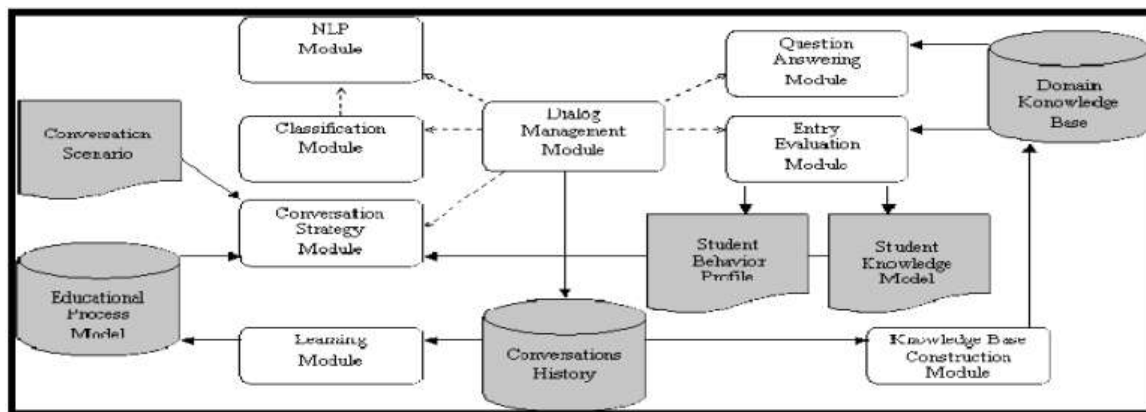


Figure A-5 Describes Proposed conversational agent architecture

Conclusion:

AI nowadays is being implemented in almost every field of study through several models such as SVM and ANN. We should be able to proceed with knowing and understanding the consequences of every technological trend. In my opinion, we are in the AI revelation era and therefore; we should adopt into this change and welcome it too by embracing AI and moving toward a better society.

REFERENCES

- 1] Artificial Intelligence Technology and Engineering Applications (2017) ACES JOURNAL, 32, 5th ser., 381-386. Retrieved November 23, 2017, from [file:///C:/Users/lenovo/Desktop/ContentServer%20\(1\).pdf](file:///C:/Users/lenovo/Desktop/ContentServer%20(1).pdf)
- 2] Apple introduces us to Sire, the Killer Patent. (2012, January 19). Retrieved November 25, 2017, From <http://www.patentlyapple.com/patently-apple/2012/01/apple-introduces-us-to-siri-the-killer-patent.html> Acceptability of Embodied Conversational Agent in a health care context (nod) Retrieved November 25, 2017, from http://www.sanpsy.univbordeauxsegalen.fr/Papers/IVA_Additional_Material.html [End Times Production] (2017, March 13). Sophia the A.I Robot [Video File] Retrieved from <https://www.youtube.com/watch?v=wimUaNqEJyw>
- 3] Galleon, D., & PhD, C. (2017, October 20). Dubai just appointed a "State Minister for Artificial Intelligence" Retrieved November 22, 2017, from <https://futurism.com/dubai-just-appointed-astate-minister-for-artificial-intelligence>
- 4] Hong, K. (nod). Machine Learning with sickie-learn. Retrieved November 22, 2017, from http://www.bogotobogo.com/python/scikitlearn/scikit_machine_learning_Support_Vector_Machines_SVM.php
- 5] Knight, W. (2017, January 04). What to expect of artificial intelligence in 2017. Retrieved November 23, 2017, from <https://www.technologyreview.com/s/603216/5-big-predictions-for-artificial-intelligence-in-2017/>
- 6] MA hanta, J. (2017, July 10) Introduction to Neural Networks, Advantages and Applications Retrieved November 23, 2017, from <https://towardsdatascience.com/introduction-to-neuralnetworks-advantages-and-applications-96851bd1a207>
- 7] Mahoney, Z. (2017, April 22). Big Data and Artificial Intelligence for Digital Business Retrieved November 25, 2017, from <http://www.immersiveauthority.com/big-data-artificialintelligence-digital-business/>
- 8] McFarlane N. (2017, October 19). The UAE now has a minister of Artificial Intelligence. Retrieved November 22, 2017, from <http://whatson.ae/dubai/2017/10/uae-now-ministerartificial-intelligence/>
- 9] Sade, A. W., & CHOWDHURY, M. (2012, November) Artificial Intelligence Applications to Critical Transportation Issues Retrieved November 24, 2017, from https://www.researchgate.net/profile/Said_Easa/publication/273576102_Design_and_construction_of_transportation_infrastructure_onlinepubstrborgonlinepubscircularsec168pdf/links/55097a910cf26ff55f85932b.pdf#page=14
- 10] Smith, C., McGuire, B., Huang, T., & Yang, G. (2006, December) History of Artificial Intelligent [Scholarly project] Retrieved November 20, 2017, from <https://courses.cs.washington.edu/courses/csep590/06au/projects/history-ai.pdf>
- 11] Yao, M. (2017, August 19). Factories of the Future Need AI to Survive and Compete Retrieved November 23, 2017, from <https://www.forbes.com/sites/mariyayao/2017/08/08/industrial-ai-factories-offuture/#30b20565128e>

Cloud Computing: Types, Security Issues, Benefits

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Abstract:-

The global competition have extended the scope of trade and extended the supply chains causing the information management to be an essential part of the businesses. Many new technologies have recently been adapted by organizations in the era of digitalization. Cloud computing had an important place in these technologies and has been integrated widely to organizations. In recent days unexpected and risky periods such as the global pandemic increased the interest towards cloud computing topic in both academically and practically. The purpose of this study is to analyze and classify the contributions of the studies published in cloud computing field. This research summarizes the current research attempts, discovers the research gaps and provides a research agenda for the future research on cloud computing within the context of inforAbstract. Computing increases the flexibility and access of educational users to a wide range of educational resources. This includes access to infrastructure, software, hardware, and platform at any time in any place provided there is internet access.

1. Introduction:-

The influence of cloud computing on business and end users is impossible to overstate: the ubiquitous presence of software that operates on cloud networks has altered many elements of daily life. Start-ups and organisations can save costs and expand their offerings by utilising cloud computing instead of purchasing and managing all of the necessary hardware and software[1][2]. Independent developers now have the ability to create apps and internet services that are available worldwide. Researchers can now share and analyse data at scales previously only available to large-scale operations. Furthermore, internet users may instantly access software and storage to produce, exchange, and store digital media in quantities much exceeding their personal computing power. Despite the fact that cloud computing is becoming more prevalent, many people are unaware of its specifics. little research has been devoted to the continuance use in an organizational setting. The collective nature of all these entities is known as the Cloud. While respondents from all types and sizes of institutions showed some similarities in their perceptions of the cloud and cloud usage, there are some notable differences that are highlighted in the key findings. This paper also aims to identify the benefits and limitations of SaaS in higher educational institutions, closes with a discussion of the research limitations, contribution, and future directions.

2. CLOUD COMPUTING DEFINITION

The term "cloud" refers to software tools and services that run over the Internet or through a web browser. This is in contrast to traditional systems, which are limited to running on a single machine. As a result, cloud computing refers to the delivery of services such as data storage, networking, and servers over the Internet. Users can save files on a distant database rather than a hard drive or storage tool with cloud computing. A device that is linked to the internet is all that is required to access the database.

2.1 What is cloud computing?



Cloud computing is on-demand access, via the internet, to computing resources—applications, servers (physical servers and virtual servers), data storage, development tools, networking capabilities, and more—hosted at a remote data center managed by a cloud services provider (or CSP). The CSP makes these resources available for a monthly subscription fee or bills them according to usage.

Compared to traditional on-premises IT, and depending on the cloud services you select, cloud computing helps do the following:

- **Lower IT costs:** Cloud lets you offload some or most of the costs and effort of purchasing, installing, configuring, and managing your own on-premises infrastructure.
- **Improve agility and time-to-value:** With cloud, your organization can start using enterprise applications in minutes, instead of waiting weeks or months for IT to respond to a request, purchase and configure supporting hardware, and install software. Cloud also lets you empower certain users—specifically developers and data scientists—to help themselves to software and support infrastructure.
- **Scale more easily and cost-effectively:** Cloud provides elasticity—instead of purchasing excess capacity that sits unused during slow periods, you can scale capacity up and down in response to spikes and dips in traffic. You can also take advantage of your cloud provider’s global network to spread your applications closer to users around the world.

The term ‘cloud computing’ also refers to the technology that makes cloud work. This includes some form of *virtualized IT infrastructure*—servers, operating system software, networking, and other infrastructure that’s abstracted, using special software, so that it can be pooled and divided irrespective of physical hardware boundaries. For example, a single hardware server can be divided into multiple virtual servers.

Virtualization enables cloud providers to make maximum use of their data center resources. Not surprisingly, many corporations have adopted the cloud delivery model for their on-premises infrastructure so they can realize maximum utilization and cost savings vs. traditional IT infrastructure and offer the same self-service and agility to their end-users. If you use a computer or mobile device at home or at work, you almost certainly use some form of cloud computing every day, whether it’s a cloud application like Google Gmail or Salesforce, streaming media like Netflix, or cloud file storage like Dropbox.

2.2 History of Cloud Computing :-

In this, we will discuss the history of Cloud computing. Before Computing was come into existence, client Server Architecture was used where all the data and control of client resides in Server side. If a single user want to access some data, firstly user need to connect to the

server and after that user will get appropriate access. But it has many disadvantages. So, After Client Server computing, Distributed Computing was come into existence, in this type of computing all computers are networked together with the help of this, user can share their resources when needed. It also has certain limitations. So in order to remove limitations faced in distributed system, cloud computing was emerged.

- During 1961, John MacCharly delivered his speech at MIT that "Computing Can be sold as a Utility, like Water and Electricity." According to John MacCharly it was a brilliant idea. But people at that time don't want to adopt this technology. They thought the technology they are using efficient enough for them. So, this concept of computing was not appreciated much so and very less will research on it. But as the time fleet the technology caught the idea after few years this idea is implemented. So, this is implemented by Salesforce.com in 1999.
- This company started delivering an enterprise application over the internet and this way the boom of Cloud Computing was started.
- In 2002, Amazon started Amazon Web Services (AWS), Amazon will provide storage, computation over the internet. In 2006 Amazon will launch Elastic Compute Cloud Commercial Service which is open for Everybody touse.
- After that in 2009, Google Play also started providing Cloud Computing Enterprise Application as other companies will see the emergence of cloud Computing they also started providing their cloud services. Thus, in 2009, Microsoft launch Microsoft Azure and after that other companies like Alibaba, IBM, Oracle, HP also introduces their Cloud Services. In today the Cloud Computing become very popular and important skill.

2.3 TYPES OF CLOUD COMPUTING

Public Cloud: The public cloud is a computing service supplied by the third party providers atop the public internet . These services are available for any user who wants to use them and they have to pay only for the services they consumed.

Private Cloud: The computing services provided over the internet or private network come under the private cloud and these services are offered only to the selected users in place of common people . A higher security and privacy is delegated by private clouds through the firewall and internal hosting . **Hybrid Cloud:** Hybrid cloud is the combination of public cloud and private cloud. In the hybrid cloud, each cloud can be managed independently but data and applications can be shared among the clouds in the hybrid cloud(19) .

2.4 BENEFITS OF CLOUD COMPUTING

Cost Saving: In cloud computing users have to only pay for the services they consumed. **Maintenance cost is low** as user do not need to purchase the infrastructure **Flexibility:** Cloud computing is scalable. The rapid scale up and down in the operations of your business may require quick adjustment of hardware and resources so in order to manage this variations cloud computing provide flexibility. **Enhanced Security:** Cloud computing provide high security by using the data encryption, strong access controls, key management, and security intelligence.

2.5 SECURITY ISSUES IN CLOUD COMPUTING

There are various security issues for cloud computing as it comprises of numerous advancements including systems, databases, working frameworks, virtualization, asset planning, exchange administration, stack adjusting, simultaneousness control and memory administration. Similarly, security issues for greater number of these frameworks and technology are pertinent to Cloud computing. According to the RSA conference which was

conducted in the March 2016, the CSA (Cloud Security Alliance) has released the list known as Treacherous 12, which includes the top 12 Cloud Computing threats in 2016. The following are the 12 threats in cloud computing .

1 Data Breaches

2 Compromised credentials and broken authentication

3. Hacked Interfaces and APIs

4 Exploited system vulnerabilities

5 Account Hijacking

1. Data Breaches: Due to the improved technology, large amount of data is stored in cloud servers, which becomes a target for the hackers. More the amount of data exposed, greater will be the damage to the society and users. The exposure of personal profile would be a normal one, but breaches which involve health information, trading secrets, intellectual property rights would bring a larger destruction. Though Cloud provider typically disposed security controls to protect their environments, it is enterprises which are responsible for securing their own data in cloud. Use of multi-factor authentication and encoding the data or information so that only authorized users can access it.

2. Compromised credential sand broken authentication: Data breaches and other attacks frequently result from slack authentications, weak passwords, poor key or certificate management. Sometimes, not only organizations even we forget to remove the access after our job is done. We can consider for example, the Gmail account if we login in the public accessing places (internet cafes) and forget to logout after our use, exposes our own private data to others. It is our responsibility to remember everything and take care. To avoid these issues, Multi-factor authentications such as one-time passwords, phone-based authentications, OTPs, security questions would make the attacker harder to login from stolen passwords. The rotation of cryptographic keys periodically will not only keep the records secure but also make the resources difficult for the attackers who use keys without authorization.

3. Hacked Interfaces and APIs: At present, every cloud service provides APIs. They are used to manage the cloud services, management, orchestration, monitoring. The interfaces and APIs which are weak would expose the authorizations to security issues like confidentiality, integrity, availability and accountability. It is recommended by CSA, to focus on threat modeling applications such as architecture/ design which are the primary concepts for the future developments and also to examine the flaws in the security-coding reviews and high level of testing.

4. Exploited system vulnerabilities: We have been facing the problem of bugs since a very longtime. One can say that they are always observed in one or the form. As the usage of technology has increased in a wide range, these vulnerabilities had become a bigger issue. The sharing of memory, data bases and other data among the organizations would lead to data crash or reports larger bugs and later on even may be affected by virus too. To eschew these bugs and system vulnerabilities one may probably have to scan the systems, mobile phones etc. regularly and try to find the solutions for the reported bugs.

5. Account Hijacking: Security concerns with cloud computing . One of the most common and daily heard issues in the society at present(12)(13).

2.6 CHARACTERISTICS OF CLOUD COMPUTING

There has been much discussion in industry and academia about what cloud computing actually means . The US National Institute of Standards and Technology (NIST) has developed a working definition that covers the commonly agreed aspects of cloud computing . It summarizes cloud computing as: “a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal

management effort or service provider interaction". According to this definition, cloud computing has the five essential characteristics, 1) On-demand self-service. 2) Broad network access. 3) Resource pooling. 4) Rapid elasticity. 5) Measured Service. Cloud computing is an emerging distributed computing paradigm that promises to offer cost-effective scalable on demand services to users, without the need for large up-front infrastructure investments . One of the main reasons for the success of cloud computing is the role it has played in eliminating the size of an enterprise as a critical factor in its economic success. An excellent example of this change is the notion of data centers which eliminate the need for small companies to make a large capital expenditure in building an infrastructure to create a global customer base

Conclusion:-

Cloud computing will affect large part of computer industry including Software companies, Internet service providers. Cloud computing makes it very easy for companies to provide their products to end-user without worrying about hardware configurations and other requirements of servers. The cloud computing and virtualization are distinguished by the fact that all of the control plane activities that center around creation, management, and maintenance of the virtual environment, are outsourced to an automated layer that is called as an API and other management servers for the cloud management.

In simple words, the virtualization is a part of cloud computing where manual management is done for interacting with a hypervisor. On the other hand, in cloud computing, the activities are self-managing where an API (Application Program Interface) is used so that the users can self-consume the cloud service.

References :-

- [1] L.Wang, J. Tao, M. Kunze, A. C. Castellanos, D. Kramer, and W. Karl, "Scientific cloud computing: Early definition and experience," 2008 10th IEEE International Conference on High Performance Computing and communications, 2008.
- [2] <https://www.ugc.edu.hk>.
- [3] <https://www.academia.edu>.
- [4] veritisadmn,"cloud computing trends,benefits,"go to veritis group inc.,12-oct- 2022.[online].
- [5] l qian,z.luo,y.du,and l.guo,"cloud computing:anoverview,"incloudcom '09:proceedings of the 1st international conference on cloud computing.springer-verlag pp.626-631,2009.
- [6] g.lin,d.fu,j.zhu,and g.dasmalchi,"cloud computing:IT as a service,"IT professional,vol.11,no.2,pp. 10-13,2009.
- [7] L.gonzalez, L.merino,j.caccres, and M. Lindner, " A Break in the Clouds: Towards a Cloud Definition", Computer Communication Review,39(1),2009.
- [8] D.Plummer, T. Bittman, T. Austin, D. Cearly, and D.Smith, "Cloud computing: Defining and describing an emerging phenomenon", Technical report, Gartner, 2008.
- [9] J. Staten, S. Yates, F. Gillett, W. Saleh, and R. Dines, "Is cloud computing ready for the enterprise?", Technical report, Forrester Research, March 2008.
- [10] Herhalt, J., Cochrane, K..Exploring the Cloud: A Global Study of Governments' Adoption of Cloud(2012).
- [11] <http://www.appcore.com/types-cloud-computing-private-public-hybrid-clouds/>
- [12] C. O. Rolim, F. L. Koch, C. B. Westphall, J. Werner, A. Fracalossi, and G. S. Salvador, "A Cloud Computing Solution for Patient ' s Data Collection in Health Care Institutions," no. ii, pp. 95–99, 2010.
- [13] J. S. Sengar, "SURVEY : Reputation and Trust Management in VANETs," Int. J. Grid Distrib. Comput., vol. 8, no. 4, pp. 301–306, 2015.

A Deep Dive Into Extended Reality -Six Sense Integration -Merging Real And Virtual World

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Abstract:

The merging of Extended Reality (XR) and sixth sense technologies is a burgeoning field with immense potential to redefine human-computer interaction. This review aims to explore the current state of research on their integration, highlighting key findings, applications, and future directions. As Extended Reality (XR) redefines user experiences across diverse fields. Extended Reality (XR), encompassing Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR), has revolutionized user experiences across various fields. However, the next frontier lies in seamlessly integrating XR with sixth sense technologies, enabling deeper immersion and intuitive interaction through bio-sensing. This paper explores the synergistic potential of this integration, analyzing its impact on user experience, outlining promising applications, and identifying key challenges and future directions. We argue that the fusion of XR's immersive environments with sixth sense's biofeedback and contextual awareness capabilities can unlock an unprecedented level of human-computer interaction, paving the way for personalized, adaptive, and hyper-realistic experiences

Keywords:

Extended reality, sixth sense, bio-sensing, haptic feedback, immersive interaction, human-computer interaction, user experience, applications, challenges, future directions

Introduction:

Mixing extended reality (XR) with sixth sense technology has the potential to create incredibly immersive and intuitive experiences that blur the lines between the physical and digital worlds.

Extended Reality (XR):

XR encompasses a spectrum of immersive technologies that blend real and virtual environments. It includes:

Augmented Reality (AR): Superimposes Digital Information onto the real world, viewed through a device like a smartphone or smart glasses. Imagine seeing repair instruction on machinery or historical facts popping up as you explore landmark.

Virtual Reality (VR): Creates a fully immersive, computer-generated environment experienced through a headset. Imagine attending virtual concert, collaborating in design session or undergoing therapy in simulated scenarios.

Mixed Reality (MR): Combines element of AR and VR, allowing real and virtual object to interact in real time, imagine manipulating 3d model in your living room or participating in holographic training exercises.

Sixth Sense Integration:

Six-sense refer to expanding our current five sense (sight, touch, taste, smell and hearing) with technological capabilities. This could involve:

Biometric Sensors: Monitoring vital signs like heart rate and brain activity to track emotion, fatigue or focus.

Haptic Feedback: Providing realistic textures and sensations through devices worn on the skin or clothing.

Small and Taste Simulation: Delivering virtual scents and flavors through specialized devices, enhancing immersive experiences.

XR And Sixth Sense Integration:

Integrating Six-Sense capabilities into XR environment can create even more profound and impactful experiences.

Imaging:

VR Training simulations: Feeling Virtual Texture of objects, experiencing heat and wind changes, and even tasting virtual food samples for enhanced skill development.

AR-Assisted Learning: Receiving haptic feedback while assembling furniture or feeling the emotional pluse of historical characters through holographic presentations.

Remote Collaboration: Having a realistic sense of presence in virtual meetings, felling handshakes virtually and sharing immersive spatial data.

Algorithms and design for integrating XR and Six-Sense Technology:

Integrating XR and Six-Sense Technologies is a complex task that requires a combination of various algorithms and design principles. Here's an overview of some key areas:

Algorithms:

Real-Time Sensor Fusion: Algorithms are needed to process and combine data from various XR sensors (e.g., head tracking, hand gestures, biometrics) and six-sense devices (e.g., haptic feedback, smell diffusers) in real-time. This creates a unified sensory experience that reacts dynamically to user interactions.

Sensory Simulation: Algorithms translate digital information into realistic sensory stimuli for smell, taste, and touch. This involves understanding human sensory perception and generating appropriate signals for six-sense devices based on virtual elements.

Adaptive Personalization: Algorithms can personalize the sensory experience based on individual user preferences and biofeedback data. This ensures optimal comfort and engagement for each user by adjusting intensity, type, and timing of sensory stimuli.

Machine Learning: Machine Learning Algorithms can be used to analyze user data and preferences, allowing the system to adapt and improve the sensory experience over time.

Design principles:

User-Centered Design: The integration should prioritize user comfort, safety, and well-being. Interfaces need to be intuitive and non-overwhelming, considering potential sensory overload and individual needs.

Data Privacy And Security: Robust security measures are crucial to protect sensitive user data collected from sensors and biometrics. Transparent data handling practices and user control over information are essential.

Ethical Considerations: Design should address potential ethical concerns like addiction, manipulation, and impact on mental health. Transparency, user agency, and clear guidelines are necessary to ensure responsible use.

Accessibility and Inclusivity: The system should be accessible to people with disabilities and diverse physical abilities. This requires designing for different sensory modalities and providing alternative interaction methods.

Interoperability and Standardization: Open standards and protocols are needed to enable seamless integration across different xr platforms and six-sense devices, fostering wider adoption and innovation.

Specific technologies:

Haptic Technology: Various haptic technologies exist, from vibration motors to exoskeletons, each with its advantages and limitations. Choosing the right technology depends on the desired sensory experience and application.

Smell and Taste Simulation: While still in early stages, technologies like scent diffusers and taste buds on the tongue are being explored to generate virtual smells and tastes.

Brain-Computer interfaces (bcis): Though futuristic, bci technology holds potential for directly translating brain activity into sensory experiences, bypassing traditional interfaces.

Model of integrating XR And Six-Sense Technology:

Here is a possible model of XR with six-sense technology:

Hardware:

Head-mounted display (HMD): This is the primary display that users will see through. It should be high-resolution and have a wide field of view to create a truly immersive experience.

Haptic gloves: These gloves will provide users with a sense of touch in the virtual world. They can be used to feel objects, textures, and even other people.

Olfactory display: This device will emit smells that correspond to what users are seeing and doing in the virtual world.

Gustatory display: This device will allow users to taste things in the virtual world. It is still in the early stages of development, but it has the potential to revolutionize the way we experience virtual reality.

Biometric sensors: These sensors will track users' heart rate, respiration, and other physiological responses. This information can be used to personalize the experience and make it more realistic.

Software:

Rendering engine: This software will create the graphics and sounds that users see and hear in the virtual world. It should be able to handle the complex demands of six-sense technology.

Physics engine: This software will simulate the physics of the virtual world, so that objects move and interact realistically.

Sensory feedback software: This software will translate data from the haptic gloves, olfactory display, gustatory display, and biometric sensors into sensory experiences for the user.

Challenges in XR with Six-Sense Integration:

While XR And Six-Sense Technologies hold immense potential, integrating them seamlessly comes with several challenges:

Technical:

Hardware limitations: Current devices are bulky, expensive, and have limited sensory fidelity. Creating miniature, comfortable, and affordable devices that deliver realistic touch, smell, and taste sensations remains a hurdle.

Real-time processing: Integrating and processing data from multiple sensors and six-sense technologies in real-time to create a synchronized and responsive experience requires significant processing power and efficient algorithms.

Sensory fidelity and personalization:

Individual variability: Sensory perception varies greatly between people. Creating personalized experiences that cater to individual differences in sensitivity and preferences adds complexity.

Limited understanding of senses: Our Scientific understanding of how humans perceive smell, taste, and touch is still evolving, making it difficult to accurately replicate these sensations in a virtual environment.

Privacy and security:

Biometric data collection: Integrating Six-Sense Technologies often involves collecting sensitive biometric data. Ensuring user privacy and data security in these immersive environments is crucial.

Virtual embodiment manipulation: The ability to manipulate users' virtual avatars and sensory experiences raises ethical concerns about potential misuse and manipulation.

Ethical

considerations:

Impact on Mental Health: The potential impact of extended exposure to highly immersive and sensory-rich XR environments on mental health and well-being needs careful consideration.

Accessibility and Equity: Ensuring Equitable access to these technologies for people with disabilities and diverse socioeconomic backgrounds is vital to avoid exacerbating existing inequalities.

Social and societal impact:

Addiction and Escapism: the immersive nature of XR raises concerns about potential addiction and escapism, particularly with the addition of multisensory experiences.

Real-World Impact: The blurring of lines between the physical and virtual worlds has societal implications in areas like social interaction, work-life balance, and perception of reality.

Applications:

Gaming: Imagine being able to feel the weight of a gun in your hand, smell the gunpowder, and even taste the blood of your enemies. Six-sense technology could take gaming to a whole new level of immersion.

Education: Students could learn about history by walking through the streets of ancient rome, or about biology by dissecting a virtual frog. Six-sense technology could make education more engaging and interactive than ever before.

Training: Soldiers could train for combat in a virtual battlefield that feels and smells like the real thing. Doctors could practice surgery on virtual patients. Six-sense technology could revolutionize the way we train for a variety of professions.

Therapy: People with phobias could be exposed to their fears in a safe and controlled environment. People with chronic pain could experience pain relief through virtual reality. Six-sense technology could have a major impact on mental and physical health.

Conclusion:

Integrating XR and six-sense technologies is a dynamic field with continuous advancements. Utilizing powerful algorithms and adhering to ethical design principles is crucial for creating immersive, responsible, and beneficial experiences for all users. Collaboration between researchers, developers, and ethicists is key to unlocking the full potential of this exciting technology. Despite these challenges, ongoing research and development efforts are addressing these issues. With careful consideration of ethical and societal implications, XR-Six-Sense Integration has the potential to revolutionize various aspects of life, offering exciting possibilities for education, healthcare, entertainment, and more. It's important to approach this technology responsibly and collaboratively to ensure its benefits reach everyone in a positive and sustainable way."

References:**Research Papers :**

- [1] "Crafting the Senses: Designing for Extended Reality and the Internet of Things" by Pranav Mistry and Patricio Freire (2017):
<https://www.jetir.org/papers/JETIR1701013.pdf>
- [2] "Sensory Augmentation for Mixed Reality: State of the Art, User Acceptance, and Future Directions" by Tobias Knodel, Michael Naceri, and Matthias Rauter (2019):
<https://www.nature.com/articles/srep42197>
- [3] "Six Senses of Presence: VR beyond Vision and Hearing" by Jeremy Bailenson, Nick Yee, Matei Zaharia, and Daniel Nowosielski (2007):
<https://ieeexplore.ieee.org/document/10179147/>
- [4] "Haptic Interfaces for Immersive Virtual Reality" by Eunyoung Kim, Minyoung Kim, Sunghyun Kim, and Byungjin Kim (2020):
<https://www.sciencedirect.com/science/article/abs/pii/B9780128217504000116>
- [5] "The 6 senses of the future: How VR is evolving beyond sight and sound" by The Next Web: <https://thenextweb.com/conference/themes>
- [6] "The Future of Smell and Taste in VR" by XR Today:
<https://www.tandfonline.com/doi/full/10.1080/17458927.2018.1556952>
- [7] "The Challenges and Opportunities of XR and Six-Sense Integration" by Futurism:
<https://futurism.com/>
- [8] "The Ethical Implications of Six-Sense Technology" by MIT Technology Review:
<https://www.technologyreview.com/magazines/the-ethics-issue/>

Books:

- [9] "The Augmented Mind: How VR Will Revolutionize Reality" by Chris Milk (2020)
- [10] "Reality+: Virtual Worlds and the Future of Experience" by David J. Chalmers (2020)
- [11] "Beyond Vision: The Hidden Senses That Shape Our World" by Michael J. Slepian (2020)

Cyber Security: Hacking, Child Pornography, Virus Dissmination

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ABSTRACT

Cyber Security plays an important role in the field of information technology. Securing the information have become one of the biggest challenges in the present day. Whenever we think about the cyber security the first thing that comes to our mind is 'cyber crimes' which are increasing immensely day by day. Various Governments and companies are taking many measures in order to prevent these cybercrimes. Besides various measures cyber security is still a very big concern to many. This paper mainly focuses on challenges faced by cyber security on the latest technologies .It also focuses on latest about the cyber security techniques, ethics and the trends changing the face of cyber security.

Keywords: cyber security, cybercrime, cyber ethics, social media, cloud computing, android apps.

INTRODUCTION

Today man is able to send and receive any form of data may be an e-mail or an audio or video just by the click of a button but did he ever think how securely his data id being transmitted or sent to the other person safely without any leakage of information?? The answerlies in cyber security. Today Internetis the fastest growing infrastructure in every daylife. In today's technical environment many latest technologies are changing the face of the man kind. But due to these emerging technologies we are unable to safeguard our private information in a very effective way and hence these day cybercrimes are increasing day by day. Today more than 60 percent of total commercial transactions are done online, so this field required a high quality of security for transparent and best transactions. Hence cyber security has become a latest issue. The scope of cyber security is not just limited to securing the information inIT industry but also to various other fields like cyber space etc.

CYBER SECURITY

Cyber Security is the body of technologies, processes, and practices designed to protect networks, devices, programs, and data from attack, theft, damage, modification or unauthorized access. Privacy and security of the data will always be top securitymeasures that any organization takes care. We are presently living in a world where all the information is maintained in a digital or a cyber form. Social networking sites provide a space where users feel safe as they interact with friends and family. In the case of home users, cyber-criminals would continue to target social media sites to steal personal data. Not only social networking but also during bank transactions a person must take all the required security measures.

CYBER SECURITY: - Cyber Security involves protection of sensitive personal and business information through prevention, detection and response to different online attacks. Cyber security actually preventing the attacks, cyber security.

PRIVACY POLICY: - Before submitting your name, e-mail, address, on a website look for the sites privacy policy.

KEEP SOFTWARE UP TO DATE: - If the seller reduces patches for the software operating system your device, install them as soon as possible. Instilling them will prevent attackers from being able to take advantage. Use good password which will be difficult for thieves to guess. Do not choose option that allows your computer to remember your passwords.



TYPES OF CYBER CRIME

- **HACKING:** - Hacking in simple terms means an illegal intrusion into a computer system and network. It is also known as cracking.
- **DENIAL OF SERVICE ATTACK:** - This is an act by the criminals who floods the bandwidth of the victim's networks or fills his E-mail box with spam mail depriving him of the service he is entitled to access or provide.
- **CHILD PORNOGRAPHY:** - The internet is being highly used by its abuses to reach and abuse children sexually, worldwide. As more homes have access to internet, more children would be using the internet and more are the chances of falling victim to the aggression of Pedophiles.
- **VIRUS DISSEMINATION:** - Malicious software that attaches itself to other software VIRUS, WORMS, TROJAN HORSE.

- **COMPUTER VANDALISM:** - Damaging or destroying data rather than stealing or misusing them is called cyber vandalism. These are programs that attach themselves to a file and then circulate.
- **CYBER TERRORISM:** - Terrorist attacks on the internet is by disturbed denial of service attacks, hate websites and hate E-mails, attacks on service network etc.

Advantages of the cyber security

a) Data safety from hackers

- Cyber security is designed to reduce the chance of data breaches against criminals. It uses tools and techniques like the DLP technique in conjunction with firewalls, web servers, and access control methods for protection. It also restricts resource access based on user tasks and powers or network connections.

b) Reduces computer crash

- While working with technology, the user must deal with various harmful attacks that may result in freezing screens and computer crashes. This can bring the work life of people working with tight deadlines at risk. These kinds of problems can be diminished by cyber security and lower the hindrance of working with technology.

c) Decreased data theft hazard

- The major benefit of cyber security is that it prevents unauthorized or malicious user access to the system. The high-security protocol is implemented to protect against major data theft and makes the experience a lot more relieving.

d) System availability and improved data

- If a system is free from threats due to cyber security, it can boost the effectiveness of data and its network. It also improves the quality of data as it is less harmful.

e) Protect business reputation

- Every organization's primary strategy is to win customers' trust, but a data breach can weaken the whole effort and bond of trust. Various examples have proved that data breaches have badly spoiled the business reputation because, after an attack, they failed to get the customer retention needed to strengthen brand loyalty. Organizations use technologies like network security and cloud security to avoid these sudden setbacks in the system and strengthen the security, which can also open new paths to future recommendations, ventures and expansions.

f) Assist remote working

- Cyber securities always protect analytics, strategies, and sensitive data that risk being leaked or hacked. Rather some organizations or business uses multiple remote models for their workflows. Still, it became more popular after COVID-19, where 80% of workers worked from home with their personal or professional devices, Wi-Fi, and IoT. This result in the increase of average data breach costs that make it necessary for a business to protect its sensitive data.

g) Saves the bottom line

- Cybercriminals or cyber crimes are the prime rivals of any business or individual that can suddenly take everything from bed to floor, including its sales and revenue. With low, competitive criteria, a business can't survive its continuity. Therefore cyber security has some developed technologies that defend businesses from reaching their bottom line.

h) Cyber posture is improved

- Digital protection provided by cyber security to the firms provides safety, liberty, and flexibility to the employees in freely accessing the internet. Cybersecurity technology continuously increases its safety posture by tracking all the systems with a single click.

Cyber security organizations can protect and respond during and after a cyber-attack. Cyber security protocols are strengthened to prevent threats.

Disadvantages of Cyber Security

a) Not affordable to everyone

Users or businesses have to buy their services and pay for maintenance, which seems an expenditure to them. Usually, small or medium business needs more finances to protect their system and data from internal or outside cyber-attacks. They need to be aware of the advantage of using cyber security in business and invest less in cyber security. Even an individual using a system and internet couldn't afford an antivirus or firewall for their system and doesn't feel the need for it. Rather some free antivirus and window defender already installed in window help in prevention, but nothing is 100% secure.

b) Can be complicated

Cyber security measures are hard to understand for its user, normal persons, or business persons as they require a lot of time and effort. Suppose the user needs help understanding how to use cyber security, then instead of benefit. In that case, it can damage data loss, or hackers can easily take advantage of it. If a business doesn't have a proper security mechanism, it can be easily trapped and attacked by hackers with various methods. Cyber security experts must break the complexity of getting through cyber security to avoid damage.

c) Security patches may backfire

To secure the system, security experts always work on designing security patches against vulnerabilities, and once they release a new security update or patch, the hackers start their work. They try to find the weakness mended in patched files by comparing the patches and unpatched files. Then unpatched files are attacked, which is why patches can backfire on the system it was meant to secure.

d) Need of constant monitoring

As we know, hackers and cybercriminals continuously work to penetrate a business network. To tackle them, businesses have to monitor their cyber security constantly. It has two benefits. One, it keeps the system up to date, finding threats before they create harm and ensuring everything is in place.

e) Slow down the system

One of the best and most dedicated security systems consists of several passwords and checks all the system files. This can consume lots of time, resulting in slow system processing and the productivity of the person working on it.

f) Can be risky

Sometimes implementing cyber security measures can be risky for individuals or businesses because they have to compromise their data. It also increases the risk of security breaches that result in loss of money, customer trust, and the company's reputation.

Importance of Cybersecurity

- Cybersecurity is just an ethical practice to protect our devices from such hackers and make them more secure. People involved in cybersecurity perform security measures and operations in order to keep our data and devices safe. Cybersecurity basically deals with protecting our network, devices, and data from illegal and unauthorized access by other people. Hackers and cybercriminals use the Internet as an opportunity to crack into other's people devices by using spyware, malware and carrying out cyber attacks.
- The main purpose of Cybersecurity is to protect all the users on the Internet from infected files, malware, and digital attacks which lead the users to access private sensitive information of users, extort ransom from users by using their private data or even disrupting important critical infrastructure like shutting down power supplies and military infrastructure.

- Cybersecurity helps to solve pre-built vulnerabilities in applications and helps them to remain stable throughout. More and more devices are getting connected to the Internet, hence it is more and more important to secure all the devices over the Internet to protect them all against unauthorized access.

CONCLUSION

Computer security is a vast topic that is becoming more important because the world is becoming highly interconnected, with networks being used to carry out critical transactions. Cyber crime continues to diverge down different paths with each New Year that passes and so does the security of the information. The latest and disruptive technologies, along with the new cyber tools and threats that come to light each day, are challenging organizations with not only how they secure their infrastructure, but how they require new platforms and intelligence to do so. There is no perfect solution for cyber crimes but we should try our level best to minimize them in order to have a safe and secure future in cyber space.

REFERENCE

- 1]. A Sophos Article 04.12v1.dNA, eight trends changing network security by James Lyne.
- 2]. Cyber Security: Understanding Cyber Crimes- Sunit Belapure Nina Godbole
- 3]. Computer Security Practices in Non Profit Organisations – A NetAction Report by Audrie Krause.
- 4]. A Look back on Cyber Security 2012 by Luis corróns – Panda Labs
- 5]. International Journal of Scientific & Engineering Research, Volume 4, Issue 9, September-2013 Page nos.68 – 71 ISSN 2229-5518, “Study of Cloud Computing in HealthCare Industry “ by G.Nikhita Reddy, G.J.Ugander Reddy
- 6]. IEEE Security and Privacy Magazine – IEEECS “Safety Critical Systems – Next Generation “July/ Aug 2013.
- 7]. CIO Asia, September 3rd, H1 2013: Cyber security in malasia by Avanthi Kumar.
- 8]. M. M. Yamin, B. Katt, and V. Gkioulos, “Cyber ranges and security testbeds: Scenarios, functions, tools and architecture,” Computers and Security. 2020.
- 9]. M. A. Khan and K. Salah, “IoT security: Review, blockchain solutions, and open challenges,” Futur. Gener. Comput. Syst., 2018.
- 10]. C. Lee, H. Bin Yim, and P. H. Seong, “Development of a quantitative method for evaluating the efficacy of cyber security controls in NPPs based on intrusion tolerant concept,” Ann. Nucl. Energy, 2018.
- 11]. J. Srinivas, A. K. Das, and N. Kumar, “Government regulations in cyber security: Framework, standards and recommendations,” Futur. Gener. Comput. Syst., 2019.

How biometric affects Cyber Security

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ABSTRACT

Cybersecurity is crucial to the information technology industry. One of the main problems of the modern world is information security. The first thing that springs to mind when considering cyber security is the rapidly rising number of cybercrimes. Numerous governments and businesses are implementing numerous efforts to deter these cybercrimes. Despite these precautions, many people continue to have serious concerns about cyber security. This essay primarily addresses the difficulties that modern technology present for cyber security. It also emphasizes the most recent developments in cyber security methods, morality, and fashions that are redefining the field.

KEYWORDS

Keywords: cyber security, cyber crime, Biometrics Security.

INTRODUCTION

Cybersecurity is the discipline of defending hardware, software, and data connected to the internet from cyberthreats such as theft, hacking, and data breaches. It includes a range of tools, procedures, and methods intended to protect devices, networks, and private data against harm or illegal access. Network security, application security, endpoint security, data security, identity management, and cloud security are important aspects of cybersecurity. As people depend more and more on digital technologies for personal and professional purposes, cybersecurity is essential to maintaining the privacy, availability, and integrity of data and systems.

Even the newest technology, such as online banking, cloud computing, mobile computing, and e-commerce, require a high level of security. These technologies now require heightened protection since they include some very sensitive personal data.

DEFINATION

The process of protecting networks, computers, servers, mobile devices, electronic systems, and data from hostile intrusions is known as cyber security. It is often referred to as electronic information security or information technology security..

Techniques for Cyber Security :-

Password security and access control

A key component of information security has always been the idea of a user name and password. This can be among the initial steps taken in terms of cyber security.

Data authentication

Before downloading, any papers that we receive must always be authenticated. This means that they must be verified to have come from a reputable source and to not have been altered. Usually, the anti-virus software on the devices is responsible for authenticating these documents. Therefore, to safeguard the devices against viruses, effective anti-virus software is also necessary.

Software for Antivirus

Computer programs known as antivirus software are designed to identify, stop, and eliminate harmful software, including worms and viruses. The majority of antivirus software comes with an auto-update capability that allows the application to download virus profiles as soon as they are found, allowing it to scan for new infections right away. Every system needs anti-virus software as a basic requirement.

Firewalls:-

A firewall is a piece of hardware or software that helps block viruses, worms, and hackers from infecting your computer via the Internet. Every message that enters or exits the internet is filtered by the firewall, which checks each one and deletes any that don't fit the predetermined security requirements. Firewalls are crucial in identifying malware because of this.

Malware Detectors :-

This software typically checks all of the system's files and papers for dangerous viruses or malicious code. Malicious software is generally referred to as malware and includes programs like Trojan horses, worms, and viruses.

Cyber crime :-

Cybercrime refers to any illicit action where the primary tool for commission and theft is a computer. The concept of cybercrime has been broadened by the U.S. Department of Justice to encompass any illicit behaviour that makes use of a computer to save evidence. The increasing number of cybercrimes includes both computer-based versions of pre-existing crimes like identity theft, stalking, bullying, and terrorism, which have become serious issues for individuals and countries, as well as crimes that have been made possible by computers, like network intrusions and the spread of computer viruses. Cybercrime is generally understood to be any crime that uses a computer and the internet to steal someone's identity, sell illegal goods, harass victims, or interfere with operations through malicious software. Cybercrimes are becoming more common nationwide as technology and healthcare executives play a bigger role in people's lives every day. Silicon Valley Bank found that these crimes will rise in tandem with technological companies' belief that cyberattacks are a serious advancement. Cyberattacks pose a threat to both their data and their business.

Cyber**Security :-**

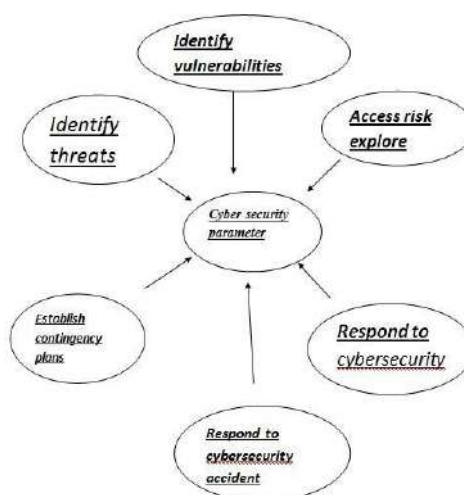
Cybersecurity is a collection of technologies, procedures, and practices created to guard against cyberattacks that could harm or allow illegal access to networks, computer systems, programs, and data. Security in the context of computers encompasses both physical and cyber security. The fact that many computer systems and software programs were created with insufficient consideration for security is one of the main causes of the internet. The Domain Name System (DNS), for example, was not intended to be totally secure.

Cybersecurity implementation involves hardware, software, and human components. Policies like creating secure passwords and keeping them secret must be implemented by humans, and software needs to be updated with updates that address vulnerabilities. Firewalls and antivirus programs can aid in preventing unwanted access to personal information.

The parameters of cyber security:-

The following are the criteria for cyber security:

1. Determine the dangers.
2. Recognize weak points.
3. Examine access risks
4. Create an emergency plan.
5. Address a cyber security mishap.
6. Develop a backup plan.



How to stop, identify, and react to cyber attacks:-

- A. Providing staff with cyber security training.
- B. Set up, use, and keep antispymware and antivirus software up to date on all work computers.
- C. Protect your internet connection with a firewall.
- D. As soon as software updates become available, download and install them on your system and apps.
- D. Create backup copies of crucial company documents and data
- E. Manage physical access to your PCs and network hardware
- F.
- G. Protect your wireless network. Make sure your workplace's Wi-Fi network is concealed and safe if you have one.
- H. Demand unique user accounts for every worker.
- I. Restrict employee access to information and data, as well as their ability to install software. Make frequent password changes.

Biometrics Security:-

Consider the term "bio" in the context of "biology" and biometrics. The scientific study of life and living things is known as biology. "Metrics" is a rules-based method of measuring data that is frequently used for comparison or tracking reasons. It is not merely a tool that the rest of the world (except from the USA) uses to calculate distances between locations. Metrics are quantitative, but biology is primarily qualitative.

How does biometrics affect cybersecurity?

In recent years, there has been a significant surge in the use of biometric authentication. These days, biometric authentication isn't simply for entering extremely secure spaces. The usage of biometric authentication has expanded across applications, from simple daily use-cases like taking attendance and unlocking your phone, to entry into server rooms and safes.

Certain systems employ biometrics as one of the authentication methods, while other systems require it based on the use case and criticality. In any case, biometrics has improved security. The majority of firms choose the latter since authentication requires both something you are (biometrics) and something you know/have (passwords, authentication devices). This guarantees a person's strict identification and adds another level of protection. It therefore restricts breaches. Certain extremely secure server rooms, for instance, require both a password and facial recognition to be allowed to enter.

One of the most innovative security innovations is biometrics, which is simple to use and "difficult to break through." To bolster that claim, consider this statistic: over the past five

years, there has been a 90% growth in the use of biometrics. Therefore, it is undeniable that biometrics have become the new norm in security.

Risks of Biometrics in Security:-

Not impervious to hacks of personal information:-

Biometric authentication does, without a doubt, improve security. Biometrics are not impervious to data intrusions, though. Your biometrics are obtained if a malevolent actor gains entry to the database. This creates a risk not only to the company you work for, but also to your identity because hackers may use your biometrics against you.

Confidentiality:-

Personal biometrics are traits unique to each person. Your privacy may therefore be violated if an unauthorized individual has access to your biometrics. The reason this matters most for facial biometrics is that your appearance can be used to identify you if someone gains access to the database.

Inaccuracy and deception:-

Not all biometrics use all available biometric data. They employ partial data for authentication even if they keep complete data, in order to speed up the process and allow for unforeseen little discrepancies. This indicates that just a portion of the biometric data is used by these systems. Because of this, authentication may be inaccurate, and if someone discovers the data points the system utilizes for authentication, they may be able to fraudulently circumvent it.

System Errors:-

The world we live in is not perfect. So, the possibility of anything going wrong never goes away. Failures in the biometric authentication system could be quite inconvenient. In situations where it's one of the authentication alternatives, it might not be a huge concern. For instance, you can unlock your phone with a password or facial recognition if the fingerprint scanner isn't working. However, the issue arises when a system that requires biometric authentication malfunctions. For instance, in the event that a room requires fingerprint authentication and the scanner malfunctions, you will be without alternative access until the equipment is repaired or the system is bypassed.1qq

Reference :-

1. https://www.researchgate.net/publication/3278329_Biometric_security_technology
2. <https://www.softwaresecured.com/post/risks-and-benefits-of-biometrics-in-security#what-is-the-impact-of-biometrics-on-cybersecurity>
3. Book: JainNandakumar_BiometricAuthenticationSystemSecurityUserPrivacy_IEEEComputer2012
4. https://www.researchgate.net/publication/262284740_Teaching_the_security_mindset_with_reference_monitors
5. <https://www.mdpi.com/2078-2489/7/2/23>
6. <https://scholars.unh.edu/cgi/viewcontent.cgi?article=2083&context=thesis>
7. https://www.researchgate.net/publication/372483435_Cybercrime_Monitoring_System_for_Online_Security_Experts
8. AIG Study: Systemic Cyber Attacks Likely in 2017; Financial Services, Power/Energy, International Cyber Conflicts Key Concerns. (2017, May 10). Retrieved September 4, 2019, from <https://www.businesswire.com/news/home/20170510005781/en/AIG-Study-Systemic-Cyber-Attacks-2017-Financial>.
9. Martin , john rice . cyber crimes understanding and addressing the concern of stake holders computer and security.in computational and applies science ‘MIT A.
10. Research paper : A Study Of Cyber Security Challenges And Its Emergning Trends On Latest Technologies G.Nikhita Reddy1 , G.J.Ugander Reddy2
11. The Reference Monitor Concept as a Unifying Principle in Computer

Cyber Security Awareness on Cyber Attacks

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Abstract:

Now, a day we know very well the electronic technology is very important. That's why today's world is highly and deeply dependent on electronic technology, which are many types of devices, and mostly important role of that is information technology in field of cyber security. That is plays crucial work to secure cyber security and protecting the data from cyber-attacks because it is a challenging issue. Cyber security is an important role of information technology for securing the data Systems, important files, data, and other important virtual things are at risk if there is no security to protect it. When ever we think about the cyber security the first thing that comes to our mind to protect the data From 'cyber attack' which are increasing extremely day by day. various types of companies and Government organisations are work continuously after taking many measures in order to prevent these cyber crimes. That's why Focuses on Challenges faced by cyber security on the latest technologies. And we should have to focused the latest cyber security trends, techniques and also ethics changing the face of cyber security. but to prevents the cyber attacks Besides various measures cyber security is still actually it is a very big concern to many. Otherwise military, government, financial, medical and corporate organizations accumulate, practise, and stock unprecedented quantities of data on PCs are essential in cyber security and other devices. It's all of the important quota which can be very sensitive information.

Keywords: cyber security, cyber attacks, cyber crime, cyber ethics, social media, cloud computing.

Introduction:

Today cyber security is the process of protecting Systems, network and program from digital attacks. it's used to accessing, changing, or destroying sensitive information also cyber security refers to every aspect of protecting an organization and exporting money from users via ransomware; or interrupting normal business processes also employees and assets against cyber threats. cyber Security is crucial also security awareness is the process of educating people to understand, identify that how to protect and stay security and avoid the cyber threats. the cyber Security of today, work on defending computer, network, database and smartphones from the threat. most people just don't have knowledge, tools and support they need to protect themselves and their organization. And the average person's cybersecurity knowledge. [4] The youth in the present world have embraced the internet based communication methods faster than the elders and they are now at a state where they can't even imagine a world without internet and smart phones. These devices have now become a part of their daily life and they spend a considerable amount of time using computers, smart phones and especially social media. Hence, there is a huge threat to youth, Therefore it is mandatory to analyze the awareness level of cyber security among the youth. [3] cybersecurity outbreak can result in entirety from individuality theft, cyber attacks to blackmail attempts, to the damage of vital data similar family photographs. Everybody relies on dangerous structure like influence plants, infirmaries, and monetary service businesses. Securing these and other societies is essential to trust our civilization operative. There are many varieties of cyber attacks that happen in the world today. If we know

the various types of cyberattacks, it becomes easier for us to protect our networks and systems against them. Here, we will closely examine the top ten cyber-attacks that can affect an individual, or a large business, depending on the scale. The fight against cyber crime needs a comprehensive and safer approach. Given that technical measures alone cannot prevent any crime, it is critical that law enforcement agencies are allowed to investigate and prosecute cyber crime effectively.[1]Hence cyber security has become a latest issue. The scope of cyber security is not just limited to securing the information in IT industry but also to various other fields like cyber space etc.

Cyber Security:

Cyber security is the process of protecting Systems, network, data and program from digital attacks. It's used to accessing, changing, or destroying sensitive information also cyber security refers to every aspect of protecting an organization and exporting money from users via ransomware or interrupting normal business processes also employees and assets against cyber threats. Privacy and security of the data will always be top security measures that any organization takes care. We are presently living in a world where all the information is maintained in a digital or a cyber form. Social networking sites provide a space where users feel safe as they interact with friends and family. In the case of home users, cyber-criminals continuously target to social media sites to steal personal data. Not only social networking but also during bank transactions a person must take all the required security measures. As cyber attacks become more common and corporate networks grow more complicated, implementing effective cyber security measure is particularly challenging today and a variety of cyber security solutions are required to mitigate corporate cyber risk and also that process.

People: Users must understand and comply with basic data security principles like choosing strong passwords, being wary of attachments in email, and backing up data. Learn more about basic cybersecurity principles with these **1. Keep personal information private, 2. Use caution to avoid bad actors, 3. Update software regularly, 4. Create strong passwords by using paraphrases, 5. Use two-step verification whenever possible, 6. Be cautious of free Wi-Fi, 7. Don't leave a cyber footprint on shared or public devices, 8. Manage your privacy settings, 9. Regularly audit applications you have installed as privacy settings can change with upgrades, 10. Secure tomorrow, 10 together**

Processes: Organizations must have a framework for how they deal with both attempted and successful cyber attacks. One well-respected framework can guide you. It explains how you can identify attacks, protect systems, detect and respond to threats, and recover from successful attacks. Learn about the the NIST cybersecurity framework. NIST is The Cybersecurity Framework (CSF) is a set of cybersecurity best practices and recommendations from the National Institute of Standards and Technology (NIST). The CSF makes it easier to understand cyber risks and improve your defenses.

Principles of Cyber Security: The primary objective of cyber security is to ensure protect data. The security community commonly refers to a triangle of three related principles that ensure data is secure, known as the CIA triad:

- **Confidentiality** — ensuring sensitive data is only accessible to those people who actually need it, and are permitted to access according to organizational policies, while blocking access to others.
- **Integrity** — making sure data and systems are not modified due to actions by threat actors, or accidental modification. Measures should be taken to prevent corruption or loss of sensitive data, and to speedily recover from such an event if it occurs.
- **Availability** — ensuring that data remains available and useful for its end-users, and that this access is not hindered by system malfunction, cyber attacks, or even security measures themselves. The CIA Triad defines three key principles of data security .

To achieve the CIA objectives organizations must protect two aspects of their IT environment: application security and data security.

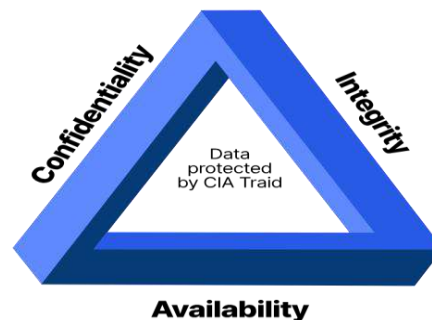


Fig.1 Principles of Cyber Security:

Cyber Attacks:

The most important cyber-attacks methods are Denial of service, logical bomb, Abuse tools, Sniffer, Trojan horse, Virus, Worm, Send spam, and Botnet. Fig. 1. illustrates the important cyber-attacks types. In the Denial of service method, the authorized users access to the system and vice versa is lost. In fact, the attacker from one point starts immersing the target computers in various messages and blocking the legal flow of data. This prevents any system from using the Internet or communicating with other System.[6] Cyber has increased the yield of the community and effectively distributed information over time. No problem what application or industry cyber is used in, increasing production has always been considered. Fast data transfer to cyberspace mostly declines the total system security. Cyber crime is a term for any illegal activity that uses a computer as its primary means of commission and theft. such as network intrusions and the dissemination of computer viruses, as well as computer-based variations of existing crimes, such as identity theft, stalking, bullying and terrorism which have become as major problem to people and nations. As day by day technology is playing in major role in a person's life the cyber crimes also will increase along with the technological advances.[3] Cyber Security Privacy and security of the data will always attention

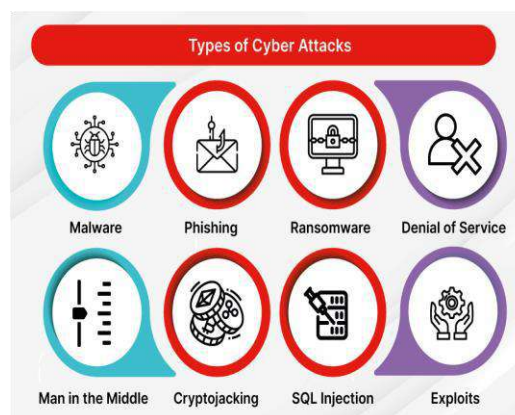


Fig .2 Types of cyber Attacks:

Types of cyber Attacks:

1. Malware: Malware is a form of application that performs nefarious activities. Some types of malware are designed to create access to networks, some to spy on credentials while others are simply used to cause disruption.

Malwares can be used for extortion as well. An example of it can be found in Ransomware attacks of 2017 where a program was designed to encrypt the victim's files and then ask them to pay a ransom in order to get the decryption key.

Latest Update about Malware Attacks in India :-Mobile Security Report 2021 asserted that mobile malware attacks in India are on rise (845 percent increase) since October 2020.

2. Phishing: In Phishing, an attacker tricks an unsuspecting target into handing over valuable information, such as passwords, credit card details, etc. An example of this is a message regarding One-Time Passwords (OTP). A hacker using a phishing method will send a clickable link where a user can submit their OTPs. Once the link is clicked a hacker will have access to the users personal information. Phishing is the common form of cyber attack due to its effectiveness and simplistic execution pattern.

Latest Update about Phishing in India:-Indian Computer Emergency Response Team (CERT-In) released a public advisory to alert citizens against all attempts of phishing through fake domains, emails and text messages that promise registration for a job against the pandemic.

3. Man-in-the-middle attack (MITM): A man-in-the-middle attack (MITM) consists of a message interception between two parties in an attempt to spy on the targets. Due to the advent of end-to-end encryption, MITM attacks have taken a dip in frequency of attacks. Such encryptions prevent third parties in intercepting or tampering data transmitted in the network. Whether the network is secure or not is hardly a factor.

4. Distributed Denial-of-Service (DDoS) attack: In a DDoS attack, an attacker floods a target server with traffic that will disrupt it. Since most servers cannot handle it, it may lead to services slowing down on the website and if it eventually crashes. Unlike standard denial-of-service attacks, DDoS uses multiple compromised devices to bombard the target server, which sophisticated firewalls cannot respond to or are unable to.

Update about Distributed Denial-of-Service attack in India:-In August 2020 the number of Distributed Denial of Service (DDoS) incidents in India hit a record high in terms of total DDOS packets, which were well in excess of 10 billion as per a study by global cyber security firm Radware

5. SQL Injection: This type of cyber attack targets specific SQL databases. These databases use SQL statements for data query. In case permissions are not set properly, a hacker can manipulate SQL queries into changing the data if not deleting them altogether.

6. Zero-day exploit: When cyber-criminals learn of a vulnerability in a frequently used software application they target users and organizations using the software to exploit it until a fix is available. This is called a Zero-day exploit.

7. DNS Tunnelling: A DNS Tunnelling provides attackers with a stable and consistent line of communication to the given target. The malware used will gather information as long as the DNS tunnelling is active. Chances are that firewalls won't be able detect such an attack.

Update about DNS Tunneling in India:-India saw the highest number of domain name system or DNS attacks in 2020 with 12.13 attacks per organisation, even though the cost of attacks in the country decreased by 6.08% to ₹5.97 crores, said International Data Corporation or IDC's DNS Threat Report.

8. Business Email Compromise (BEC): In a BEC attack, hackers target employees who have specific authority to finalize business transactions. They trick them into transferring money into an account belonging to the hacker.

BEC attacks are the most common, if not one of the most damaging attacks for a business firm.

9. Cryptojacking: Cryptojacking is used to target a computer in order to mine cryptocurrencies such as bitcoin. The hackers will be able to get all the cryptocurrency they can instead of the original owners. Cryptojacking is not so widely known but its severity cannot be underestimated.

10. Drive-by Attack: A website is loaded with a malware, and when a visitor happens to come across such a website their device is infected with the malware. The malware will steal valuable data or crash the system.[8]

Conclusion:

The target of the report was to present the importance of Cyber Security in India and also analyze the present framework and policies of Government. The study concludes that what is cyber Security, and what is cyber attacks and that types, it has been an exponential increase in the number of Cyber Attacks throughout the globe causing large amount of loss to their system. The response to the Cyber Attacks but such policies failed due to lack of resources and serious government interest. As a result the users in India are still not safe when connected to the Internet. Each new each day, are challenging organizations with not only how they secure their infrastructure, but how they require new platforms and intelligence to do so. There is no perfect solution for cyber-crimes but we should try our level best to minimize them in order to have a safe and secure future in cyber space. They should be aware on how to protect our privacy management and encrypt their personal data, which is still in a very low level. In sum, the government should be alarmed of this situation and should implement relevant laws and regulations, even after they themselves were hacked during the pandemic in last few months. Measures should be taken to enhance cyber security in the country and further delay will lead to unbearable circumstances.[9]

References:

1. A Study Of Cyber Security Challenges And Its Emerging Trends On Latest Technologies February 2014
https://www.researchgate.net/publication/260126665_A_Study_Of_Cyber_Security_Challenges_And_Its_Emerging_Trends_On_Latest_Technologies.
2. S. Tayal, N. Gupta, P. Gupta, D. Goyal, and M. Goyal, "A Review paper on Network Security and Cryptography." *Advances in Computational Sciences and Technology*, vol. 10 (5), pp. 763-770, 2017.
3. R. Khan, and M. Hasan, "Network threats, attacks and security measures: A review." *International Journal of Advanced Research in Computer Science*, vol. 8 (8), pp. 116-120, 2017.
4. S. Rathore, P. K. Sharma, V. Loia, Y.-S. Jeong, and J. H. Park, "Social network security: Issues, challenges, threats, and solutions." *Information Sciences*, vol. 421 pp. 43-69, 2017.
4. [4] S. Gao, Z. Li, B. Xiao, and G. Wei, "Security threats in the data plane of software-defined networks." *IEEE Network*, vol. 32 (4), pp. 108-113, 2018.
5. [5] P. Sinha, A. Kumar Rai, and B. Bhushan "Information Security threats and attacks with conceivable counteraction," In: 2019 2nd International Conference on Intelligent Computing, Instrumentation and Control Technologies (ICICT). IEEE, pp. 1208-1213, 2019.
6. A. Tayal, N. Mishra, and S. Sharma, "Active monitoring & postmortem forensic analysis of network threats: A survey." *International Journal of Electronics and Information Engineering*, vol. 6 (1), pp. 49-59, 2017.

7. M. Wazid, A. K. Das, V. Odelu, N. Kumar, M. Conti, and M. Jo, "Design of secure user authenticated key management protocol for generic IoT networks." *IEEE Internet of Things Journal*, vol. 5 (1), pp. 269-282, 2017.
8. H. I. Kobo, A. M. Abu-Mahfouz, and G. P. Hancke, "A survey on software-defined wireless sensor networks: Challenges and design requirements." *IEEE access*, vol. 5pp. 1872-1899, 2017.
9. D. Barrera, I. Molloy, and H. Huang "Standardizing IoT network security policy enforcement," In: *Workshop on Decentralized IoT Security and Standards (DISS)*. p 6, 2018.
10. S. Zheng, Z. Li, and B. Li "Implementation and application of ACL in campus network," In: *AIP Conference Proceedings*. vol 1. AIP Publishing LLC, p 090014, 2017.
11. T. Hayajneh, S. Ullah, B. J. Mohd, and K. S. Balagani, "An enhanced WLAN security system with FPGA implementation for multimedia applications." *IEEE Systems Journal*, vol. 11 (4), pp. 2536-2545, 2015.
12. P. Sinha, V. Jha, A. K. Rai, and B. Bhushan "Security vulnerabilities attacks and countermeasures in wireless sensor networks at various layers of OSI reference model: A survey," In: *2017 International Conference on Signal Processing and Communication (ICSPC)*. IEEE, pp. 288-293, 2017.
13. V. Pruthi, K. Mittal, N. Sharma, and I. Kaushik "Network Layers Threats & its Countermeasures in WSNs," In: *2019 International Conference on Computing, Communication, and Intelligent Systems (ICCCIS)*. IEEE, pp. 156-163, 2019.
14. J. Singh, Y. Bello, A. Refaey, and A. Mohamed, "Five-Layers SDP- Based Hierarchical Security Paradigm for Multiaccess Edge Computing." *arXiv preprint arXiv :200701246*, vol. pp., 2020.
15. N. Wagner, C. Ş. Şahin, J. Pena, J. Riordan, and S. Neumayer "Capturing the security effects of network segmentation via a continuous-time markov chain model," In: *Proceedings of the 50th Annual Simulation Symposium*. Society for Computer Simulation International, p 17, 2017.
16. M. Oqaily, Y. Jarraya, M. Mohammady, S. Majumdar, M. Pourzandi, L. Wang, and M. Debbabi, "SegGuard: Segmentation-based Anonymization of Network Data in Clouds for Privacy-Preserving Security Auditing." *IEEE Transactions on Dependable and Secure Computing*, vol. pp., 2019

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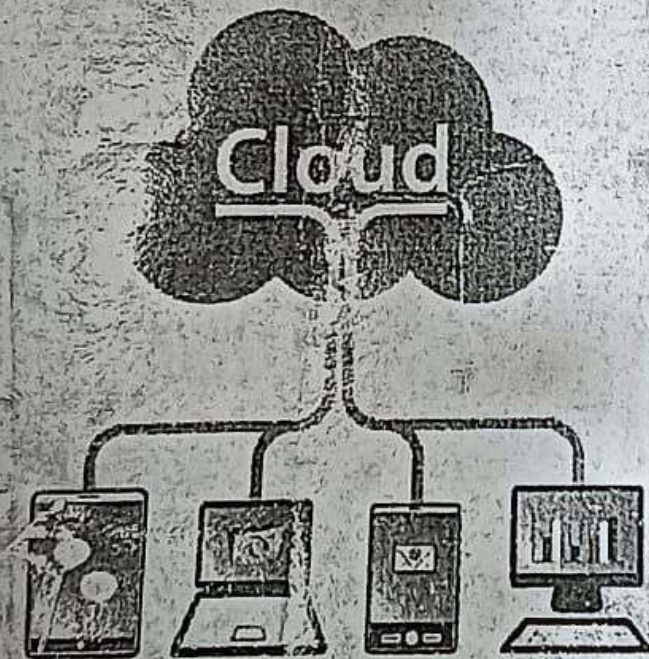
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Android Application Development

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Investigation of Dielectric Constant of PVC-PMMA Thin Films Doped with Salicylic Acid at Different Frequency, Dopant and Temperature

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ABSTRACT

This research study examines the influence of frequency and salicylic acid dopant and temperature on the dielectric constant of PVC-PMMA thin films. The thin films were prepared using the isothermal evaporation technique, and their dielectric constants were measured using an LCR meter over a frequency range of 20 Hz to 200 KHz at 303 k and 323 k. The $\ln f$ vs dielectric constant plots were analyzed to investigate the effects of frequency and salicylic acid dopant concentration and temperature on the dielectric properties of the films.

Keyword: PVC; PMMA; Salicylic Acid; Dielectric Constant

INTRODUCTION

Dielectric materials find extensive applications in various electronic devices and capacitors due to their ability to store and transmit electrical energy. Polymer blends, such as PVC-PMMA, have gained significant attention for their potential in dielectric applications. The dielectric properties of such blends can be modified by incorporating dopants, offering opportunities for enhanced electrical performance.

EXPERIMENTAL PROCEDURE

The PVC-PMMA thin films were prepared by the isothermal evaporation technique. Two sets of films were fabricated: one with a 6% salicylic acid dopant and the other without any dopant. The dielectric constants of the films were measured using an LCR meter over a frequency range of 20 Hz to 200 kHz at 303 k and 323 k. The natural logarithm of frequency ($\ln f$) and dielectric constant values were recorded and tabulated for further analysis.

GRAPH RELATED FOR DIELECTRIC CONSTANT

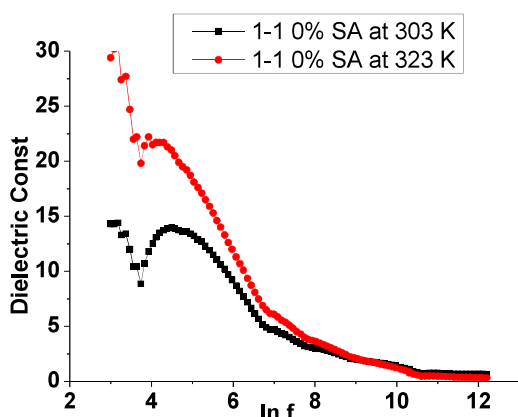


Fig 1.1 Variation of $\ln f$ vs Dielectric constant

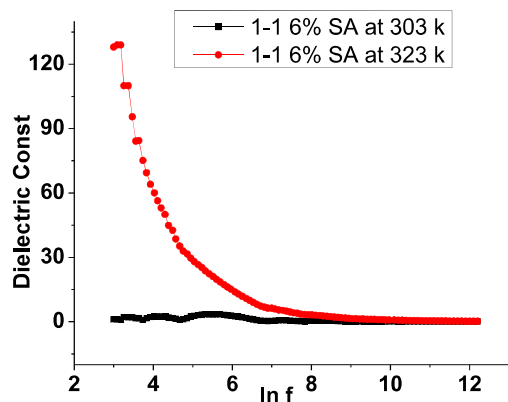


Fig 1.2 Variation of ln f vs Dielectric constant

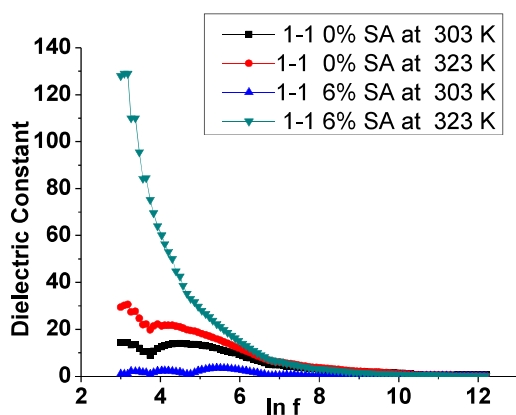


Fig 1.3 Variation of ln f vs. Dielectric constant doped and undoped SA

RESULTS AND DISCUSSION

The ln f vs. dielectric constant (fig1.1, 1.2, 1.3) plots were examined to analyze the effects of frequency and salicylic acid dopant on the dielectric properties of the PVC-PMMA thin films.

Effect of Frequency

The dielectric constant of the PVC-PMMA films exhibited a frequency-dependent behavior. As the frequency increased, the dielectric constant decreased for both the film with 6% salicylic acid dopant and the film without any dopant. This behavior is consistent with the characteristics of dielectric materials, where the dielectric constant decreases with increasing frequency.

The behavior of the dielectric constant of a material in response to varying frequencies of an electric field provides valuable insights into its electrical and structural properties. The observed trends in the dielectric constant of the PVC-PMMA thin film can be explained through the interaction of the polymer matrix with the electric field, as well as the inherent characteristics of the system.

1. High Dielectric Constant at Lower Frequencies:

In the lower frequency range, it is observed that the dielectric constant of the PVC-PMMA thin film is relatively high. The high dielectric constant can be attributed to the presence of charges that are able to respond to the electric field. In the case of the PVC-PMMA thin film, the presence of localized charge carriers, such as polarons, might contribute to this behavior. These charges can align and respond to the field, leading to an enhanced dielectric constant.

2. Decrease in Dielectric Constant at Higher Frequencies:

As the frequency of the applied electric field increases beyond 100 Hz, the dielectric constant of the PVC-PMMA thin film is observed to decrease. This decrease can be attributed to the interplay between the ordered structure of the material and the mobility of ions within the polymer matrix. At higher frequencies, the mobility of ions becomes significant, allowing them to move and oppose the effect of the applied electric field.

The decrease in dielectric constant could be explained by considering the following factors:

i. Ordered Material Characteristics:

In materials with an ordered structure, such as crystalline regions within the PVC-PMMA thin film, the alignment of charges in response to the electric field can be hindered by the organized arrangement of molecules. This leads to a lower dielectric constant as the material becomes less responsive to the field.

ii. Ionic Mobility:

As the frequency increases, the mobility of ions within the polymer matrix becomes more pronounced. These ions are not tightly bound to the polymer chains and can move in response to the field, counteracting its effect. This ion movement contributes to a decrease in the overall dielectric constant.

The findings presented in Migahed et al.'s work (reference [24]) further support the observed trend of decreasing dielectric constant with increasing frequency in ordered materials.

Influence of Temperature on Dielectric Constant in PVC-PMMA Films

The dielectric constant of the PVC-PMMA films was also affected by temperature. As the temperature increased from 303 K to 323 K, the dielectric constant values for both the film with 6% salicylic acid dopant and the film without any dopant generally increased. This temperature-dependent behavior indicates that the dielectric constant of the films is influenced by thermal effects.

Temperature is a critical parameter that can significantly impact the electrical properties of materials, including the dielectric constant. In this study, the effect of temperature on the dielectric constant of PVC-PMMA films was investigated. The dielectric constant was analyzed across a temperature range, and the results reveal a clear correlation between temperature and dielectric constant values.

Influence of Salicylic Acid Dopant on Dielectric Constant in PVC-PMMA Films

The presence of salicylic acid dopant influenced the dielectric constant behavior of the PVC-PMMA films. Comparing the two sets of films, it was observed that the film with 6% salicylic acid dopant consistently exhibited higher dielectric constant values compared to the film without any dopant at all frequencies and temperatures. This suggests that the addition of salicylic acid as a dopant increases the dielectric constant of the PVC-PMMA films.

The dielectric constant of a material is a key parameter that characterizes its electrical response to an applied electric field. In this study, the impact of salicylic acid as a dopant on the dielectric constant behavior of PVC-PMMA films was investigated. The dielectric constant was examined across a range of frequencies and temperatures to elucidate the effects of the dopant on the electrical properties of the films.

CONCLUSION

In conclusion, the observed frequency-dependent behavior of the dielectric constant in the PVC-PMMA thin film is a result of the interplay between the presence of charges, the ordered or disordered nature of the material, and the

mobility of ions within the polymer matrix. The high dielectric constant at lower frequencies can be attributed to the response of charges to the electric field, while the decrease in dielectric constant at higher frequencies is influenced by the ordered structure of the material and the mobility of ions. These insights contribute to a deeper understanding of the electrical properties of the PVC-PMMA thin film.

The presence of 6% salicylic acid dopant in the PVC-PMMA films leads to a consistent increase in the dielectric constant values across frequencies and temperatures. This effect can be attributed to enhanced polarization, dipole alignment, and possibly improved charge carrier mobility within the polymer matrix due to the presence of the dopant. These findings underscore the potential of salicylic acid as a dopant to tailor the dielectric properties of PVC-PMMA films for specific applications requiring higher dielectric constants. Further investigations could delve into the underlying molecular interactions that drive this enhanced dielectric behavior.

REFERENCES

1. Vdhale. S.G., Belsare N. G., November(2013), International Journal of Scientific & Engineering Research, Volume4, Issue11, 1253, <https://doi.org/10.14299/ijser.2013.11>
2. Dakre, A. B., & Lamdhade, G. T. (2014). International Journal of Science and Research (IJSR), 3(6).
3. Ojha. P., Siddaiah. T., Gopal, N. O., & Ramu, Ch. (2018). International Journal of Scientific Research in Physics and Applied Sciences, 6(6), 80-87. <https://doi.org/10.26438/ijrps/v6i6.8087>
4. Tanwar, A., Gupta, K. K., Singh, P. J., & Vijay, Y. K. (2006). Bull. Mater. Sci., 29(4), 397-401. <https://doi.org/10.1007/bf02704142>
5. Vidhale S.G., Belsare N.G., A.S.Wadtkar, September-(2013), International Journal of Scientific & Engineering Research, Volume 4, Issue 9.
6. Renukappa, N. M., Sudhakar, S. R. D., Siddaramaigh, R., Rajan, J. S., & Vishvanathan. (2007). ICPMPE.
7. Abraham, R., Issac, J., Varughese, K., & Thomas, S. (2007). ICPMPE.
8. Mamza, P. A., & Folaranmi, F. M. (1996). European Polymer Journal, 32(7), 909-912.
9. Dandel, R. M., Belsare, N. G., & Raghuvanshi, F. C. (2011). International Journal of Polymers and Technologies, 3(2).
10. Ramesh, S., & Liew, C. W. (2013). Measurement, 46(5), 1650-1656. <https://doi.org/10.1016/j.measurement.2013.01.003>.
11. Wadtkar, A. S., Wasnik, T. S., Vidhale, S. G., & Belsare, N. G. (2014). International Journal of Basic and Applied Research, 4, 196-200.
12. Ahmad, A. H. (2014). International Journal of Computer Science, 2, 20-23.
13. Bushra, A. H., Ahmad, A. H., & Duaa, A. U. (2013). International Journal of Application or Innovation in Engineering & Management, 2(11), 86.
14. Khaled, M. A., Elwa, Y. A., Hussein, A. M., & Abdullah, K. (2003). Egypt Journal, 26(1), 83-91.
15. Sharma, D., & Tripathi, D. (2018). AIP Conference Proceedings, 1953(1), 050056. <https://doi.org/10.1063/1.5032711>
16. Rajendran, S., & Uma, T. (2000). Materials Letters, 44, 242-247.
17. Raja, V., Sharma, A. K., & Narasimha Rao, V. V. R. (2004). Materials Letters, 58, 3242-3247. <https://doi.org/10.1016/j.matlet.2004.05.061>
18. Elizabeth, R. N., Kalyanasundaram, S., Gopalan, A., & Saito, Y. (2004). Polimeros: Ciencia e Tecnologia, 14(1), 1-7.
19. Suvarna, R. P., Raghavendra Rao, K., & Subbarangaiah, K. (2002). Bull. Mater. Sci., 25(7), 647-651.
20. Roaramadan, E., Ahmad Abass Hasan (2014), PASJ International Journal of Computer Science (IIJCS), 2(3).
21. Khan, M. S., Gul, R., & Wahid, M. S. (2013). J Polym Eng, 33(7), 633-638. <https://doi.org/10.1515/polyeng-2013-0028>
22. El Sayed, A. M. (2020). Results in Physics, 17, 103025. <https://doi.org/10.1016/j.rinp.2020.103025>
23. Kyritsis A., Pissi P., Grammatikakis I., (1995). J. Polymer Sci. Part B.33 173-77.
24. Migahed, M.D., Ishra, M., Fahmy, T., Basakat, (2004). A., J. of Phys. and Chem. of Solids 65, 1121-1125
25. Devikala S., Kamaraj P. and Arthanareeswarl M., Chem Sci Trans., 2013, 2(S1), S129-S134 DOI:10.7598/cst2013.26

Synthesis and Characterisation of Cupric Oxide (CuO) Doped Tungsten Oxide (WO₃) Multilayer Thick Films

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ABSTRACT

This paper is focused on preparation of cupric oxide doped tungsten oxide multilayer thick film by screen printing method on alumina substrates. XRD and SEM are used to study structural and morphological properties of CuO-WO₃. The XRD pattern of (CuO-WO₃) system samples show nanocrystalline form and found the desired peaks of composites. FESEM study reveals that the grain size of nanometer order and shows nano-porous structure, which leads to exhibit large surface area, stability and highest response to gas. In present study B5 sensor (25CuO:75WO₃) is found to optimized multilayer thick film.

Keywords: Sol-Gel Method; (CuO-WO₃); multilayer thick films; XRD; FESEM

INTRODUCTION

Due to interesting properties and promising applications Cupric oxide (CuO) nanostructures gain interest in many applications. Nanoparticles CuO and its composite oxides have potential applications as gas sensor. As compared to bulk materials, nanoparticles of Copper oxide (CuO) show high catalytic activity and selectivity due to their large surface to volume ratio. The sensitivity and response time of CuO based sensors strongly depend on the particle size of the material [1]. With introducing changes into the procedure of its chemical synthesis, physical and micro structural properties of metal oxide can be modified. Different nanostructures of CuO like nanowire, nanorod, nanoneedle, nano-flower and nanoparticles are synthesized by using various approaches such as; Sol-Gel Combustion Route [1], Microwave Assisted Co-Precipitation Method [2], Chemical Precipitation Method [3], Simple Precipitation Method [4], Sono-chemical Method [5-7] and etc.

WO₃ films are more attractive due to their high catalytic behavior on the surface of the film. The resistance of the WO₃ increases & decreases in the presence of oxidizing and reducing gases respectively. WO₃ can be obtained in various morphological forms such as nano-wires, nano-plates, nano-sheets, nano-flowers, nano-sphere and, sub-micron porous balls. The WO₃ nano-particles or nano-crystallites have been synthesized by various techniques given below; Acid Precipitation Method [8], Hydrothermal Method [9], Reverse Micro-Emulsion-Mediated Synthesis Method [10], Sol-Gel Method [11], Calcinations Method [12] and etc.

Yu Il et al. 2010 [13] studied for gas sensing properties of CuO doped and undoped WO₃ thick films. CuO doped and undoped WO₃ thick films gas sensors were prepared using screen-printing method on alumina substrates. A structural properties of WO₃:CuO thick films had monoclinic phase and triclinic phase of WO₃ together. Artur Rydosz et al. 2014 [14] investigated results on nanocrystalline CuO and WO₃ thin films by magnetron sputtering technology. XRD, GIR, SEM and AFM methods were used to study the films phase composition, microstructure and surface topography and found to be useful in portable gas sensor applications. Nirmal Kumar et al 2018 [15] was used to deposit tungsten oxide (WO₃) thin films Cupric oxide (CuO) thin films were deposited by RF magnetron sputtering. Fuchao Yang et al 2018 [16] worked on acetone odor detection. With the formation of the interfacial heterojunction, the WO₃@CuO shows the best sensing performance. Soo-Yeon Cho et al. 2019 [17] fabricated 10 nm scale p-n heterojunction nanochannel with ultrasmall grained WO₃/CuO nanopatterns to study ethanol sensing. WO₃/CuO nanopattern was also used to study for dynamic sensing behavior for various toxic analytes such as toluene, ethanol, acetone, and

ammonia. In the present work of this paper focused on synthesis of pristine nano-particles of CuO, WO₃ and Al₂O₃, and also (CuO-WO₃) mixed oxide multilayer thick films.

EXPERIMENTAL

In the present work, we have used sol-gel method (which is under liquid phase synthesis) for the synthesis of pristine nano-particles of CuO, WO₃ and Al₂O₃ [18-20]. All the chemicals used in this study were of GR grade purchase from Sd-fine, India (purity 99.99%). The chemicals are used without any further purification.

Synthesis of Cupric Oxide (CuO)

In a cleaned round bottom flask, the aqueous solution of CuCl₂·6H₂O (0.2 M) was prepared. After addition of 1 ml of glacial acetic acid to above aqueous solution it was heated to 100°C with constant stirring. 8 M NaOH was added to above heated solution till its pH attains a value of 7. After this process immediately the color of the solution turned from blue to black and the large amount of black precipitate was obtained. The obtained precipitate was centrifuged and washed 3-4 times with de ionized water. The obtained powder was kept in vacuum oven at 70°C for 24 hours so as to gets completely dried powder of CuO.

Synthesis of Tungsten Oxide (WO₃)

For Synthesis of WO₃ particles were simply precipitation method was used. Firstly, Sodium tungstate (Na₂WO₄) salt (6.59 gm) was dissolved in (200 ml) de-ionized water. Then in to the sodium tungstate solution 10 ml of hydrochloric acid (HCL) was added dropwise with continuous stirring. After the stirring for 5 hours of this mixed solution, the precipitates were allowed to settle for 1 day at room temperature. The precipitate was filtered using a filter paper. Then precipitate was washed many times by de-ionized water until pH reached to 7. The washed precipitate was dried at 100°C in an oven for 1 hour and further the precipitates were passed from calcination processes in muffle furnace at 500° C for 4 hours to get WO₃ powder.

Synthesis of Alumina (Al₂O₃)

All chemicals used were analytical grade. Aluminium chloride, AlCl₃ (MOLYCHEM), 25% NH₃ solution (QUALIGEN Fine Chemicals) and polyvinyl alcohol (PVA) were used as raw materials for the synthesis of aluminium oxide nanoparticles. 1M alcoholic AlCl₃ solution was prepared, followed by addition of 25% ammonia solution. The resulting solution turned to a white sol. This was followed by the addition of PVA (0.5M). The solution was stirred continuously using a magnetic stirrer until it became a transparent sticky gel. The gel was allowed to mature for 24 hours at room temperature. The resultant gel was heat treated at 100°C for 24 hours which led to the formation of light weight porous materials due to the enormous gas evolution. The dried gel was, then calcined at 1000°C for 4 hours and finally, the calcined powders were crushed using mortar and pestle to get the fine homogeneous dense powder of Alumina (Al₂O₃).

Fabrication of Sensors

Three series of the samples prepared were CuO:WO₃ with Al₂O₃ base of multilayer sensors. The different combinations are shown in tables 1.

Table 1 Samples Codes of Series: CuO: WO₃/Al₂O₃/GP

Sample Code	Composition of CuO (mole %)	Composition of WO ₃ (mole %)
B1	5	95
B2	10	90
B3	15	85

B4	20	80
B5	25	75
B6	30	70
PC	100	0
PW	0	100

Out of various methods of sensors preparation, the screen-printing (thick film technology) is most widely used. Screen-printing is the transfer of pastes through a fabric screen onto a substrate.

Multilayer preparation

Fig. 1 (a), and 1(b) show fabrication of interdigitated electrodes, actual photographs of interdigitated electrodes respectively.

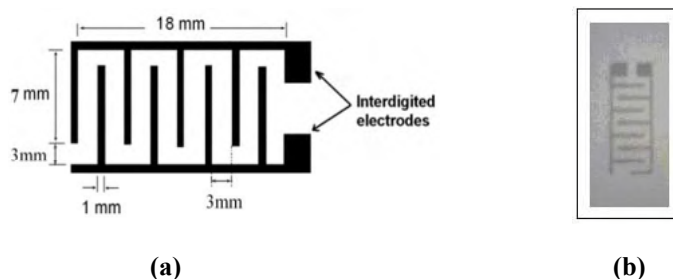


Fig. 1 (a) Fabrication of interdigitated Electrodes (b) Actual photograph of interdigitated electrodes

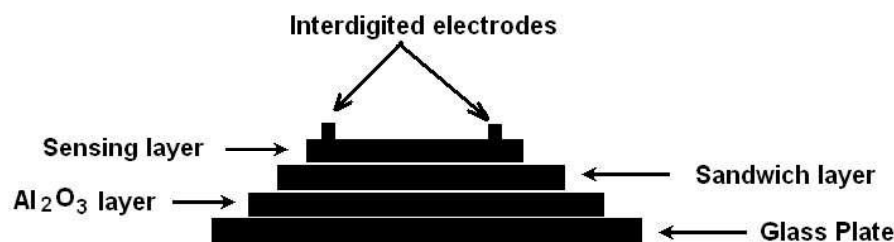


Fig.2 Design of multilayer Sensor

On clean glass plate, Al_2O_3 was deposited by using screen-printing technique and it was used as base of the sensor. On Al_2O_3 , the sample layers were prepared. Finally on the top, Interdigitated electrodes were fabricated [21] using conducting silver paste as shown in the Fig. 1(b). Design of multilayer sensor is shown in Fig. 2.

Preparation of Samples of Series: CuO: WO_3 / Al_2O_3 /GP

The obtained product of fine nanopowder of CuO and WO_3 are used for fabrication of thick films sensors by using screen-printing technique. For this, the different X mole% CuO powder ($X = 05, 10, 15, 20, 25, 30$) was mixed thoroughly with different X mole% of WO_3 ($X = 95, 90, 85, 80, 75, 70$) along with Al_2O_3 base on glass plate (GP) substrate the aid of acetone by using the mortar and pestle. The sample codes, mole% of powder, and thickness are

listed in the Table 2.. The mixed powder of CuO : WO₃ system was further calcinated at temperature 800°C for 5hrs. in the autocontrolled muffle furnace (*Gayatri Scientific, Mumbai, India.*) After, the calcinations again uniformly mixed the powder using the grinder.

Table 2 Thickness of Multi-layers for Series: CuO: WO₃ / Al₂O₃/GP Gas Sensors.

Sample Code	Composition	Thickness (x 10 ⁻⁴ cm)		
	Layers:----	Upper Layer(1)	Al ₂ O ₃ Layer(2)	Total (1+2)
	Upper /Al ₂ O ₃ /Glass plate (GP)			
B1	05CuO:95 WO ₃ / Al ₂ O ₃ /GP	4.1	29.3	33.4
B2	10CuO:90 WO ₃ / Al ₂ O ₃ /GP	3.8	28.5	32.3
B3	15CuO:85 WO ₃ / Al ₂ O ₃ /GP	2.6	29.7	32.3
B4	20CuO:80 WO ₃ / Al ₂ O ₃ /GP	3.9	28.8	32.7
B5	25CuO:75 WO ₃ / Al ₂ O ₃ /GP	4.9	28.1	33
B6	30CuO:70 WO ₃ / Al ₂ O ₃ /GP	4.1	30.2	34.3

RESULTS AND DISCUSSION

XRD of CuO & WO₃ Nanomaterial and their dopings

The average crystallite size was calculated by Debye-Scherrer's equation with the help of XRD patterns as shown in figure 3. The strong and sharp peak of CuO observed at 37° position with (1 1 1) indicates that the sample is having high crystalline quality, and it is in the structure of monoclinic with lattice parameters a = 0.4685 nm, b = 0.3532 nm, and c = 0.5121 nm, which is good agreement with JCPDS card number 88-2341. The average crystalline size was

obtained 27 nm from Debye-Scherrer's equation,
$$D = \frac{K\lambda}{\beta \cos\theta}$$

Where, D = nanoparticles crystalline size, K = Scherrer constant (0.98), λ = wavelength and β denotes the full width at half maximum (FWHM).

As shown in figure 3. spectra, main peak, in case of pure WO₃, is observed at 23.21° and this peak corresponds to the plane (0 2 0) of WO₃ in monoclinic structure (JCPDS Card No.3-1124) with 100% intensity. The other peaks of WO₃ mainly correspond to the crystalline planes (0 2 2), (1 4 0), (2 2 2), (0 4 2), matching well with the monoclinic structure of WO₃. This manifested that the WO₃ is well crystallized. As compared with diffraction peaks of WO₃, those of CuO are wide and weak due to small grain sizes [22]. From table 3., it is seen that the sample 25CuO:75 WO₃ has small crystalline size.

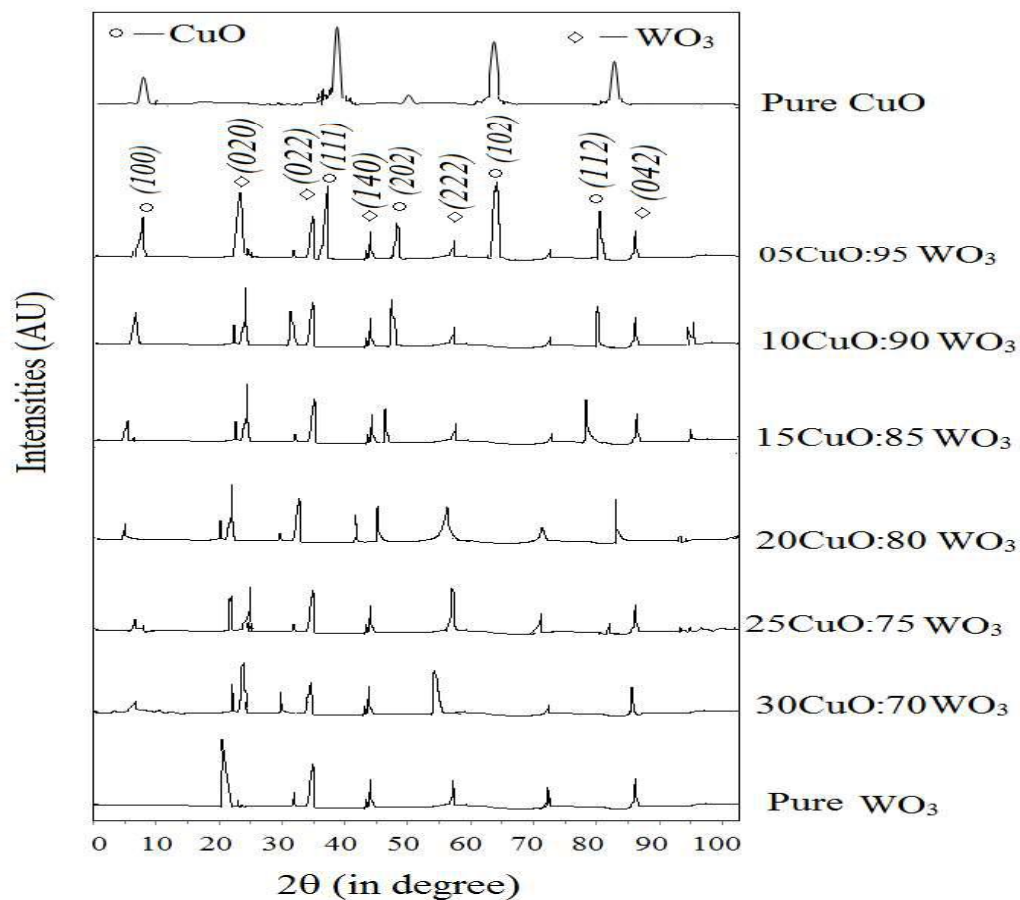


Fig.3. XRD spectra of Pure CuO, Pure WO₃ and CuO doped with WO₃ Nanomaterial

The crystallite size (D) of WO₃ and CuO doped WO₃ was calculated from Scherer's formula using FWHM and it is listed in the table 3, as below.

Table 3. Average crystallite size of WO₃ and CuO doped WO₃

Chemical Composition of CuO:WO ₃ (mole %)	Maximum Intensity Peak Position (2θ) degree	FWHM (2θ) degree	Average Crystallite Size (D) in nm
05CuO:95 WO ₃	28.34	0.2634	112.51
10CuO:90 WO ₃	29.23	0.2112	126.67
15CuO:85 WO ₃	30.65	0.2217	118.23
20CuO:80 WO ₃	31.45	0.1934	109.83
25CuO:75 WO₃	57.12	0.1732	87.72
30CuO:70 WO ₃	53.89	0.1994	105.45
Pure WO ₃	23.04	0.3214	143.22

Scanning electron microscopy (SEM) Analysis

From SEM picture (figure 4 (a) to (c)), it is observed that all the samples viz. Al_2O_3 , CuO , WO_3 are porous in nature. Porosity varies with sample to sample and among these material, SnO_2 showed more porosity (small size ~ 60 to 80 nm). Due to small pores size, its surface area is more [22-23] and it shows more sensing nature. Some portion of SEM picture shows some rods with fine voids over them which helps to increase sensing properties. The surface morphology of pure Al_2O_3 , CuO , and WO_3 , nano materials were studied by SEM and its picture is shown in the Fig. 4.

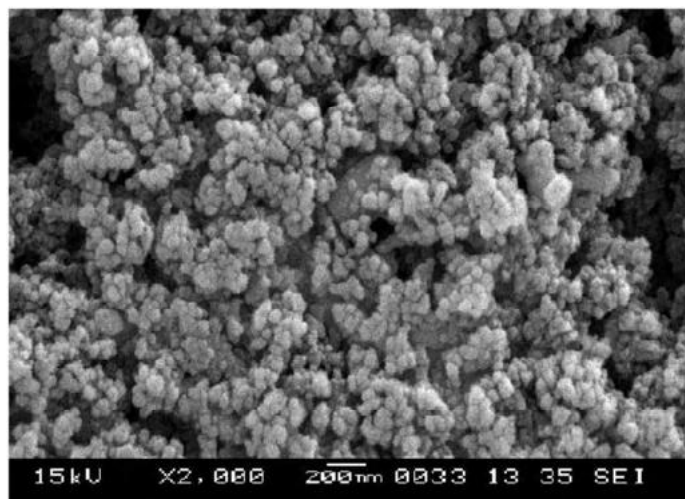


Fig. 4 (a) SEM picture of Al_2O_3

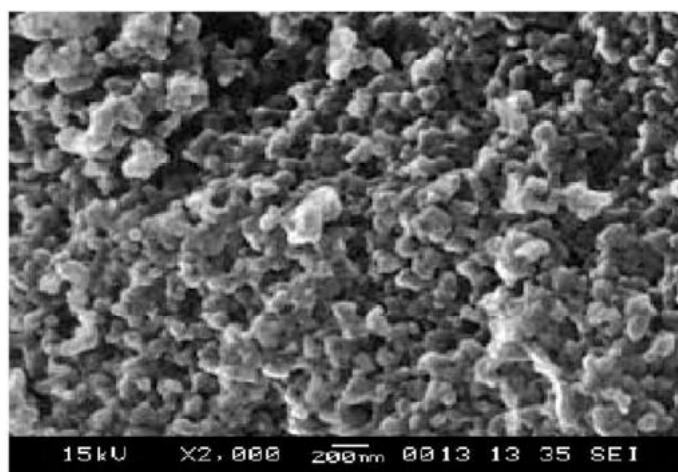


Fig. 4 (b) SEM picture of CuO

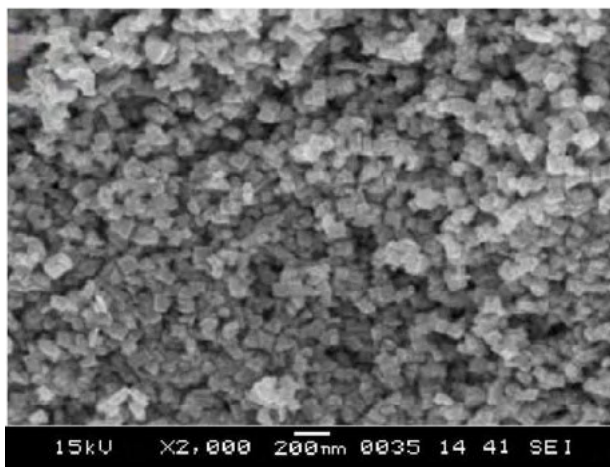


Fig. 4 (c) SEM picture of WO_3

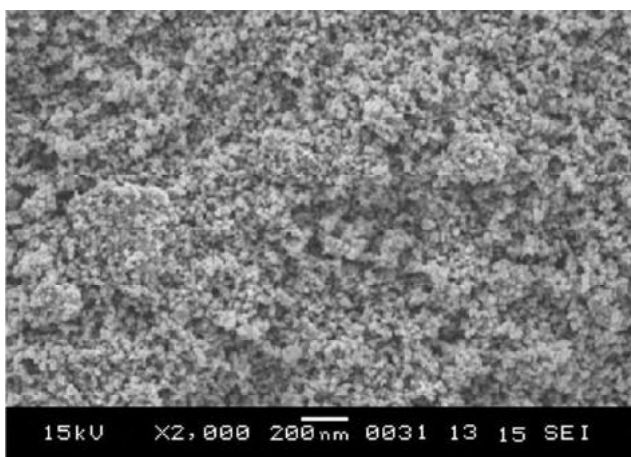


Fig. 4 (d) SEM picture of $05CuO:95WO_3$

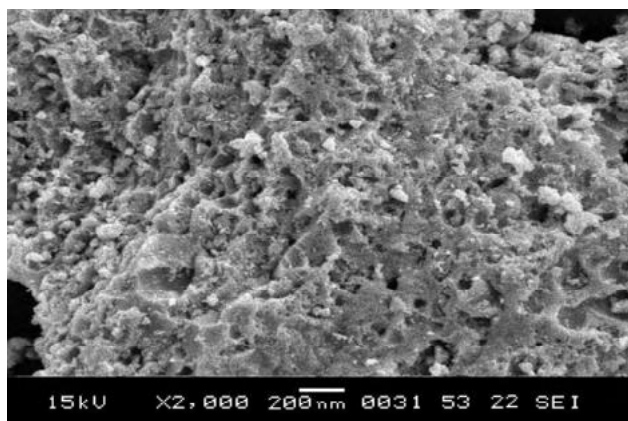


Fig. 4. (e) SEM picture of $10CuO:90WO_3$

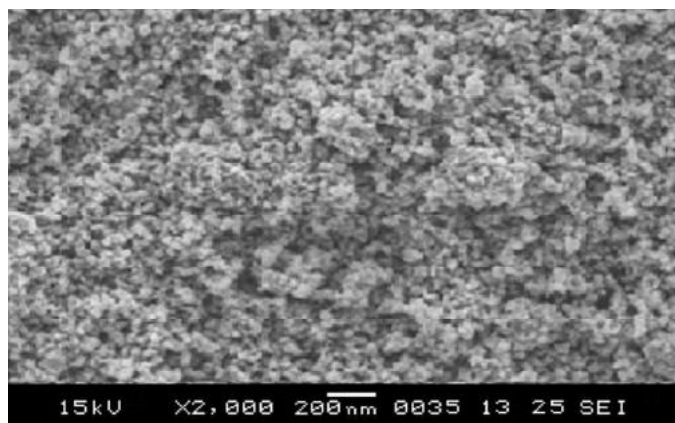


Fig. 4. (f) SEM picture of 15CuO:85WO₃

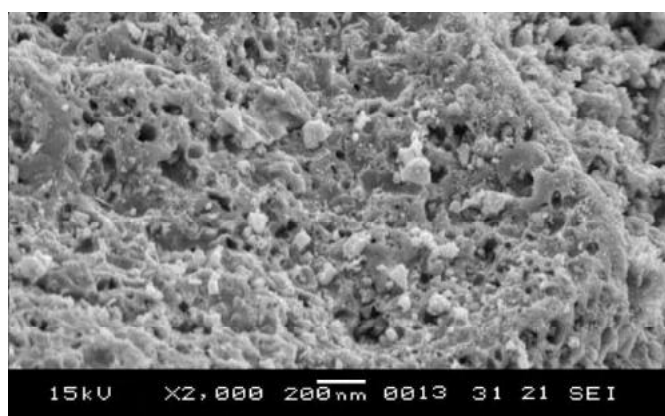


Fig. 4. (g) SEM picture of 20CuO:80WO₃

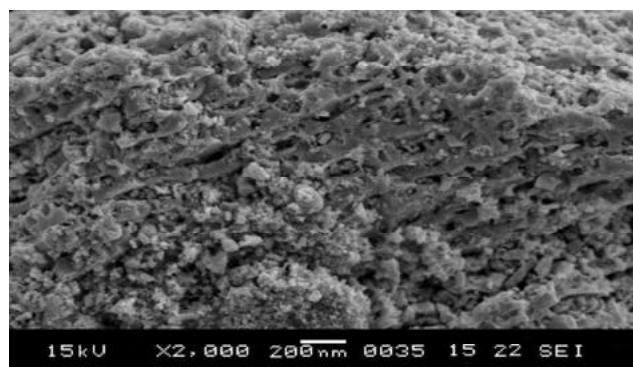


Fig. 4. (h) SEM picture of 25CuO:75WO₃

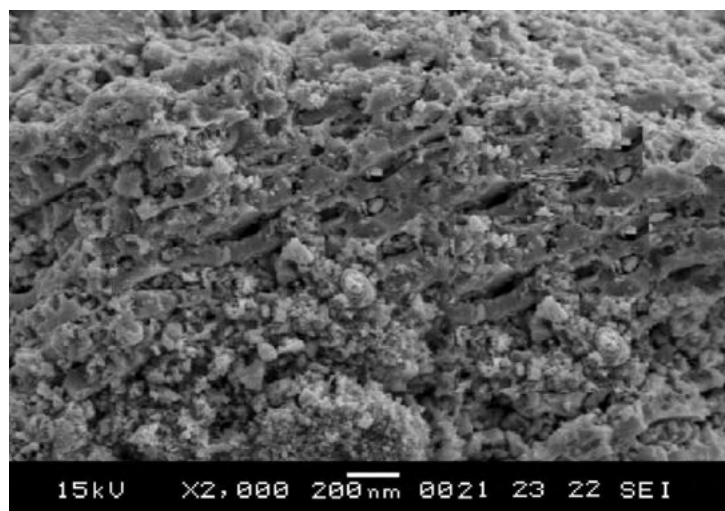


Fig. 4. (i) SEM picture of 30CuO:70WO₃

Fig. 4. SEM picture of Samples of Series CuO:WO₃

The surface morphologies of pure Al₂O₃, CuO, WO₃, and their dopings materials were studied by SEM and its picture are shown in the figures 4. As shown in the SEM pictures, some pores are in the form of rods, some are the form of circles and some are in conical shapes [24].

Table 4. shows the average diameter and number of pores per inch of pure Al₂O₃, CuO, WO₃ and their dopings.

Table 4. Average diameter of pore and number of pores per inch of pure samples and their dopings.

Sample Code	Pure sample and their dopings (mole %)	Average diameter of pore (nm)	Number of pores per inch (in x 2000 magnification)
PA	Al ₂ O ₃	95	154
PC	CuO	80	172
PW	WO ₃	98	145
B1	05CuO:95WO ₃	73	155
B2	10CuO:90WO ₃	82	143
B3	15CuO:85WO ₃	79	158
B4	20CuO:80WO ₃	83	138
B5	25CuO:75WO₃	52	218
B6	30CuO:70WO ₃	71	177

From the SEM pictures (table 4), it is observed that, Sample Code B5 i.e. (25CuO:75WO₃), have more pores per inch (calculated for x 2,000 magnification for each composition) than other sensors. Thus, these sensors have more active surface areas and exhibit more sensing nature [24-25]. It is also found that average diameter of pore in case of Sample Code B5 i.e. (25CuO:75WO₃) are small as compared to other doping. This also tends to exhibit large surface area and exhibited high response of the samples.

CONCLUSIONS

The XRD pattern of (CuO-WO₃) system samples show nanocrystalline form and found the desired peaks of composites. FESEM study reveals that the grain size of nanometer order and shows nano-porous structure, which leads to exhibit large surface area, stability and highest response. Therefore the B5 sensor (25CuO:75WO₃) is found to optimized multilayer thick film sensor.

REFERENCES

1. Sanjay Srivastava, Mahendra kumar, Arvind Agrawal and Sudhanshu Kumar Dwivedi, Synthesis and Characterisation of Copper Oxide nanoparticles, 2013, IOSR Journal of Applied Physics (IOSR-JAP) Volume 5, Issue 4 PP 61-65.
2. S. M. Sathiy, G. S. Okram, M. A. Jothi Rajan, 2017, Structural, optical and electrical properties of copper oxide nanoparticles prepared through microwave assistance, Advanced Materials Proceedings, 2(6), 371-377, DOI: 10.5185/amp.2017/605
3. R. Chopra, N. Kashyap, Amit Kumar, D. Banerjee, 2020 Chemical synthesis of copper oxide nanoparticles study of its optical and electrical properties, International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181, Vol. 9 Issue 01, IJERTV9IS010160
4. S. Thamaraiselvi, G. Thenmozhi, 2022, Synthesis of CuO Nanoparticles by using Simple Precipitation Method, International Journal of Science and Research (IJSR) ISSN: 2319-7064, Volume 11 Issue 4, DOI: 10.21275/SR22425202059
5. Nataly Silva, Sara Ramirez, Isaac Diaz, Andreina Garcia and Natalia Hassan, 2019, Easy, Quick, and Reproducible Sonochemical Synthesis of CuO Nanoparticles, Materials, 12, 804; doi:10.3390/ma12050804
6. Kailash R. Nemade and Sandeep A. Waghuley, 2014, Optical and Gas Sensing Properties of CuO Nanoparticles Grown by Spray Pyrolysis of Cupric Nitrate Solution, International Journal of Materials Science and Engineering Vol. 2, No. 1, doi: 10.12720/ijmse.2.1.63-66
7. Panya Khaenamkaew, Dhonluck Manop, Chaileok Tanghengjaroen and Worasit Palakawong Na Ayuthaya, 2020 Crystal structure, lattice strain, morphology, and Electrical Properties of SnO₂ nanoparticles induced by low calcination temperature, Advances in Materials Science and Engineering, Article ID 3852421, <https://doi.org/10.1155/2020/3852421>
8. Sitthisuntorn Supothina, Panpailin Secharaj, Sorachon Yoriya, Mana Sriyudthsak, 2007, Synthesis of tungsten oxide nanoparticles by acid precipitation method, Ceramics International 33, 931–936, doi:10.1016/j.ceramint.2006.02.007
9. X.C. Song, Y.F. Zheng, E. Yang and Y. Wang, 2007, Large-scale hydrothermal synthesis of WO₃ nanowires in the presence of K₂SO₄, Mater. Lett. 61, 3904–3908. <https://doi.org/10.1016/j.matlet.2006.12.055>.
10. L. Xiong, T. He, 2006, Synthesis and characterization of ultrafine tungsten and tungsten oxide nanoparticles by a reverse microemulsion-mediated method, Chem. Mater. 18, 2211–2218. <https://doi.org/10.1021/cm052320t>
11. M. Jamali, F and Shariatmadar Tehrani, 2020, Effect of synthesis route on the structural and morphological properties of WO₃ nanostructures, Mater. Sci. Semicond. Process. 107, 104829. <https://doi.org/10.1016/j.mssp.2019.104829>
12. P. Gibot, M. Comet, L. Vidal, F. Moitrier, F. Lacroix, Y. Suma, F. Schnell and D. Spitzer, 2011, Synthesis of WO₃ nanoparticles for superthermites by the template method from silica spheres, Solid State Sci. 13, 908–914. <https://doi.org/10.1016/j.solidstatesciences.2011.02.018>
13. Yu Il, Lee, Don-Kyu, Shin, Deuck-Jin, Yu, Yoon-Sik, 2010, Characteristics of CuO doped WO₃ Thick Film for Gas Sensors, The Transactions of The Korean Institute of Electrical Engineers Volume 59 Issue 9 / Pages.1621-1625 /1975-8359 (pISSN) / 2287-4364 (eISSN) <https://doi.org/10.5370/KIEE.2010.59.9.1621>
14. Artur Rydosz, Wojciech Maziarz, Tadeusz Pisarkiewicz, Krzysztof Wincza, Sławomir Gruszczyński, Deposition of Nanocrystalline WO₃ and CuO Thin Film in View of Gas Sensor Applications, ISBN: 978-0-9891305-4-7 ©2014 SDIWC
15. Nirmal Kumar, Stanislav Haviar, Jiri Capek, Sarka Batkova, Pavel Baroch, 2018, Nanostructured Metal-Oxide Based Hydrogen Gas Sensor Prepared by Magnetron Sputtering, Studenska Vedecka Konferenc

16. Fuchao Yang a, Fengyi Wang a, Zhiguang Guo, 2018, Characteristics of binary $\text{WO}_3@/\text{CuO}$ and ternary $\text{WO}_3@/\text{PDA}@/\text{CuO}$ based on impressive sensing acetone odor, *Journal of Colloid and Interface Science* 524, 32–41, <https://doi.org/10.1016/j.jcis.2018.04.013>
17. Soo-Yeon Cho, Doohyung Jang, Hohyung Kang, Hyeong-Jun Koh, Junghoon Choi, and Hee-Tae Jung, 2019, Ten Nanometer Scale WO_3/CuO Heterojunction Nanochannel for an Ultrasensitive Chemical Sensor, *Anal. Chem.*, 91, 6850–6858, DOI: 10.1021/acs.analchem.9b01089
18. K. B. Raulkar, (2019), Study on sensitivity of nano SnO_2 -ZnO composites with and without PPy layer for sensing CO_2 gas, 2019, *Materials Today: Proceedings* 15, 604–610.
19. Dmitry Bokov, Abduladheem Turki Jalil, Supat Chupradit, Wanich Suksatan, Mohammad Javed Ansari, 6 Iman H. Shewael, Gabdrakhman H. Valiev, and Ehsan Kianfar, (2021), Review Article, *Nanomaterial by Sol-Gel Method: Synthesis and Application*, *Advances in Materials Science and Engineering Volume 2021*, <https://doi.org/10.1155/2021/5102014>
20. Zahrah Alhalili, (2023), Review Metal Oxides Nanoparticles: General Structural Description, Chemical, Physical, and Biological Synthesis Methods, Role in Pesticides and Heavy Metal Removal through Wastewater Treatment, *Molecules* , 28, 3086. <https://doi.org/10.3390/molecules28073086>
21. Khaled Tawfik Alali, Jingyuan Liu, Kassem Aljebawi, Peili Liu, Rongrong Chen, Rumin Li, Hongquan Zhang, Limin Zhou, Jun Wang, 2019, Electrospun n-p WO_3/CuO heterostructure nanofibers as an efficient sar in nerve agent sensing material at room temperature, *Journal of Alloys and Compounds* 793, 31e41, <https://doi.org/10.1016/j.jallcom.2019.04.157>
22. Fang Peng, Yan Sun, Weiwei Yu, Yue Lu, Jiaming Hao, Rui Cong Jichao Shi, Meiyang Ge and Ning Dai, 2020, ‘Gas Sensing Performance and Mechanism of $\text{CuO(p)}-\text{WO}_3(\text{n})$ Composites to H_2S Gas.’ *Nanomaterials*, 10, 1162; doi:10.3390/nano10061162
23. Quentin Simon, Davide Barreca, Alberto Gasparotto, Chiara Maccato, Eugenio Tondello, Cinzia Sada, Elisabetta Comini, Giorgio Sberveglieri, Manish Banerjee, Ke Xu, Anjana Devi, and Roland A. Fischer, *CuO/ZnO Nanocomposite Gas Sensors Developed by a Plasma-Assisted Route*, *ChemPhysChem* 0000, 00, 1 – 8, DOI:10.1002/cphc.201101062
24. Yalu Chen, Zhurui Shen, Qianqian Jia, Jiang Zhao, Zhe Zhao, Huiming Ji, 2013, A CuO-ZnO Nanostructured p-n Junction Sensor for Enhanced N-butanol Detection, *The Royal Society of Chemistry*, DOI: 10.1039/x0xx00000x
25. Raulkar K.B, Wasnik T.S, Joat R.V., Wadtkar A.S. Agrawal, R.M. and Lamdhade G.T., (2019). Study on DC Conductivity of PPy-ZnO Nanocomposites, *Materials today Proceedings*, 15(3), 595-603.

A Review on Carbon based Nanomaterial. Properties, Characteristics and Applications

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Abstract.

In recent years, there has been a growing interest in nanomaterials, this review highlight the distinctive characteristics of carbon-based nanomaterials. Specifically, the focus extends to key advancements in carbon based nanomaterials, including fullerene , Graphene , carbon nanotube, carbon quantum dot , nanodiamond . **Throughout this review, the** exceptional features of carbon based nanomaterials are highlighted, illustrating their significance in diverse applications. The review concludes by addressing future perspectives of carbon-based nanomaterials in various fields.

Keywords: Fullerene , Graphene , Carbon Nanotube , Carbon Quantum Dot , Nanodiamond .

1.Introduction.

Nanotechnology is the general term for designing and making anything whose use depends on specific structure at the nanoscale – generally taken as being 100 nanometres (100 millionths of a millimetre or 100 billionths of a metre) or less. Nanomaterials are usually considered to be materials with at least one external dimension that measures 100 nanometres or less or with internal structures measuring 100 nm or less [1,2]. They may be in the form of particles, tubes, rods or fibres. The nanomaterials that have the same composition as known materials in bulk form may have different physico-chemical properties than the same materials in bulk form, and may behave differently if they enter the body. They may thus pose different potential hazards. Aggregated nanomaterials also need to be assessed in this light as they may exhibit properties that are similar to those of the single nanoparticles, especially when they have an unusually large surface area for a given amount of material [3,4]. The number of products produced by nanotechnology or containing nanomaterials entering the market is increasing [6]. Current applications include healthcare (in targeted drug delivery, regenerative medicine, and diagnostics)[5,7], electronics, Thermal conductivity [10],even in COVID-19 era [11] , cosmetics, textiles, information technology and environmental protection[8]. For example, nanosilver is appearing in a range of products, including washing especially close scrutiny [9].

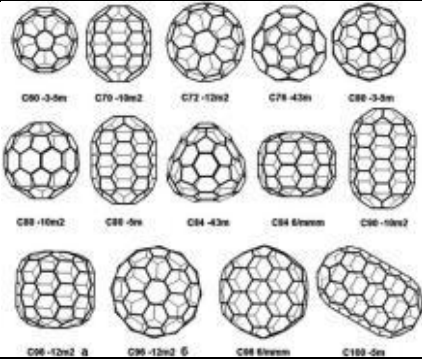
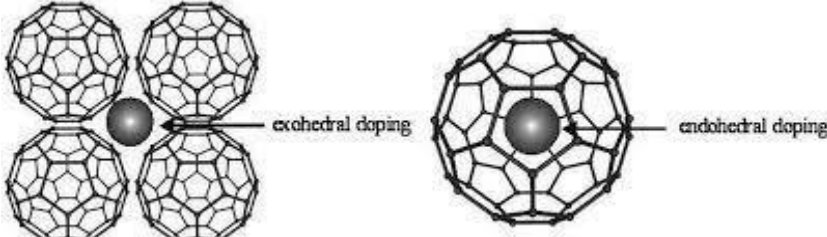
2.Special Carbon Based Nanomaterial.

Carbon is a fascinating element that has been regarded as an essential component of all living things. Carbon's capacity to link to itself to create polymers permits it to play such a significant part in biological processes. This feature may also be employed to create the diverse structures that make carbon such a valuable asset due to its exceptional features such as outstanding mechanical characteristics, variable morphologies, high thermal conductivity, and high corrosion resistance [12, 13,14]. Modern science and technology centred on carbon-based nanomaterials are changing at a fast pace with the potential to replace or complement current systems. Carbon-based materials that can be produced and characterised at the nanoscale have become a cornerstone in nanotechnology. The morphologies and topographies of these carbon compounds can be quite diverse. As the well-known allotrope of carbon based nanomaterial demonstrate, they can have hollow or filled frameworks and can assume a variety of forms . The carbon family consists of several unique nanomaterials, including CNTs, fullerenes, graphene, carbon nanohorns, carbonbased quantum dots, and many others [15]. Graphene and

carbon nanotubes are all sp^2 hybridized carbon allotropes. Due to their remarkable features such as electrochemical stability, high charge carrier mobility, and mechanical flexibility have gotten a lot of interest[16]. Hence, chemical separation, superlubricity, electronics, and catalyst support are only a few of the applications of graphene and carbon nanotubes. 3D nanodiamonds possess both the sp^3 and sp^2 carbon atoms, with the reconstruction of the sp^2 playing a key part in its stability. The Nano-diamonds have appealing surface areas, adjustable surface morphologies, and high hardness, hence, their novel applications in cosmetics and biomedicine.

Carbon nanomaterials (CNMs) have attracted a lot of interest in recent decades due to their exceptional features. The types of different carbon nanomaterials available the existing three allotropes of carbon fullerene carbon nanospheres first prepared by Kroto *et.al* in 1985, carbon nanotubes (CNT) having a cylindrical shape, and grapheme obtained from graphite contains an extended hexagonal lattice of sp^2 -bonded carbon atoms. Hence, they are characterized by remarkable chemical, mechanical, and electrical features that offer tremendous possibilities in applications such as carbon fibres, energy storage, conversion devices, biosensors, and catalysts. Carbon nanomaterials are being used to improve a variety of products, including electronics, lubricants, composites, and sporting equipment . Carbon based nanoparticles have a wide range of applications due to their unique chemical characteristics and the variety of carbon nanostructures that may be created. Some of them are discussed here :

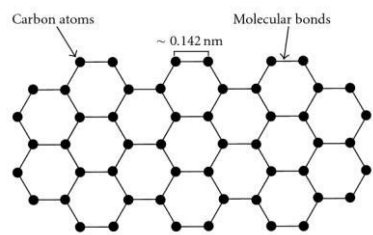
i) Fullerne

Discovered in	1985
Discovered by	Sir Harold W. Kroto
Also known as	Buckminsterfullerene , Buckyball
Hybridisation	Sp^2
Types	C_{60} , C_{70} , C_{72} , C_{76} , C_{84} , C_{100}
Structure	
Solubility	Soluble in-1,2-dichlorobenzene, toluene, p-xylene, and 1,2,3-tribromopropane. Insoluble in- Water
Modification	<p>There are two main ways to modify fullerenes:</p> <ol style="list-style-type: none"> 1.Fullerene inner-space modification(Endohedral) and 2.Fullerene outer-surface modification(Exohedral). 

Purpose of modification	Endohedral fullerene – 1.act as robust nano-container for host target species. 2.Li- based endohedral fullerene show unique solid properties. 3.Li- based endohedral fullerene can be used as nano-scale lithium batteries. 4.Fullerene cages useful for storage of gases. Exohedral Fullerene- 1.Strongly affects electronic properties. 2.Act as scavenger for reactive oxygen species.
Application.	1.Conical Fullerene amphiphiles can be used as Drug delivery agent. 2.Watersoluble cationic fullerene tetrapiperazino fullerene Exoxide(TPFE) used for targeted delivery of DNA and siRNA specifically for the lungs. 3. Combination of fullerene with polymer result in good flame retardant. 4. used as Lubricant.
Characyeristics	Anticancer, Antioxidants ,Antibacterial ,Antiviral , Highly stable , Good conductivity

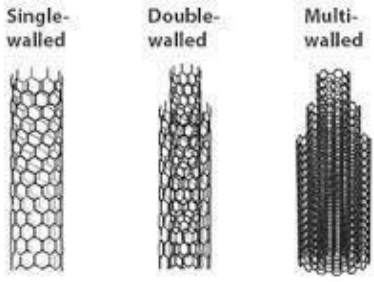
[17,18]

ii) Graphene

Discovered in	2004
Discovered by	Andre Geim and Konstantin Novoselov
Also Known as	Material of the future,
Hybridisation	Sp ²
Structure	
Stability	Soluble in - N-Methyl-2-pyrrolidone (NMP), dimethylformamide (DMF), and dimethyl sulfoxide (DMSO) Insoluble in-water or organic solvents
Properties	Thermal conductivity : Approx.3080- 5150 Wm ⁻¹ K ⁻¹ Therotical surface area: 2630 m ² g ⁻¹ Mechanical Strength:- 130 GPa Electron Moblity:-10 ⁴ cm ² /Vs
Application	1. Electrochemical sensors 2.Biosensors 3.Electrodes 4. Liquid crystal display 5.Light emitting Diode 6. Fabrication of pressure sensors. 7. Pollution absorbent. 8. Non-metal catalysts.
Characteristics	1.Large specific surface area 2.Transperent in nature 3.Good Peiezoresistive sensitivity 4.Excellent mechanical strength 5.Electronic conductivity.

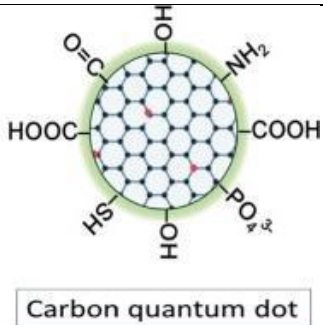
[19,20]...

iii) Carbon Nanotube

Discovered in	1991												
Discovered by	S.Iijima												
Also known as	Buckytubes												
Hybridisation	sp ²												
Types	Single Walled Carbon Nanotube Double Walled Carbon Nanotube Multiwalled Carbon Nanotube												
Structure													
Stability	Soluble in : Inorganic solvent Insoluble in : Water and Organic Solvent												
Properties	<table border="1"> <thead> <tr> <th>properties</th> <th>SWCNT</th> <th>MWCNT</th> </tr> </thead> <tbody> <tr> <td>Diameter</td> <td>0.4 to 2 nm</td> <td>0.33 to 0.42 nm</td> </tr> <tr> <td>Electrical conductivity</td> <td>10² to 10⁶ Scm⁻¹</td> <td>10³ to 10⁵ Scm⁻¹</td> </tr> <tr> <td>Thermal Conductivity</td> <td>Approx.6000 Wm⁻¹K⁻¹</td> <td>Approx.2000 Wm⁻¹K⁻¹</td> </tr> </tbody> </table>	properties	SWCNT	MWCNT	Diameter	0.4 to 2 nm	0.33 to 0.42 nm	Electrical conductivity	10 ² to 10 ⁶ Scm ⁻¹	10 ³ to 10 ⁵ Scm ⁻¹	Thermal Conductivity	Approx.6000 Wm ⁻¹ K ⁻¹	Approx.2000 Wm ⁻¹ K ⁻¹
properties	SWCNT	MWCNT											
Diameter	0.4 to 2 nm	0.33 to 0.42 nm											
Electrical conductivity	10 ² to 10 ⁶ Scm ⁻¹	10 ³ to 10 ⁵ Scm ⁻¹											
Thermal Conductivity	Approx.6000 Wm ⁻¹ K ⁻¹	Approx.2000 Wm ⁻¹ K ⁻¹											
Application	<ol style="list-style-type: none"> 1.Rectifying diodes 2.Single Electron Transistor 3. Field Effect Transistor. 4.Biomedical devices 5. Drug Delivery 6.Cell Biology. 												
Characteristics	<ol style="list-style-type: none"> 1.High Tensile Strength 2.High aspect Ratio 3.Llight weight 4.Chemical Stability 5.Nanosize 												

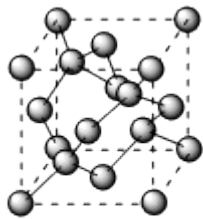
[21]

v) Carbon Quantum Dot

Discovered in	2004
Discovered by	Xu <i>et.al</i>
Also known As	Carbon Nano Dots , CQD's , C-dots or CD's
Hybridisation	
Structure	
Properties	Thermal Conductivity - 6.049 W/mK
Application	<ol style="list-style-type: none"> 1.Cell Imaging 2.Light Emitting Diodes 3. Nanomedicine 4. Solar Cells 5.Sensors 6.Catalysis 7.Bioimaging

[22]

iv) Nanodiamond

Discovered in	1963
Discovered by	K.V. Volkov, V.V. Danilenko, and V.I. Elin
Also Known as	Diamond nanoparticles
Hybridisation	Sp ³
Structure	
Properties	<ol style="list-style-type: none"> 1.Tensile Strength- (ND-reinforced aluminium) : 205 MPa 2. Thermal Conductivity: 3 W m⁻¹ K⁻¹ 3.Electrical Conductivity : 3.4 × 10⁻⁷ Ohm⁻¹ cm⁻¹
Application	<ol style="list-style-type: none"> 1. Bio sensors. 2.Wastewater treatment. 3.Imaging 4. Cancer Treatment. 5.Biomeical application
Characteristics	<ol style="list-style-type: none"> 1. Shows excellent optical properties. 2.High mechanical Properties. 3.High Specific surface area.

	<p>4. Have high number of functional group present on the surface.</p> <p>5. High thermal stability.</p> <p>6. Stable and Long fluorescence.</p>
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[23,24,25]

3. Conclusion.

Currently, huge numbers of theoretical and experimental literature studies of carbon based nanomaterials and nanotechnology have been witnessed. Future technologies depend upon how Effectively these carbon based materials can be manipulated on the nanoscale for various applications . Carbon-based nanomaterials are a fascinating class of nanomaterial, consisting of fullerene , carbon nanotube , carbon based quantum dot , graphene, and. Moreover, the surfaces of carbon-based nanomaterials can be functionalized further to tune their properties for certain applications. CNTs and graphene are highly acknowledged members of the carbonbased nanomaterials family and they have been extensively explored for various applications due to their high surface areas, rapid charge transfer properties, and high mechanical strength. Carbon quantum dots have received great attention in the fields of sensing, nanomedicine, and bioimaging. After grapheme isolation in 2004 from graphite, large interest in ultrathin 2D materials was witnessed due to their numerous unprecedented features. The experimental evaluation of these materials is still at an early stage; however, these materials are being rapidly explored for useful applications. By using nanotechnology, some commercial devices have already been introduced , much more progress is anticipated, with nanomaterials being introduced into next-generation devices to cope with future high energy demands and playing a more active role in biosensors and nanomedicine to fight against existing and novel diseases. Nanotechnology can play an active role in the decontamination of water and the recycling of wastewater. Future challenges faced by modern society can be fixed with a better understanding and the rapid development of nanotechnology.

References

- [1] Neksumi Musa, Sushmita Banerjee, N.B. Singh and Usman Lawal Usman, January (2023) Carbon Nanomaterials and Their Applications , Materials Research Foundations , Volume. 135, pages 40-71, DOI:10.21741/9781644902172-3
- [2] Wolfgang G. Kreyling , Manuela Semmler-Behnke and Qasim Chaudhry , June (2010) , A Complementary Definition of Nanomaterial , Nano Today , Volume 5, Pages 165-168 , DOI:10.1016/j.nantod.2010.03.004
- [3] Nikita Rao , Rasmeet Singh and Lavisha Bashambu (2021) Carbon-based nanomaterials: Synthesis and prospective applications , Materials Today: Proceedings , Volume 44, Part 1, Pages 608-614 , DOI:10.1016/j.matpr.2020.10.593
- [4] Robert Birundu Onyancha , Kingsley Eghonghon Ukhurebor , Uyiosa Osagie Aigbe , Otolorin Adelaja Osibote , Heri Septya Kusuma and Handoko Darmokoesoemo , May (2022) A Methodical Review on Carbon-Based Nanomaterials in Energy-Related Applications , Adsorption Science & Technology , Volume. 2024, , Page 1 , DOI:10.1155/2022/4438286
- [5] Debabrata Maiti , Xiangmin Tong , Xiaozhou Mou and Kai Yang , March (2019) , Carbon-Based Nanomaterials for Biomedical Applications: A Recent Study , Frontiers in Pharmacology , Volume. 9 , Pages 1-16 , DOI:10.3389/fphar.2018.01401
- [6] Nadeem Baig , Irshad Kammakakam and Wail Falath , February (2021), Nanomaterials: a review of synthesis methods, properties, recent progress and Challenges , Materials Advances , Volume .2 , pages:1821-1871 , DOI:10.1039/d0ma00807a
- [7] Kapil D. Patel , Rajendra K. Singh and Hae-Won Kim , March (2019) , Carbon-based nanomaterials as an emerging platform for theranostics , Materials Horizon , pages 434-469 , DOI: https://doi.org/10.1039/c8mh00966j
- [8] Rasoul Madannejad , Nahid Shoaie , Fatemeh Jahanpeyma , Mohammad Hasan Darvishi , Mostafa Azimzadeh and Hamidreza Javadi , July (2019) , Toxicity of carbon-based nanomaterials: Reviewing recent reports in medical and biological systems Chemico-Biological Interactions , Volume 307, Pages 206-222 , DOI:10.1016/j.cbi.2019.04.036

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- [9] Mathurin François , Kuen-Song Lin , Nova Rachmadona and Kuan Shiong Khoo , February (2024) , Utilization of carbon-based nanomaterials for wastewater treatment and biogas enhancement: A state-of-the-art review , *Chemosphere* , Volume 350, Page 141008 , DOI:10.1016/j.chemosphere.2023.141008
- [10] Y. Xie and X.Wang , September (2023) , Thermal conductivity of carbon-based nanomaterials: Deep understanding of the structural effects , *Green Carbon* , Volume 1 , Pages 47-57 , DOI:10.1016/j.greenca.2023.08.004
- [11] Massimiliano Papi , Marco De Spirito and Valentina Palmieri , June (2023) , Nanotechnology in the COVID-19 era: Carbon-based nanomaterials as a promising solution , *Carbon* , Volume 210, Page 118058 , DOI:10.1016/j.carbon.2023.118058
- [12] N. Díez, M. Sevilla and A.B. Fuertes , December (2021) , Dense (non-hollow) carbon nanospheres: synthesis and electrochemical energy applications , *Materials Today Nano* , Volume 16, December 2021, page 100147 , DOI:10.1016/j.mtnano.2021.100147
- [13] Thomas Hanemann and Dorothée Vinga Szabó , May (2010) , Polymer Nanoparticle Composites: From Synthesis to Modern Applications , *Materials (Basel)* , Volume 3 , Pages:3468-3517 , DOI:10.3390/ma3063468
- [14] Ayodeji Precious Ayanwale , Alejandro Donohué Cornejo , Juan Carlos Cuevas González , León Francisco Espinosa Cristóbal and Simón Yobanny Reyes López , August (2018) , Review of the synthesis, characterization and application of zirconia mixed metal oxide nanoparticles , *International journal of research –granthaalayah* , volume 6 , DOI:10.29121/granthaalayah.v6.i8.2018.1407
- [15] Vasilios Georgakilas , Jason A. Perman , Jiri Tucek and Radek Zboril , June (2015) , Broad Family of Carbon Nanoallotropes: Classification, Chemistry, and Applications of Fullerenes, Carbon Dots, Nanotubes, Graphene, Nanodiamonds, and Combined Superstructure , *Chemical Reviews* , Volume 115 , Pages : 4744–4822 , DOI: 10.1021/cr500304f
- [16] S. Iijima , M. Yudasaka , R. Yamada , S. Bandow , K. Suenaga , F. Kokai and K.Takahashi August (1999) Nano-aggregates of single-walled graphitic carbon nano-horns , *Chemical Physics Letters* , Volume 309, 13 August 1999, Pages 165-170 , DOI:10.1016/S0009-2614(99)00642-9
- [17] Peter.J.F.Harris , November (2020) , Fullerene Polymers: A Brief Review. , *Journal:C* , Volume 6 , DOI:10.3390/c6040071
- [18] Ayawei Nimibofa1, Ebelegi Augustus Newton, Abasi Yameso Cyprain and Wankasi Donbebel , June (2018) , Fullerenes: Synthesis and Applications , *Journal of Materials Science Research* , Volume 7 , Pages 22-36 , DOI : 10.5539/jmsr.v7n3p22.
- [19] Kenji Watanabe , Takashi Taniguchi , Efthimios Kaxiras and Pablo Jarillo-Herrero , March (2018) , Unconventional superconductivity in magic-angle graphene superlattices , *Nature* , volume 556 , pages 43–50 , DOI: 10.1038/nature26160
- [20] L. S. Sundar , M. A. Mir, M. W. Ashraf and F.Djavanroodi , September (2023) , Synthesis and characterization of graphene and its composites for Lithium-Ion battery applications: A comprehensive review , *Alexandria Engineering Journal* , Volume 78, Pages 224-245 , DOI:10.1016/j.aej.2023.07.044
- [21] Rajwant Kaur , April (2018) , Carbon Nanotubes: A Review Article , *International Journal for Research in Applied Science and Engineering Technology* , Volume 6 , Pages 5075-5079 , DOI:10.22214/ijraset.2018.4827
- [22] Derya Ozyurt , Mohammad Al Kobaisi , Rosalie K. Hocking and Bronwyn Fox , September (2023) , Properties, synthesis, and applications of carbon dots: A review , *Carbon Trends* , Volume 12 , Article :100276 , DOI:10.1016/j.cartre.2023.100276
- [23] Elena Perevedentseva , Yu-Chung Lin and Chia-Liang Cheng March (2020) , A review of recent advances in nanodiamond-mediated drug delivery in cancer , *Expert opinion on Drug Delivery* , Volume 18 , Pages 369-382 , DOI:10.1080/17425247.2021.1832988
- [24] Vadym Mochalin , Olga Shenderova , Dean Ho and Yury Gogotsi , December (2011) , The Properties and Applications of Nanodiamonds , *Nature Nanotechnology* , Volume 7 , Pages 11-23 , DOI:10.1038/nnano.2011.209
- [25] Luca Basso , Massimo Cazzanelli , Michele Orlandi and Antonio Miotello , June (2020) , Nanodiamonds : Synthesis and Application in Sensing, Catalysis, and the Possible Connection with Some Processes Occurring in Space , *Applied Sciences* , Article:4094 , DOI : 10.3390/app10124094.

Review on Nanofabrication Techniques

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Abstract.

The rapidly growing field of nanofabrication for functional micro/nano-features has drawn attention and applications in diverse sectors such as electronics, photonics, energy, and biological devices across the globe. The reason these devices are being created is to smoothly combine affordable, top-notch micro/nano-features into advanced 3D designs. Over the past few years, there have been important improvements, especially in making devices with tiny structures using different imprinting methods.

In the area of nanofabrication, this review totally focuses on the bottom-up nanofabrication technique. This approach involves building nanostructures from the ground up, starting with individual atoms or molecules, allowing for precise control over the final product. Within the bottom-up nanofabrication technique, four notable methods are highlighted , Atomic Layer Deposition (ALD) , Sol-Gel Method , Colloidal Self-Assembly , DNA Scaffolding of Electronics . The comprehensive review not only acknowledges these bottom-up nanofabrication methods but also emphasizes their significance in advancing the field. It sheds light on the successes achieved through these techniques and the critical role they play in ensuring the compatibility, functionality, and scalability of nano-features within large-scale production processes.

Keywords : Atomic Layer Deposition (ALD) , Sol-Gel Method , Colloidal Self-Assembly , DNA Scaffolding

1. Introduction

Nanostructured surfaces and nanoparticles are widely employed in many fields of research and technology, and there is an ever-growing demand for reliable and reproducible nanofabrication methods. In biology and medicine, nanostructured surfaces and nanoparticles are employed both because of their optical or magnetic properties alone as well as due to a combination of their optical and magnetic properties [1]. In the past two decades, several nano-manufacturing techniques [2,3] have been developed which address high expectations relating to nano-technology. This has enabled exponential knowledge development and a thorough understanding of the characteristics of many interesting nano-structures, their application-related properties, and the incorporation of engineered nanomaterials into multi-functional devices. For example, LEDs [4], solar cells [5], hard disk drives [6], laser diodes [7], self-cleaning [8,9], antibacterial [10], boost skin appearance [11], keep food fresh [12] and combine super-hydrophobic and superoleophobic properties that keep your smartphone screen clean, etc. Nanofabrication products have a number of "design requirements" according to the consumer use. These "design requirements" specify the structural quality, dimensional and geometric precision, and tolerable levels of defects. However, we must also develop proficient, lowcost, and robust nanofabrication methods to realize the potential benefits of all these products

2. BOTTOM-UP NANOFABRICATION TECHNIQUES

The ultimate objective of bottom-up techniques is self organizing integrated processes and tools . This approach has the potential to generate practical multi-component highly functional

devices [12] by regulating the integration of atoms and molecules, without wasting or removing portions of the final structure. The most appealing properties of bottom-up nanofabrication are that no pricy instruments are usually needed to fabricate structures at nanoscale and can easily fabricate in large quantities.

2.1 The vapor-liquid-solid (VLS), template assisted deposition, and solution-based growth methods are the most popular bottom-up techniques . The VLS mechanism of growth, initially described in the 1960s by Wagner and Ellis [13] later renewed in the 1990s by Morales and Lieber [14] and became a common technique to grow inorganic nanowires nowadays shown in figure a . The bottom-up synthesis of nanowires has several benefits and preserve the defined reaction conditions for the creation of nanowires without sacrificing the other materials in the final product. In addition, bottom-up nano-material synthesis permits the formation of an unlimited number of structures [15] and hetero-structures [16] that are entirely controlled by the dimension and composition. By using bottom-up methods, various heterostructures can be prepared such as axial [17], radial core/shell , shell in the form of a nanotube after removal of the core , multisegmented , possibly also with mixed 0–1 dimensionality . These structures are used in various types of electrical, opto-electronic, and energy conversion systems including logic and memory chips , photodetectors [18], light-emitting diodes [19], lasers, and solar cell photovoltaic components [20].

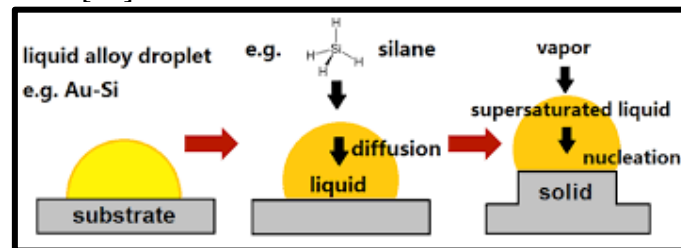


Figure a. Vapour Liquid Solid

2.2 Atomic Layer Deposition method (ALD) [21] is one of the fascinating techniques to fabricate continuous and economical semiconductor devices [22] by using thin-film deposition method. ALD film growth occurs when a series of two or more self-governed surface reactions are performed on to the substrate having respective reactants introduced periodically with reactor purging transition as shown in Figure b . Due to the self-governing mechanism of ALD reactions, one can get deposition thickness up to the sub-nanometer scale. Consistent distribution of the active surface sites means that the added reactants react evenly onto the entire substrate surface, including all non-planar characteristics. This gives uniform thickness on the substrate . The selection of reactants and deposition cycle parameters is based on the thermodynamics and kinetics of the surface reactions involved in ALD process growth. In the 1980s, the ALD approach was used for the first commercial application of ZnS flat-panel electroluminescent displays and then further adapted for semiconductor manufacturing in the 1990s [14]. In manufacturing modern devices ALD continues to be an important process that includes broad bandwidth semiconductor [23], FinFET, and other nanoscale electronics [24].

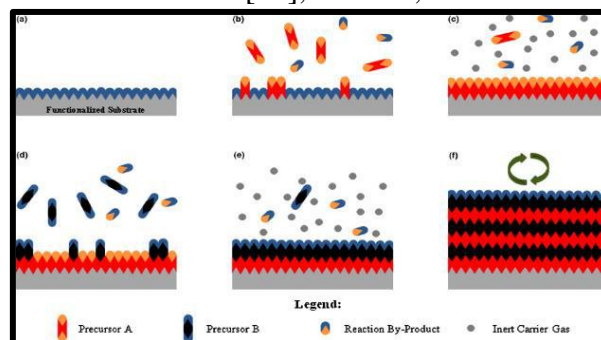


Figure b. Atomic Layer Deposition

2.3 The SOL-GEL method has been commonly used nanostructures fabrication based on metal oxide materials [25] and alloys . SG processing is highly cost-effective when compared to physical, chemical, and plasma deposition techniques. The SG process uses a combination of metal catalysts used in the solvent, catalyst deposition on the substrate, and heating procedure used for the oxidation or sintering of the final product as shown in Figure c . For the growth of a wide range of materials SG method also concentrate on the materials synthesis which usually depends on the hydrolysis and condensation of molecular catalysts [26,27]. The typical application of the SG method is silica to form highly liquid-repellent surfaces and films.

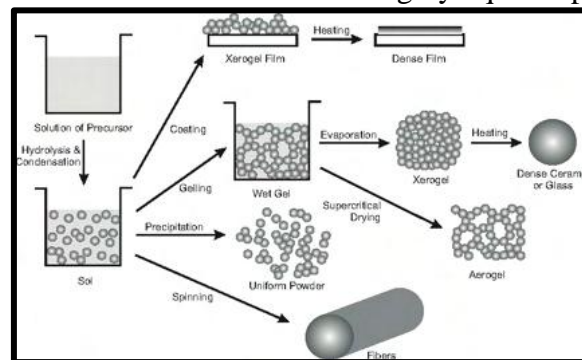


Figure c. Sol-Gel Method

2.4 Colloidal Self-Assembly (CSA) method has been intensively studied for decades for the production of nanostructures used in photonic bandgap materials and high density recording media [28,29]. The early work was geared towards the utilization of bandgap materials for nanophotonic applications. Figure d shows the fabrication of PDMS mold by using CSA method . However, to achieve the necessary structural perfection such as waveguides [30] , it is essential to overcome the difficulty of preventing kinetic trapping and to find cost-effective ways to combine the structures created with other photonic devices. In comparison with other methods, the CSA method is the ideal candidate for the production of large-area, inexpensive, structural color materials [31]. CSA has the exciting potential to generate new materials at the nanoscale by integrating nanoparticles with different characteristics into transparent crystalline structures [5].

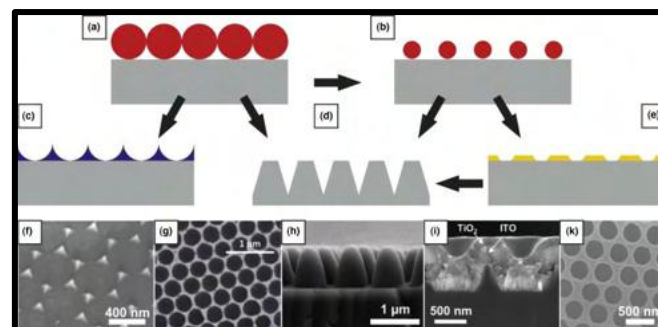


Figure d. Colloidal Self Assembly

2.5 DNA Scaffold method is extremely flexible to generate structures by single-stranded (ssDNA), double or duplex (dsDNA) structures and complex supramolecular assemblies shown in Figure e [32]. 1, 2 and 3-dimensional structures can be created by the DSSA method, and the capacity of other nanoscale artifacts to work with DNA, coupled with the precision of complementary sequence recognition, implies that DNA may bind and organize disparate nano-structures to make relatively complex constructions, containing well-precise nanoparticle crystal lattices, and even active systems [32]. DNA origami [32] is a perfect example of the power of DNA to regulate the configuration of nanoscale objects, creating a molecularly precise “breadboard” to which nano-structures can be attached.

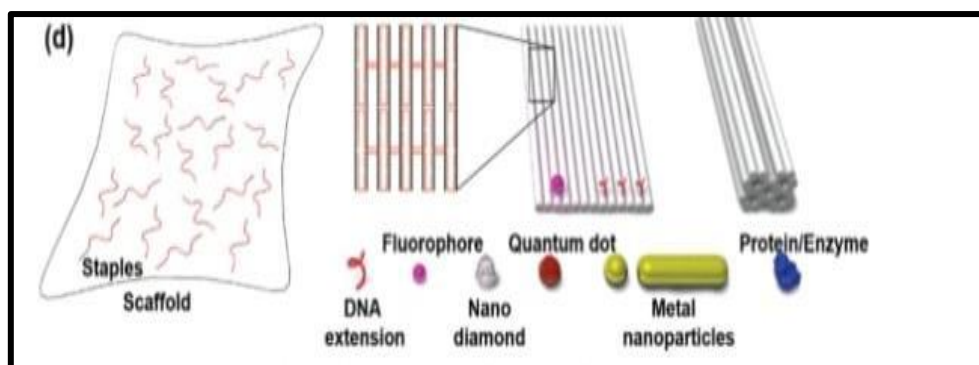


Figure e. DNA Scaffolding.

3. Conclusion:

The world of nanofabrication, mainly guided by bottom-up approaches, is leading the way in innovation, marking a pivotal moment for nanostructured surfaces and nanoparticles. The constant need for reliable fabrication methods in biology, medicine, and technology has driven the creation of various techniques over the last two decades. This progress not only enhances our understanding of nanostructures but also makes it easier to blend them seamlessly into versatile, multi-functional devices. The paradigm shift offered by the bottom-up approach, with its emphasis on self-organizing integrated processes, marks a revolutionary stride in nanofabrication. Significantly, this methodology enables the practical realization of highly functional devices by orchestrating the integration of atoms and molecules without unnecessary material removal. The accessibility of this technique, requiring fewer expensive instruments and enabling large-scale fabrication at the nanoscale.

In conclusion, exploring well-known bottom-up techniques like Vapor-Liquid-Solid, Atomic Layer Deposition, SOL-GEL, Colloidal Self-Assembly, and DNA Sequence-Specific Assembly reveals a flexible set of tools for creating structures tailored to specific needs. These methods cover a wide range of applications, from making semiconductor devices to producing materials with unique structural colors, showcasing their versatility.

REFERENCES:

- [1] Stefan Schrittwieser, Michael J. Haslinger, Tina Mitterramskogler, Michael Mühlberger, Astrit Shoshi, Hubert Brückl, Martin Bauch, Theodoros Dimopoulos, Barbara Schmid and Joerg Schotter, (2019), Multifunctional Nanostructures and Nanopocket Particles Fabricated by Nanoimprint Lithography, *Nanomaterials* 20, Volume 9 Issue 12, DOI: 10.3390/nano9121790.
- [2] Abhijit Biswas, Ilker S. Bayer, Alexandru S. Biris, Tao Wang, Enkeleda Dervishi and Franz Faupel (2012), Advances in top-down and bottom-up surface nanofabrication: Techniques, applications and future prospects, *Advances in Colloid and Interface Science*, Volume 170, Issues 1–2, Page 2–27, DOI: 10.1016/j.cis.2011.11.001.
- [3] Kyowon Kang, Younguk Cho and Ki Jun Yu (2018) Nano-Materials and Nano-Fabrication Techniques for Flexible Electronic Systems, *Micromachines*, Volume 9, Issue 6, 3; DOI:10.3390/mi9060263.
- [4] Yeeu-Chang Lee and Sheng-Han Tu, (2011), Improving the light-emitting efficiency of GaN LEDs using nanoimprint lithography in *Recent Advances in Nanofabrication Techniques and Applications*, Book: Improving the Light-Emitting Efficiency of GaN LEDs Using Nanoimprint Lithography, Volume 1, Page 173-196, DOI: 10.5772/20712.
- [5] Amalraj Peter Amalathas and Maan M Alkaisi, (2017), Efficient light trapping nanopyramid structures for solar cells patterned using UV nanoimprint lithography, *Materials Science in Semiconductor Processing*, volume 57, Page 54–58, DOI:10.1016/j.mssp.2016.09.032.
- [6] Daniel B. Sullivan, Thomas Boonstra, Mark T. Kief, Lily Youtt, Sethuraman Jayashankar, Carolyn Van Dorn, Harold Gentile, Sriram Viswanathan, Dexin Wang, Dion Song, Dongsung Hong, Sung-Hoon Gee Sullivan, (2013), Hard disk drive thin film head

- manufactured using nanoimprint lithography , *Journal of Micro/Nanolithography, MEMS, and MOEMS* , Volume 12 , Issue 3 , DOI:10.1117/1.JMM.12.3.031105.
- [7] Masaki Yanagisawa , (2011) , Application of nanoimprint lithography to distributed feedback laser diodes , *Recent Advances in Nanofabrication Techniques and Applications* , Volume 1 , Page 211–224 , DOI: 10.5772/22678.
- [8] Yushan Yang , Haishan He , Yougui Li & Jian Qiu , (2019) , Using nanoimprint lithography to create robust, buoyant, superhydrophobic PVB/SiO₂ coatings on wood surfaces inspired by red roses petal , *Scientific Reports* , Volume 9 , Issue 1 , Page 1–9 , DOI :10.1038/s41598-019-46337-y.
- [9] Feyza Dundar Arisoy , Kristopher W. Kolewe , Benjamin Homyak , Irene S. Kurtz, Jessica D. Schiffman and James J. Watkins , (2018) , Bioinspired photocatalytic shark-skin surfaces with antibacterial and antifouling activity via nanoimprint lithography , *ACS Applied Materials & Interfaces* , Volume 10 , Issue 23, Page 20055–20063 , DOI: 10.1021/acsami.8b05066.
- [10] Khanh T.M. Tran and Thanh D. Nguyen , (2017) , Lithography-based methods to manufacture biomaterials at small scales , *Journal of Science: Advanced Materials and Devices* , Volume 2 , Issue 1 , Page 1–14 , DOI:10.1016/j.jsamd.2016.12.001.
- [11] Juhong Chen , Yiliang Zhou , Danhui Wang , Fei He , Vincent M. Rotello , Kenneth R. Carter , James J. Watkins^b and Sam R. Nugen , (2015) , UV-nanoimprint lithography as a tool to develop flexible microfluidic devices for electrochemical detection , *Lab on a Chip* , Volume 15 , Issue 14, Page 3086–3094 , DOI : [10.1039/C5LC00515A](https://doi.org/10.1039/C5LC00515A).
- [12] Mi Kyung Yu , Jinho Park , and Sangyong Jon , (2012) , Targeting strategies for multifunctional nanoparticles in cancer imaging and therapy , *Theranostics* , Volume 2 Issue 1 ,Page 3–44 , DOI : [10.7150/thno.3463](https://doi.org/10.7150/thno.3463).
- [13] R. S. Wagner and W. C. Ellis (1964) Vapor-liquid-solid mechanism of single crystal growth , *Applied Physics Letters* , Volume 4 , Issue 5 , Page 89–90 , DOI:10.1063/1.1753975.
- [14] Alfredo M. Morales and Charles M Lieber , (1998) , A laser ablation method for the synthesis of crystalline semiconductor nanowires , *Science* , Volume 279 , Issue 5348 , Page 208–211 , DOI: 10.1126/science.279.5348.208.
- [15] Bining Tian , Bethany B Smith , M. C. Scott , Qin Lei , Ruian Hua , Yue Tian and Yi Liu , (2018) , Facile bottom-up synthesis of partially oxidized black phosphorus nanosheets as metal-free photocatalyst for hydrogen evolution , *Proceedings of the National Academy of Sciences* , Volume 115 , Issue 17 , Pages : 4345–4350 , DOI:10.1073/pnas.1800069115.
- [16] Yuan Liu , Nathan O. Weiss , Xidong Duan , Hung-Chieh Cheng , Yu Huang and Xiangfeng Duan , (2016) , Van der Waals heterostructures and devices , *Nature Reviews Materials* , Volume 1 Issue 9 , Page 1–17 , DOI:10.1038/natrevmats.2016.42.
- [17] Aurélie Lecestre, Mickael Martin, Fuccio Cristiano, Thierry Baron and Guilhem Larrieu , (2022) , Large-Scale Monolithic Fabrication of III–V Vertical Nanowires on a Standard Si(100) Microelectronic Substrate , *ACS Omega* , Volume 7 , Page 5836 – 5843 , DOI:10.1021/acsomega.1c05876 .
- [18] Anupam Midya , Arup Ghorai , Subhrajit Mukherjee , Rishi Maiti and Samit K. Ray , (2016) , Hydrothermal growth of few layer 2H-MoS₂ for heterojunction photodetector and visible light induced photocatalytic applications , *Journal of Materials Chemistry A* , Volume 4 , Issue 12 , Page 4534–4543 , DOI: 10.1039/c5ta09003b.
- [19] Tyler A Growden, Weidong Zhang, Elliott R Brown, David F Storm, David J Meyer and Paul R Berger , (2018) , Near-UV electroluminescence in unipolar-doped, bipolar-tunneling GaN/AlN heterostructures , *Light: Science & Applications* volume 7, page 17150 , DOI:10.1038/lsa.2017.150.
- [20] Tomasi, Andrea;Paviet-Salomon, Bertrand;Jeangros, Quentin;Haschke, Jan;Christmann, Gabriel;Barraud, Loris;Descoeurdes, Antoine;Seif, Johannes Peter;Nicolay, Sylvain;Despeisse, Matthieu;De Wolf, Stefaan;Ballif, Christophe , (2017) , Simple processing of back-contacted silicon heterojunction solar cells using selective-area crystalline growth , *Nature Energy* , Volume 2 , Issue 5, Pages 1–8 , DOI 10.1038/nenergy.2017.62.
- [21] Junling Lu , Jeffrey W. Elam and Peter C Stair , (2016) , Atomic layer deposition— Sequential self-limiting surface reactions for advanced catalyst “bottom-up” synthesis , *Surface Science Reports* , Volume 71 Issue 2 , Page 410– 472 , DOI:10.1016/j.surfrep.2016.03.003.

- [22] Janne-Petteri Niemelä , Giovanni Marin and Maarit Karppinen , (2017) , Titanium dioxide thin films by atomic layer deposition: A review , *Semiconductor Science and Technology*, Volume 32 , Issue 9 , Article 093005 , DOI: 10.1088/1361-6641/aa78ce. Stefan Nanz, Aimi Abass, Peter M. Piechulla, Alexander Sprafke, Ralf B. Wehrspohn, and Carsten Rockstuhl , (2018) , Strategy for tailoring the size distribution of nanospheres to optimize rough backreflectors of solar cells, *Optics Express* , Volume 26, Issue 2 , Pages A111-A123 , DOI:10.1364/OE.26.00A111.
- [23] Chen-Hui Zhai , Rong-Jun Zhang , Xin Chen , Yu-Xiang Zheng , Song-You Wang , Juan Liu , Ning Dai and Liang-Yao Chen , (2016) , Effects of Al doping on the properties of ZnO thin films deposited by atomic layer deposition , *Nanoscale Research Letters* , Volume 11 , Issue 1, Pages 1–8 , DOI 10.1186/s11671-016-1625-0.
- [24] Shrividhya Thiagarajan, Anandhavelu Sanmugam and Dhanasekaran Vikraman., (2017) . Facile methodology of sol–gel synthesis for metal oxide nanostructures. in *Recent Applications in Sol–Gel Synthesis* , Intech Open, Volume 1 , page 1-17. Facile methodology of sol–gel synthesis , DOI:10.5772/intechopen.68708.
- [25] Michelle Saltarella , Emerson H. de Fariaa , Katia J. Ciuffia , Eduardo J. Nassara , Raquel Trujillano , Vicente Rives and Miguel A. Vicente , (2019) , Aminoiron (III)-porphyrin-alumina catalyst obtained by non-hydrolytic sol–gel process for heterogeneous oxidation of hydrocarbons , *Molecular Catalysis*, Volume 462, pp.114–125 , DOI:10.1016/j.mcat.2018.09.014.
- [26] Ashleigh Danks , Simon Hall and Zoe Schnepf ,(2016) , The evolution of ‘sol–gel’ chemistry as a technique for materials synthesis. *Materials Horizons*, Volume 3 Issue 2 , Page 91–112 , DOI: 10.1039/c5mh00260e.
- [27] Longfei Ye , Tari Pearson , Y. Cordeau , Olin Thompson Mefford and T. M. Crawford , (2016) , Triggered self assembly of magnetic nanoparticles , *Scientific Reports*, Volume 6, Article ID: 23145 , DOI:10.1038/srep23145.
- [28] Rose K. Cersonsky, Greg van Anders, Paul M. Dodd and Sharon C. Glotzer , (2018) , Relevance of packing to colloidal self-assembly , *Proceedings of the National Academy of Sciences*, Volume 115 Issue 7, Page 1439–1444 , DOI : 10.1073/pnas.1720139115.
- [29] Muhammad Umar Khan , Joseph McGrath , Brian Corbett and Martyn Pemble , (2017) , Airclad broadband waveguide using micro-molded polyimide combined with a robust, silica-based inverted opal substrate , *Optical Materials Express* , Volume 7 Issue 9 , Pages 3155–3161 , DOI:10.1364/OME.7.003155.
- [30] Lijing Zhang , Maximilian T. Hörantner , Wei Zhang , Qingfeng Yan and Henry J. Snaith , (2017) , Near-neutral-colored semitransparent perovskite films using a combination of colloidal self-assembly and plasma etching. *Solar Energy Materials and Solar Cells*, Volume 160, Pages 193–202 , DOI:10.1016/j.solmat.2016.10.035.
- [31] Anton Kuzyk , Ralf Jungmann , Guillermo P. Acuna and Na Liu , (2018) , DNA origami route for nanophotonics. *ACS Photonics*, Volume 5 Issue 4 , Pages 1151– 1163 , DOI: 10.1021/acsp Photonics.7b01580.

A Review On TiO₂ Nanoparticle: Structure, Properties & Applications

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Abstract

Titanium dioxide (TiO₂) nanoparticle is manufactured worldwide in large quantities for use in wide range of application in each and every sector. TiO₂ belongs to the family of transition metal oxide with large band semiconductor and high photocatalytic activity. The key features of TiO₂ nanoparticle involves high surface area that can be utilize for catalytic reactions, low toxicity, chemical and physical stability, cost effectiveness and bio compatible etc. Titanium dioxide (TiO₂) is stable compound, non-volatile, extremely insoluble and its low thermal conductivity has a refractory character. The main properties of TiO₂ nanoparticle are insoluble in water and insulator. TiO₂ considered a non-toxic material chemically inert and has been use in various industrial applications. It exists mainly in three different forms namely Anatase, Rutile and Brookite and their structures.

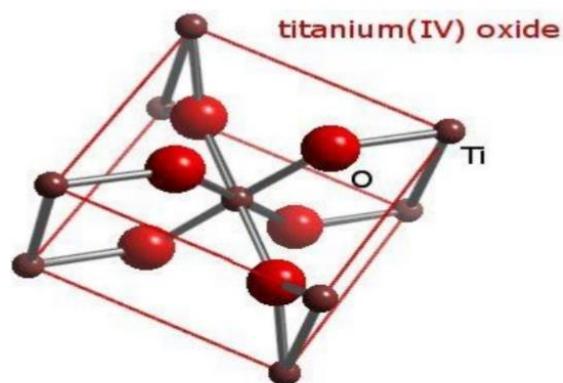
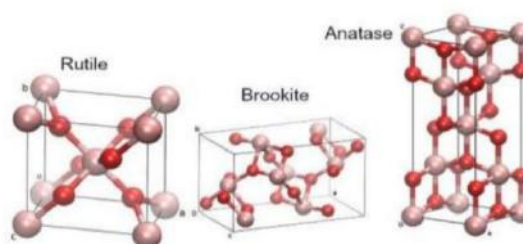
Keywords: Nanoparticle, TiO₂, Non-toxic, Photocatalytic, Properties, insulator

INTRODUCTION

Titanium dioxide (TiO₂) is considered very close to an ideal semiconductor for photocatalysis because of its high stability, low cost and safety toward both humans and the environment [1]. Traditionally, TiO₂ nanoparticle have been considered as poorly soluble, low toxicity particle [2]. TiO₂ is non-toxic, durable, and fairly cheap, it possesses a great ability to oxidatively degrade organic pollutants [3]. It has wide range of industrial and technological application as pigment, photocatalyst and UV absorption. Hence TiO₂ is an important compound suitable for fuel cells, solar cells different sensors, pollution control system, waste management and self-cleaning glass coating materials along with food, cosmetics, paint, UV protector etc. TiO₂ nanoparticle used in sunscreen, Cosmetics, candies, Toothpaste, Chewing gums as a whitening agents [4]. Non-toxicity, chemical stability, poor solubility and high refractive index are properties which add to its practical applicability. TiO₂ is the most promising photocatalyst because of its appropriate electronic band structure, photostability, chemical inertness and commercial availability [5]. Titanium dioxide (TiO₂) semiconductor nanoparticle is one kind of important and promising photocatalysts in photocatalysis because of their unique optical and electronic properties [6]. Titanium dioxide (TiO₂) is a component of many sunscreens, soaps, shampoos, toothpastes, cosmetics, paper products, plastics, ink, paint, and building materials in both its bulk form and its nanoform. TiO₂ nanoparticle occupational exposure occurs during production, bagging and waste manipulation [7]. Titanium dioxide nanoparticles are white pigments, and due to their brightness and high refractive index, they have a variety of applications [8].

1. STRUCTURE

TiO₂ exists mainly in three different forms namely anatase, rutile and brookite and their structures [9].

**Fig. 2.1 Structure of TiO₂****Fig. 2.2 a) Rutile b) Brookite c) Anatase**

Titanium dioxide exists in three phases: as rutile, anatase, and brookite. These crystal phases assemble as octahedra, where six oxygen anions are shared by three titanium (IV) cations, hence the formula $\text{TiO}_{6/3}$, which equals TiO_2 [10]. It belongs to the family of transition metal oxides. The most important titanium minerals are rutile (TiO_2), ilmenite (FeTiO_3), and titanite (CaTiSiO_5) [11]. Table 2.1: shows some of the structural and physical properties of the anatase and rutile phase of titanium dioxide [12].

Properties	Anatase	Rutile
Molecular Weight (g/mol)	79.88	79.88
Melting Point (°C)	1825	1825
Boiling Point (°C)	2500-3000	2500-3000

Table 2.1: Shows the Molecular weight, Melting point & Boiling point

2. PROPERTIES

Titanium dioxide is one of the most studied and well-researched compounds in materials science, due to its outstanding and exceptional properties which include stability of its chemical structure, biocompatibility, physical, optical, and electrical properties, nontoxicity, corrosion resistance, and low cost [13]. For instance, their high light-conversion efficiencies have been exploited for the fabrication of energy devices. Their chemical stability, thin film transparency and low production costs are responsible for their utility as photocatalysts for various environmental remediation strategies such as waste water treatment, air pollution and soil viability improvement [14].

3. APPLICATION

Semiconductors with photocatalytic properties have caught interest for providing a promising solution to deal with environmental pollution in a green way. One of the most promising solutions are provided Titanium dioxide (TiO_2) nanoparticles and its composites in contrast to other semiconductor photocatalyst TiO_2 has caught most attention due to its vital properties like low toxicity, it is biocompatible, has a wide band gap, it is cost effective has tremendous chemical and physical properties [15]. The combination of Au-NPs with a variety of materials for the modification of TiO_2 gives rise to a great number of novel catalysts [16]. The effective utilization of clean, safe, and abundant solar energy through the TiO_2 photocatalysis provides promising solutions to the energy crisis and serious environmental challenges. TiO_2 has been

widely used commercially in pigments, sunscreens, paints, toothpaste [17]. TiO₂ nanoparticle are used in sunscreen, Cosmetics, candies, Toothpaste, Chewing gums as a whitening agent in various food products [18]. TiO₂ nanoparticle are the nanostructures mostly used in commercially available sunscreens, due to their ability to reflect and spread ultraviolet A (UVA, 320–400 nm) and ultraviolet B (UVB, 290–320 nm) rays, protecting against sunburn and photoaging [19]. TiO₂ nanoparticles can be used for the photo degradation of toxic dyes and other pharmaceutical drugs, thus avoid harmful effects on environment [20]. Applications of titanium dioxide in medicine are going further than the design of drug delivery systems or applications as vehicles for chemotherapeutics. Titanium dioxide NPs have been applied in pharmacy, especially in pharmaceutical chemistry and technology, as well as medicine, including growing areas related to dentistry and surgery [21]. The transition metal oxide, mainly TiO₂, is widely used in cosmetics, photocatalysts, medicines, sensors, and solar cell applications because of its peculiar properties like interconnected pores and large surface area [22]. Titanium dioxide (TiO₂) is a component of many sunscreens, soaps, shampoos, toothpastes, cosmetics, paper products, plastics, ink, paint, and building materials in both its bulk form and its nanoform [23]. The application of TiO₂ nanoparticle in dentistry has increased due to its high corrosion resistance, strength, and refractive index. In addition, the cytotoxicity and biocompatibility of TiO₂ nanoparticle have been tested in multiple studies, which have shown its excellent biocompatibility and chemical stability [24].

4. CONCLUSION

TiO₂ nanoparticle has a great future due to its efficiency in each and every sector holistically. TiO₂ has excellent corrosion resistance, good thermal, chemical stability and low cost. TiO₂ nanoparticle with attractive properties have been widely fabricated and developed alongside one of the most valuable raw materials. Typically, TiO₂ has three crystalline phases namely anatase, rutile and brookite. TiO₂ is insoluble in water and insulator.

REFERENCE

- [1] Gupta S. M, Tripathi M. June (2011), A Review of TiO₂ nanoparticles, Chinese Sci Bull, Volume 56, Pages 1639-1657, doi: 10.1007/s11434-011-4476-1.
- [2] Hongbo Shi, Ruth Magaye, Vincent Castranova, Jinshun Zhao, April (2013), Titanium dioxide nanoparticles: a review of current toxicological data, Part Fibre Toxicol, Volume 10, doi:10.1186/1743-8977-10-15.
- [3] Shalini Reghunath, Dephan Pinheiro, Sunaja Devi KR, March (2021), A review of hierarchical nanostructures of TiO₂: Advances and applications, Surface Science advances, Volume 3, doi.org/10.1016/j.apsadv.2021.100063.
- [4] Mohammad Rafiquewani, GGHA Shadab, (2020), Titanium Dioxide nanoparticle genotoxicity : A review of recent on Vivo and in Vitro studies, Toxicology and Industrial health, Volume 36, Pages 514-530, DOI:10.1177/0748233720936835.
- [5] Shipra Gupta, Manoj Tripathi, January (2012), A review on the synthesis of TiO₂ nanoparticles by solution route, Open chemistry, Volume 10, Pages 279-294, doi.org/10.2478/s11532-011-0155-y.
- [6] Pardon Nyamukamba, Omobola Okoh, Henry Mungondori, Raymond Taziwa and Simcelile Zinya, February (2018), Synthetic Methods for Titanium Dioxide Nanoparticles: A Review, DOI: 10.5772/intechopen.75425.
- [7] ShivaMehran, SoroushGhodratizadeh, AliZolfiGol, HamedCharkhian, MojtabaRanjbari, VahedEbrahimi, Zafar Gholinejad, December (2022), Titanium Dioxide Nanoparticle and Cardiovascular Diseases: A Critical Review of the Literature and Possible Underlying Mechanisms, Nano Biomedicine and Engineering, Volume 14, Issue 4, Pages 329-342, doi.org/10.5101/nbe.v14i4.p329-342.
- [8] OladipupoMoyinoluwa David, Kim Leigh Lategan, Maria Fidalgo de Cortalezzi, Edmund John Pool, September (2022), The Stability and Anti-Angiogenic Properties of Titanium Dioxide Nanoparticles (TiO₂NPs) Using Caco-2 Cells, Biomolecules, Volume 12, Issue 10, doi:10.3390/biom12101334

-
- [9] Pardon Nyamukamba, Omobola Okoh, Henry Mungondori, ymond Taziwa and Simcelile Zinya, February (2018), Synthetic Methods for Titanium Dioxide Nanoparticles: A Review, DOI: 10.5772/intechopen.75425.
- [10] Anca Diana Racovita, Martin David Rose, May (2022), Titanium Dioxide: Structure, Impact, and Toxicity, Int J Environ Res Public Volume 19, Issue 9, doi: 10.3390/ijerph19095681
- [11] BochraBejaoui, ImenBouchmila, KhaoulaNefzi, ImenBelhadjSlimen, SidrineKoumbad, Patrick Martin, Nicolas Joly and Naceur M Hamdi, May (2023), Nanostructured Titanium Dioxide (NS-TiO₂), DOI: 10.5772/intechopen.111648
- [12] Pardon Nyamukamba, Omobola Okoh, Henry Mungondori, Raymond Taziwa and Simcelile Zinya, February (2018), Synthetic Methods for Titanium Dioxide Nanoparticles: A Review, DOI: 10.5772/intechopen.75425.
- [13] BochraBejaoui, ImenBouchmila, KhaoulaNefzi, ImenBelhadjSlimen, SidrineKoumbad, Patrick Martin, Nicolas Joly and NaceurM'Hamdi, May (2023), Nanostructured Titanium Dioxide (NS-TiO₂), DOI: 10.5772/intechopen.111648
- [14] Ozioma U. Akakuru, Zubair M. Iqbal, Aiguo Wu, (2020), TiO₂ Nanoparticle: Properties and Application, Application in Nanobiotechnology and nanomedicine
- [15] Rijuan Mutsak Ahmed, Imran Hasan, (2023), A review on properties and applications of TiO₂ and associated nanocomposite materials, Materials Today: Proceedings, Volume 81, Pages 1073-1078, doi.org/10.1016/j.matpr.2021.04.381
- [16] Ali Ayati, Ali Ahmadpour, Fatemeh F. Bamoharram, Bahareh Tanhaei, Mika Mänttari, Mika Sillanpää, July (2014), A review on catalytic applications of Au/TiO₂ nanoparticles in the removal of water pollutant, Chemosphere, Volume 107, Pages 163-174, doi.org/10.1016/j.chemosphere.2014.01.040.
- [17] Shipra Gupta, Manoj Tripathi, January (2012), A review on the synthesis of TiO₂ nanoparticles by solution route, Open chemistry, Volume 10, Pages 279-294, doi.org/10.2478/s11532-011-0155-y.
- [18] Mohammad Rafiquewani, GGHA Shadab, July (2020), Titanium Dioxide nanoparticle genotoxicity : A review of recent on Vivo and in Vitro studies, Toxicology and Industrial health, Volume 36, Issue 7, Pages 514-530, DOI:10.1177/0748233720936835.
- [19] Priscilla Laviola Sanches, Luths Raquel de Oliveria Greaquinto, Rebecca Cruz, Desiree Cigaran, Schuck, Marcio Lorencini, Jose Mauro Granjeiro, Ana Tosa, Lopes Ribeiro, June (2020), Toxicity Evaluation of TiO₂ Nanoparticles on the 3D Skin Model: A Systematic Review, Front. Bioeng. Biotechnol, Volume 8, doi.org/10.3389/fbioe.2020.00575.
- [20] Meghmala S. Waghmode, Aparna B. Gunjal, Neelu N. Nawani, March (2019), Studies on the Titanium dioxide nanoparticles: Biosynthesis, Application and remediation, SN applied Science, Volume 1, doi:org/10.1007/s42452-019-0337-3.
- [21] Danie Ziental, Beata Czarczynska-Goslinska, Dariusz T. Mlynarczyk, Atkta Glowacka-Sobotta, Beata Stanis, Tomasz Goslinski, Lukasz Sobotta, January (2020), Titanium Dioxide Nanoparticles: Prospects and Applications in Medicine, National Library of Medicine, Volume 10, Issue 2, Pages 60-780, doi.org/10.3390/nano10020387.
- [22] M. Aravind, M. Amalanathan, M. Sony Michael Mary, March (2021), Synthesis of TiO₂ nanoparticle by chemical and green synthesis methods and their multifaceted properties, SN applied sciences, Volume 3, doi:org/10.1007/s42452-021-04281-5.
- [23] Boris Jovanovic, January (2015), Review of titanium dioxide nanoparticle phototoxicity: Developing a phototoxicity ratio to correct the endpoint values of toxicity tests, Environ Toxicol Chem. Volume 34, Issue 5, Pages 1070-1077, Volume 34, doi: 10.1002/etc.2891.
- [24] Moram A. AlGhamdi, Shaimaa M. Fouda, Noha Taymour, Sultan Akhtar, Soban Q. Khan, Mohamed S. Ali, Ahmed M. Elakel, Essam A. Nassar, Mohammed M. Gad, October (2023), Comparative Evaluation of TiO₂ Nanoparticle Addition and Postcuring Time on the Flexural Properties and Hardness of Additively Fabricated Denture Base Resins, National Library of Medicine, Volume 13, Issue 23, doi.org/10.3390/nano13233061.

A Review on Supercapacitor: Types and Applications

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Abstract

The storage of enormous energies is a significant challenge for electrical generation. Supercapacitor have gained a lot of attention due to their features like high power and long life cycle. In this review paper, all types of supercapacitor such as Electrostatic double layer capacitor, hybrid capacitor and pseudocapacitor are covered, depending on the energy storage mechanism. Supercapacitor are also called as ultra capacitor. It is an high capacity capacitor with a capacitance value much higher than other capacitor. It is used to store extremely large amount of electrical charge.

Keywords: Supercapacitor, Hybrid capacitor, Pseudocapacitor, Electrostatic double layer capacitor, Ultra capacitor

1. INTRODUCTION

Batteries, supercapacitor and fuel cells are unconventional energy devices working on the principle of electrochemical energy conversion. Supercapacitor have gained much attention on account of high specific capacitance, long life cycle, high power density being almost maintenance free, experiencing no memory effect, safe and function as a bridge for power-energy difference that exist between capacitor and fuel cells/batteries [1]. The Supercapacitor have several advantages including high power density, quick charge-discharge time, low input resistance, extended lifetime and they are environmentally friendly [2]. Batteries and Supercapacitor both rely on electrochemical processes although separate electrochemical mechanism determine their relative energy and power density [3]. In different fields such as electric transit vehicles, hybrid cars and transportable electronics devices including numerous non-conventional electrically driven devices, Supercapacitor, batteries and fuel cells are used [4]. Supercapacitor can be used in electric and hybrid vehicles to provide the high power density needed for short term acceleration in addition to energy recovery throughout braking [5]. Compared to the conventional battery or capacitor, charging time of supercapacitor is very less and can discharge like a regular battery [6]. Supercapacitors behave at the protruding power density, their inferior energy density compared to batteries makes them hard to satisfy the requirements for mobile energy-storage devices [7]. Supercapacitors are quickly gaining interest owing to their high cycle stability and power density with less environmental effect [8]. Supercapacitor offer a compromise between specific energy and power and can be partitioned into electrochemical double layer capacitors (EDLCs), pseudocapacitor and the combination hybrid-capacitor [9]. The supercapacitor is also known as the ultracapacitor or electrochemical capacitor [10]. Supercapacitors are an increasingly attractive option in the race to develop new and improved energy storage technologies due to their high-power density and long cycle life [11]. Supercapacitor store electrical charge on high-surface-area conducting materials [12]. In addition, the satisfactory electro-active sites, and chemical and high-thermal stabilities of the metal oxide materials guarantee high pseudo-capacitive performances and cyclic stability [13].

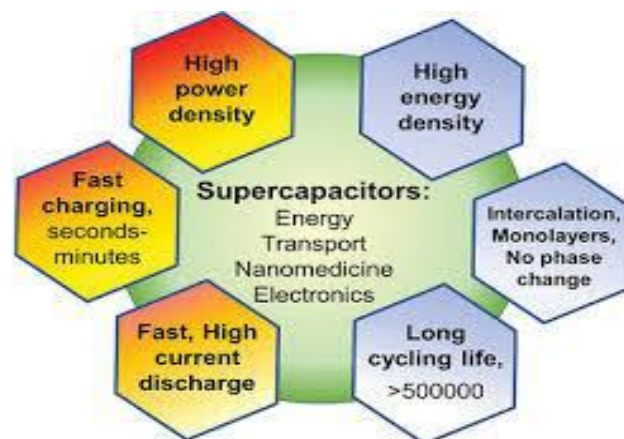


Fig 1.1: Features of Supercapacitor

2. TYPES OF CAPACITOR

- **Electrostatic double layer capacitor:** Electrostatic double layer capacitor is a rechargeable battery type and charge storage electrostatically. Electrostatic double layer capacitor can either store charge electrostatically without the transfer of charge loads with the electrochemical double layer storage principle.
- **Pseudo capacitor:** Carbon nanotubes (CNT), graphene, carbon aerogels, carbide derived carbon, foams and activated carbon are the main types of pseudo capacitor [14].
- **Hybrid capacitor:** Hybrid capacitor are developed by using the techniques of Electrostatic double layer capacitor and Pseudo capacitor. Conducting polymers and metal oxides are the main types of hybrid capacitor. In addition, the hybrid capacitor were a combination of performance properties which previously was unachievable, Also they are combining the best features related to pseudo capacitor and Electrostatic double layer capacitor into a unified supercapacitor [15].

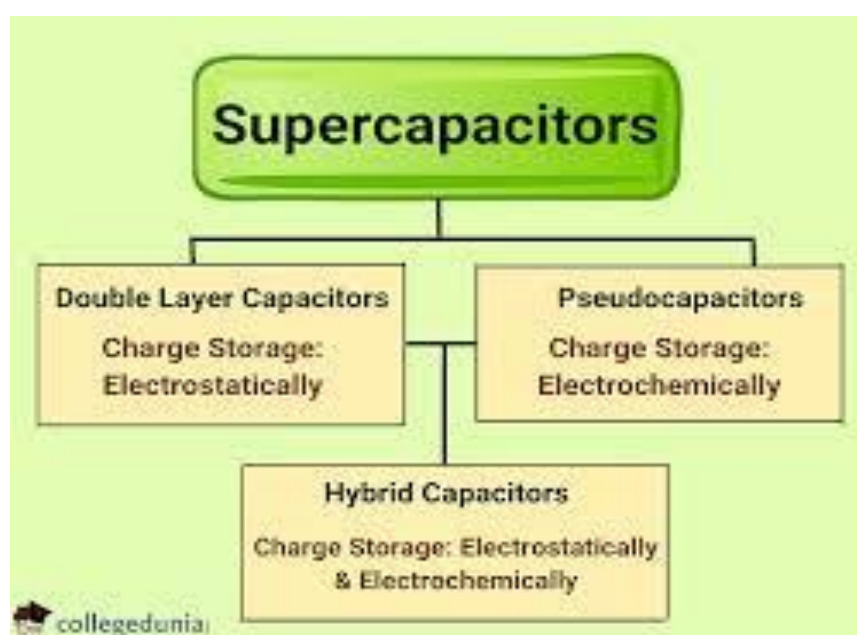


Fig 2.1: Types of Supercapacitor

3. APPLICATIONS

Supercapacitor are used in wind turbines, mobile base stations, electronic devices and different industrial practices. In addition, they have started to be used in UPS, electric vehicles and various power electronics applications. In recent years, supercapacitor have been used as an energy storage device for voltage stability in renewable and hybrid energy storage system to regulate the source and grid. Supercapacitor can stabilize the power supply in applications with fluctuating loads [16]. The use of supercapacitor has recently also been extended to wearable electronics [17]. Electrostatic double layer capacitor are particularly useful for high power bursts. For example accelerating/breaking high-speed transportation systems [18]. In general, supercapacitor used for energy storage configurations that can achieve a high power density, rapid charge and extremely long-term cyclic stability [19]. Supercapacitors are electrochemical energy storage devices possessing both great power density and energy density with long lifecycle and high charging/discharging [20]. Supercapacitor used for electrical energy storage devices to power portable gadgets such as tablets, smartphones, smartwatches, laptops, state of the art flexible medical implants, as well as wearable smart fabric has grown, the demand for supercapacitor research has been increased tremendously [21].



Fig 3.1: Application of Supercapacitor

4. CONCLUSION

The types and applications of supercapacitor presented in this paper and discuss about holistic terms of types of supercapacitors such as Electrostatic double layer capacitor, Pseudo capacitor and hybrid capacitor. Supercapacitor has short charging time, high power, long life and high cycling stability.

REFERENCE

- [1] Poonam, Kriti Sharma, Anmol Arora, S. K. Tripathi, February (2019), Review of supercapacitors: Materials and devices, Journal of Energy storage, Volume 21, Pages 801-825, doi.org/10.1016/j.est.2019.01.010.
- [2] Mustafa Ergin, Sahin, Frede Blaabjerg, Ariya Sangwongwanich, October (2021), A Comprehensive Review on Supercapacitor Applications and Developments, Energies, Volume 15, Issue 3, doi.org/10.3390/en15030674.
- [3] P. Simon, Yury Gogotsi, Bruce Dunn, March (2014), Where Do Batteries End and Supercapacitors Begin? Science Magazine, Volume 343, Pages 1210-1211, doi:10.1126/science.1249625.
- [4] Muhammad Yaseen, Muhammad Arif Khan Khattak, Muhammad Humayun, Muhammad Usman, Syed Shaheen Shah, Shaista Bibi, Bakhtiar Syed UIHasnain, Shah Masood Ahmad, Abbas Khan, Nasrullah Shah, Asif Ali Tahir, Habib Ullah, November (2021), A Review of Supercapacitors: Materials Design, Modification, and Applications, Energies, Volume 14, Issue 22, doi.org/10.3390/en14227779.
- [5] Noor I. Jalal, RaheekI I. Ibrahim, Monal K. Oudah, June (2021), A review on Supercapacitor: Types and Components, Conference series, Volume 1973, Issue 1, doi: 10.1088/1742-6596/1973/1/012015.
- [6] Gautham Prasad G, Niddheesh Shetty, Simran Thakur, Rakshitha, November(2019), Supercapacitor technology and its applications: a review, doi:10.1088/1757-899X/561/1/012105.
- [7] Jiale Sun, Huanxin Li, BingchengLuo, April(2022), A Review on the Conventional Capacitors, Supercapacitors, and Emerging Hybrid Ion Capacitors: Past, Present, and Future, Advanced Energy and Sustainability Research, Volume 3, Issue 6, doi.org/10.1002/aesr.202100191.
- [8] Arpit Mendhe, H.S. Panda, October (2023), A review on electrolytes for Supercapacitor device, Discover Materials, Volume 3, Issue 1, doi:org/10.1007/s43939-023-00065-3.
- [9] EmileS. Greenhalgh, Sang Nguyen, Maria Valkova, Natasha Shirshova, Milo S.P. Shaffer, A.R.J. Kucernak d, April (2023), A critical review of structural supercapacitors and outlook on future research challenges, Composites Science and Technology, Volume 235, doi.org/10.1016/j.compscitech.2023.109968.
- [10] Guoping Wang, Benhe Zhong, Hongqing Wang, Lei Zhang, December (2015), Supercapacitors Applications, Electrochemical Energy, Pages 479-492, doi:10.1201/b19061-27.
- [11] Niraj Kumar, Su-Bin Kim, Seul-Yi Lee, and Soo-Jin Park, October (2022), Recent Advanced Supercapacitor: A Review of Storage Mechanisms, Electrode Materials, Modification, and Perspectives, Volume 12, Issue 20, Nanomaterials, doi: 10.3390/nano12203708.

-
- [12] Priyanka Sharma, Vinod Kumar, (2018), A Brief review on Supercapacitor, Pramana research, Volume 8, Issues 3.
- [13] Cuihua An, Yan Zhang, Hyinan Guo, Yijing Wang, (2019), Metal oxide-based supercapacitors: progress and prospectives, Nanoscale Advance, Issue 12, doi.org/10.1039/C9NA00543A.
- [14] Mustafa Ergin Sahin, Frede Blaabjerg, Ariya Sangwongwanich, October (2021), A Comprehensive Review on Supercapacitor Applications and Developments, Energies, Volume 15, Issue 3, doi.org/10.3390/en15030674.
- [15] Noor I. Jalal, RaheekI I. Ibrahim, Monal K. Oudah, June (2021), A review on Supercapacitor: Types and Components, Conference series, Volume 1973, Issue 1, doi: 10.1088/1742-6596/1973/1/012015.
- [16] Mustafa Ergin Şahin, Frede Blaabjerg, Ariya Sangwongwanich, October (2021), A Comprehensive Review on Supercapacitor Applications and Developments, Energies, Volume 15, Issue 3, doi.org/10.3390/en15030674.
- [17] Tae Gwang Yun, Xichen, Jun Young Cheong, July (2023), Research in Electrochromic Supercapacitor -A focused Review, Volume 6, doi: org/10.1002/batt.202200454.
- [18] Xuli Chen, Rajib Paul, Liming Dai, May(2017), Carbon-based supercapacitors for efficient energy storage, National Science Review, Volume 4, Issue 3, Pages 453–489, doi.org/10.1093/nsr/nwx009.
- [19] Cuihua An, Yan Zhang, Huinan Guo, Yijing Wang, October 2019, Metal Oxide-based Supercapacitors: Progress and Prospective, Nanoscale Advances, Volume 1, Issue 12, doi:10.1039/C9NA00543A.
- [20] M. I. A. Abdel Maksoud, Ramy Amer Fahim, Ahmed Esmail Shalan, M. AbdElkodous, S. O. Olojede, Ahmed I. Osman, Charlie Farrell, Ala'a H. Al-Muhtaseb, A. S. Awed, A. H. Ashour & David W. Rooney ,August (2020), Advanced materials and technologies for supercapacitors used in energy conversion and storage: a review, Environmental Chemistry Letters, Volume 19, Pages 375–439, doi: org/10.1007/s10311-020-01075-w.
- [21] T. Kedara Shivasharma, Nakul Upadhyay, Tushar Balasaheb Deshmukh, Babasaheb R. Sankapal, October, (2023), Exploring Vacuum-Assisted Thin Films toward Supercapacitor Applications: Present Status and Future Prospects, **American Chemical Society, Volume 8, Pages 37685–37719**, doi.org/10.1021/acsomega.3c05285.

Synthesis and Characterization of MgO Nano-particles by Sol-Gel Method

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Abstract:

Metal oxide Nanoparticles can be used in electronics, catalysis, ceramics, petrochemical products, coatings and many other fields such as sound proof, light weight, refractory fibre board, heat insulating and metallic ceramics. Synthesis of metal oxide nanoparticle can be done through three methods like physical, chemical and green method. Present work focus on synthesis of MgO Nanoparticle by sol gel method. Magnesium Oxide nanoparticles were synthesized by Sol-Gel Method using Magnesium Nitrate ($\text{MgNO}_3 \cdot 6\text{H}_2\text{O}$), Deionized Water, Sodium Hydroxide (NaOH), Methanol. The obtained MgO nanoparticle was characterized using XRD, UV Visible Spectra and FTIR. The result shows that MgO nanoparticles were Successfully Synthesized by Sol-Gel Method. Sol-Gel Method is Simplest Method and has ability to control Particle Size.

Keywords: Sol-Gel Method, MgO, XRD, UV, FTIR

Introduction:

In recent years, nanoparticles have attracted great attention due to their unique physical and chemical properties, such as high activity, low activity, stable and dynamic state, and good thermal conductivity. Metal oxide nanomaterial with high surface area have attracted great research interest due to their applications in optical devices, electronics, and nanoelectronics. [2] The high reactivity, chemical stability, and thermal stability of MgO are important; This makes it a material with wide application possibilities in sensors, catalysis, coatings, additives and other fields. Researchers have paid more attention to the synthesis of MgO nanoparticles and nanocomposites. Due to its applications in high technology, MgO is an important inorganic oxide widely used in many fields. 1st way. There are also many physical and chemical applications to produce nanomagnesium oxide particles. [2] The size and morphology of oxide particles can be controlled by many parameters such as pH, ionic strength, precipitation temperature and different calcination temperature. Over the past few years, various precursors have been used to synthesize MgO nanoparticles, leading to various morphologies. Precursors that can be obtained through the synthetic process can have different types, such as magnesium hydroxide and magnesium carbonate. Various preparations have also been used to synthesize magnesium oxide nanoparticles, each with their own advantages and disadvantages. Spherical magnesium oxide nanoparticles were prepared by the sol-gel method using magnesium nitrate and sodium hydroxide. [3-6] The sol-gel method is an important technology to produce magnesium hydroxide and then put it at room temperature to produce MgO. After synthesis of MgO nanoparticles, their structure, morphology and optical properties were examined using XRD, FTIR, TEM and UV-visible spectroscopy. This study focuses on the synthesis of MgO nanoparticles and their production at room temperature. [7-10] Magnesium and its alloys have unique properties such as lightness and non-toxicity. Nanoparticles in hydroxide form have many applications. They are often used as flame retardants made of different materials, and also as polymers made of different materials or materials, to provide support for children to purify carbon dioxide from different salt products and neutralize acid wastes. Magnesium hydroxide is used as an additional fertilizer in papermaking. This alkaline product has another use; It can also be used to process old cellulose paper. The sol-gel process is a synthetic method that involves preparation of a sol followed by gelation and removal of the solvent. [5] Sol-gel

is an inexpensive and environmentally friendly method for the preparation of high purity oxide nanoparticles. The first step of the chemical process is always carried out at high temperature, thus reducing the chemical interaction between the equipment and the container. Additionally, the kinetics of many reactions can be easily controlled with low activity and often dilute conditions. Magnesium oxide nanoparticles have attracted special attention due to their high reactivity, high chemical and thermal stability, and catalytic properties. [5] The widespread use of magnesium oxide nanomaterial supports the study of these materials. Various production methods are used to grow magnesium oxide nanoparticles, such as pulsed laser, plasma enhanced chemical vapor deposition (PECVD), chemical vapor deposition (CVD), solid vapor (VLS) Pulsed Laser Deposition (PLD) Laser ablation. Molecular beam epitaxy (MBE) and sputtering methods are frequently used. All these processes require high temperatures or complex and expensive equipment. The chemical method, sol-gel process, has become a good choice for the synthesis and mass production of nanostructured materials, including magnesium oxide. [5] These materials are widely used in industries such as medicine, agriculture, information technology, electrical, electronics, defense and environment due to their unique properties. [4]

Experimental Method and Materials:

APPARATUS:

Digital pH meter, magnetic stirrer, beaker, funnel, stirrer, filter paper, test tube, dropper. UV-visible spectrophotometer, FTIR machine, X-ray diffractometer (XRD).[3-10]

MATERIAL :

The chemicals required for the formation of magnesium oxide nanoparticles are Magnesium nitrate ($MgNO_3 \cdot 6H_2O$), deionized water, sodium hydroxide (NaOH), methanol.[3-10]

PREPARATION OF MgO NANOPARTICLES:

Magnesium oxide nanoparticles were synthesized using magnesium nitrate ($MgNO_3 \cdot 6H_2O$) as a precursor material with sodium hydroxide. For the experimental process; 0.2M magnesium nitrate ($MgNO_3 \cdot 6H_2O$) was dissolved in 100 ml of water. 0.5M sodium hydroxide solution was added drop wise to the got ready magnesium nitrate ($MgNO_3 \cdot 6H_2O$) solution while stirring it continuously.

White precipitate of magnesium hydroxide appeared in beaker after few minutes. The stirring was continued for 30 minutes.. The precipitate was made clean and washed with methanol to remove ionic impurities and then centrifuged for 5 minutes at 5000 rpm/min and dried at room temperature. The dried white powder samples were heat and then cool in air for two hours at 300 and 500°C to obtain MgO powder.[3-10]

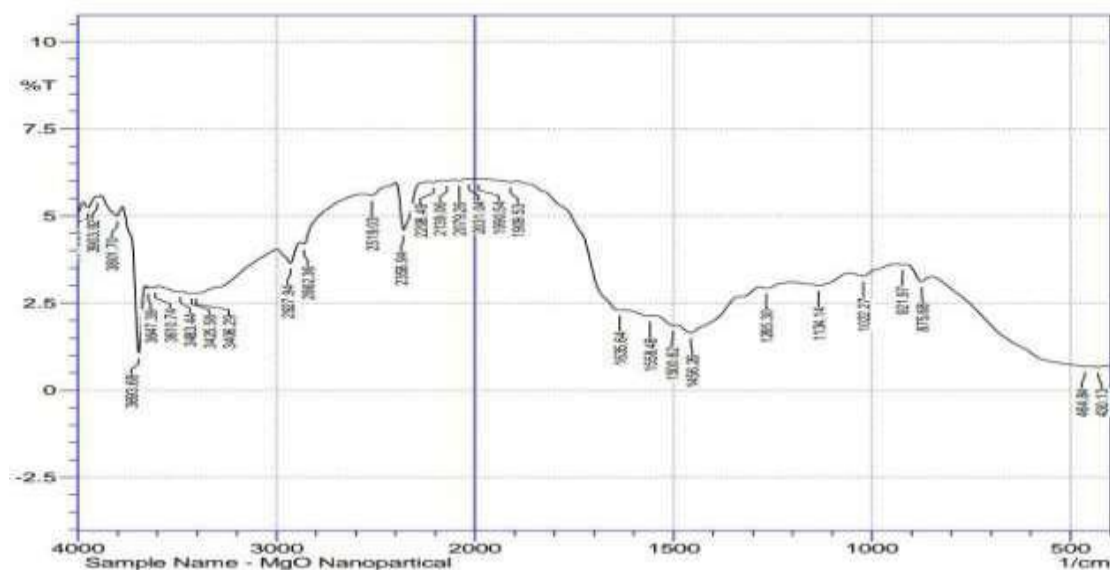


Result and Discussion:

a) FOURIER TRANSFORM INFRARED SPECTROSCOPY ANALYSIS :

The composition of the sample was analyzed by the FTIR measurement. The absorption band at 1635.64 cm^{-1} indicates the bending mode of vibration in water and the broad absorption band at 3693.68 cm^{-1} indicates the stretching mode of vibration in hydroxyl group. The peak

at 1022.27 cm^{-1} is due to the adsorption of CO_2 , whereas peaks at 875.68 cm^{-1} attributes to different Mg-O-Mg vibration modes of MgO.

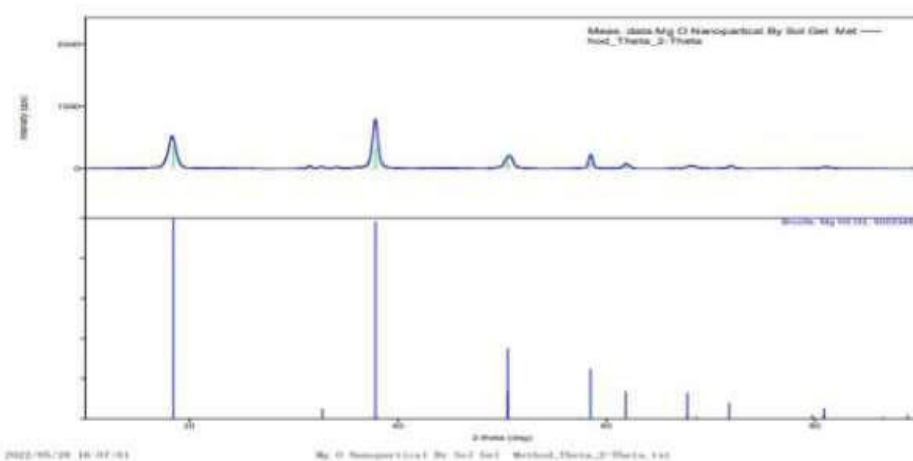


FTIR of MgO Nanoparticles

b) X-ray Diffraction Analysis :

The crystal structure of MgO nanoparticles was determined by XRD analysis .

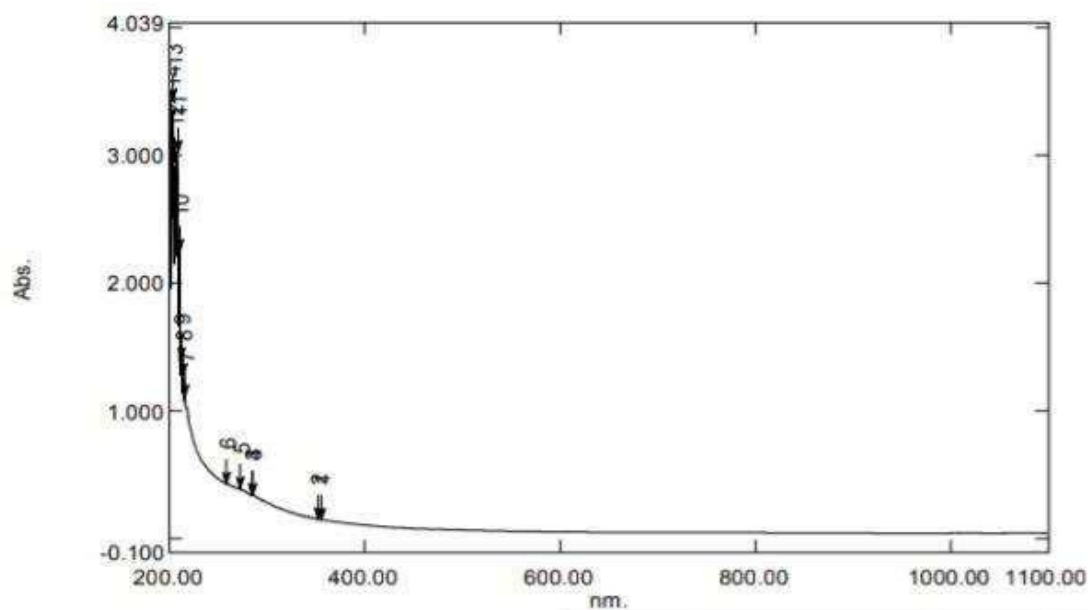
From the peak width and intensity the small particle size and better crystalline can be easily seen. The peaks in XRD pattern of the prepared MgO sample is observed at 2θ - 18.318, 37.800, 50.630, 58.493.



XRD Pattern of MgO Nanoparticles

c) UV-visible Spectral Analysis :

The optical properties of the MgO nanoparticles were studied by means of the UV-visible absorption spectra in wavelength range of 200 – 1100 nm. The maximum absorption band of MgO nanoparticles was found at 205.60 nm, as shown in fig. It has been found that firstly the absorbance decreases with an increase in wavelength.



UV Visible Spectra Analysis

Conclusion:

In the present work, MgO was successfully synthesized by sol-gel method as this method is easy, effective and fast. Magnesium oxide nanoparticles were chemically synthesized using magnesium nitrate as a starting material. Size, shape and other characteristics of nanoparticles are characterized by different analytical method. FTIR measures infrared intensity v/s wavelength of light. It determine the nature of functional groups and structural features of biological extracts with nanoparticles. It shows different peaks corresponding to different functional groups.

References:

- 1] **Rajesh Kumar¹, Ashwani Sharma, Nawal Kishore³** (2013), Preparation and Characterization of MgO Nanoparticles by Co-Precipitation Method Precipitation Method
- 2] **Harshal Dabhane, Suresh Ghotekar, Pawan Tambade, Shreyas Pansambal, Rajeshwari Oza and Vijay Medhane** (2021), MgO nanoparticles: Synthesis, characterization, and applications as a catalyst for organic transformations
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- 5] **Dr.Ziad T. Khodair, Ahmed H. Abed, Samer G. Majeed Assist.Prof.**(2016) Department of Physics, College of Science, Diala University, Iraq P.G.student, Department of Physics, College of Science, Diala University, Iraq P.G.student, Department of Physics, College of Education for pure science -Ibn Al-Haitham, Baghdad University, Iraq
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- 8] **Rizwan W, Absari S, Dar M, Kim Y and Shin H:** (2007) Synthesis of magnesium oxide nanoparticles by sol-gel process. Material Science Forum 1: 558-559.
- 9] **K. TamizhSelvi, M. Rathnakumari, M. Priya and P. Suresh Kumar,**(2014) "Shape Transition Effect of Temperature on MgO Nanostructures and its Optical Properties," International Journal of Scientific & Engineering Research, 5, pp. 60-64, 2014.

Green synthesized TiO₂ nanoparticles for antimicrobial properties: Review

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Abstract

The Green Synthesis of metal/metal oxide nanoparticles has gained huge attention in recent years due to its increasing applications in various fields and owing to its less usage of chemicals and easy experimental methods. Plant extracts are increasingly being used to make green nanoparticles since they are harmless and environmentally friendly. Green Synthesis aims to reduce the usage of toxic chemicals which are replaced by biomolecules from plants. They also possess many applications in the fields of Biomedicine and Dentistry. Studies have become interested in the size and shape of titanium dioxide (TiO₂) NPs due to their excellent durability, good electrical conductivity, nontoxicity, ability to absorb UV light and antimicrobial activity properties, all of which make them an excellent material for nanostructures. The antimicrobial properties of the TiO₂ nanoparticles were observed to be highly toxic against bacterial strains. This review signifies the Green technique for the synthesis of Titanium nanoparticles (TiO₂-NP's) using various plant extracts, fungi and bacteria and its applications. The focus is on TiO₂ NPs that are obtained by Green synthesis methods and study their antimicrobial activity against different bacteria and fungus.

Keywords: TiO₂-NP's, green synthesis, antimicrobial activity, future perspectives

Introduction

Nanotechnology has attained vast attention over time, and it involves synthesizing and developing different nonmaterial and it is an accelerating field of recent research with desirable applications in medicine and electronic and has been developing very fast in recent generation, impacting on distinct areas such as environment and economy. Nanoparticles are characterized as building blocks of nanotechnology and the size ranging from 1 to 100 nm in diameter. The foremost feature of nanoparticles is their surface area to volume aspect ratio, enabling them to combine with other particles easier. Nanotechnology has been a pioneering area of research for the last decades and NPs are regarded as an essential part of nanotechnology as they're the foremost source of various nanostructure devices and their specific complexes that are manufactured from solid units whose sizes range between 1 and 100nm. When compared to the size of their bulk materials, the particles in their unique property have a large surface area. Based on this property, the nanomaterial allows for greater reactivity and indicates specialized

properties. Consequently, these ascribed NPs are applied in biological, chemical and industrial fields [1].

The two paths of synthesis for NPs are bottom-up and top-down. Consistent with the top-down approaches, NPs are synthesized from bulk materials. Due to their size and morphology, they show enhanced and unique properties and also have wide applications. The bottom-up approach combines atoms to create bulk materials and shows constant physical properties; these properties limit their applications. Different synthetic methods result in the evolution of new materials, which play an important role in NPs. Chemical and physical processes are used

to manufacture metal and metal oxide NPs. Green Synthesis, Solid-state, microwave, hydrothermal, sol-gel, solution route method, solvothermal crystallization, chemical phase decomposition vapor and ultrasonic irradiation are some of the processes. These methods develop heterogeneous NPs with high energy exhaustion. The chemical process involves synthetic stabilizing, capping and reducing agents, which are not eco-friendly and also need high temperatures, pressures and toxic chemicals. . As a result, in recent years, more sustainable methods for developing an eco-friendly process for synthesizing nontoxic nanomaterials, regarded as a safe, cost-effective and biocompatible process, have been introduced. The green synthesis method and the chemical synthesis method are indistinguishable. In the chemical method, reducing agents were high-cost chemical reducing reagents that were replaced in the green method by plant extract and microorganisms. Toxicity is reduced as well, which benefits biomedical applications such as drug delivery, nanocatalysts and nanomedicine biosensors and so on. This method is now used in metal oxides such as TiO_2 , zirconium dioxide (ZrO), lanthanum chromite (LaCrO), nickel oxide (NiO), dimanganese trioxide (Mn O), zinc oxide (ZnO), copper (II) oxide (CuO) and others. Because of their high stability, optical properties and non-toxicity, TiO_2 NPs have been widely used as an eco-friendly and enhanced photocatalyst. Employing a "green" approach, the authors were able to produce TiO_2 NPs rapidly, reliably, and in low concentrations to significantly reduce malaria vector populations [2, 3].

Synthesis of TiO_2 Nanoparticles using different methods:

The two primary methodologies for the synthesis of nanomaterials is top-down and bottom-up approaches

- Top-down: size reduction from bulk materials
- Bottom-up: material synthesis from the atomic level

Top-down:

Bulk material is turned into a nano product using a top-down technique. For size reduction, both physical and chemical approaches were applied. Sputtering, pulse wire discharge, physical milling/ball milling, etching, evaporation–condensation reaction, pulse laser ablation, and lithography are some of the processes employed in the top-down approach. However, there are

certain disadvantages to the top-down approach, the most significant of which is that defects are imposed on the product's surface. This could affect the product's surface properties and other physical characteristics

Bottom-up:

The materials were built up from the bottom in the bottom-up approach: atom by atom, molecule by molecule, and cluster by cluster. Most nanostructures with the potential to make a homogeneity, size, and morphology are synthesized using this process. Chemical synthesis is offering a broad range of techniques like chemical vapor deposition, solvothermal, polymer condensation, sol-gel method, aerosol methodology, electrochemistry, pyrolysis, thermal decomposition, frameworks, plasma, and spinning also available Green synthesis, in particular, controlling the process in the bottom-up synthesis to decrease particle development. As a result, scientists can state that the bottom-up technique is crucial in the creation of nanostructures and nanomaterials. Almost all of these nanomaterial synthesis methods are employed, however, if we consider that, the bottom-up approach is the most efficient as it is beneficial and achieves perfection at the atomic scale. The bottom-up technique is also used since the green synthesis routes have been thought-out to be a practical strategy due to the employment of non-toxic,

cost-effective, and ecologically friendly matter. Natural various plant extracts are employed in green synthesis. In green chemistry, the plant extract serves as a capping and reducing agent, and it is blended with a simple precursor salt. The plant extract's phytochemicals can then reduce and stabilize the nanomaterials. With the new revolution, a lot of work has been done in green synthesis to synthesize a variety of metal NPs such as Cu, Pt, Pb, Ag, Au, Zn, and so on. Phyto-synthesis of TiO₂ NPs utilizing various plant extracts is discussed in this review. In this regard, recent research has been compiled from the literature to summarize research efforts [4].

Diagrammatic representation of Nanomaterial synthesis methods.

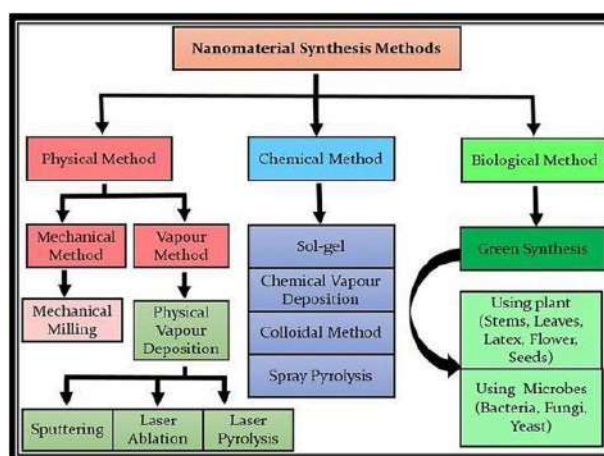


Figure 1

Green Synthesis:

Green synthesis of TiO₂ nanoparticles using jasmine flower extract:

Green synthesis is considered to play a key role in the current engineering and science field. As a result of their distinctive properties of biosynthesized nanomaterials, which are used for the treatment of water and contaminated sites. Nanoparticles are of keen interest due to their special attributes, such as their exceedingly small size, high surface area to volume ratio, surface modifiability, and size-dependent properties. These nanoparticles also showed their applications in the medical field and pharmacy. Nowadays, vast research is being conducted on the biological system. The biological synthesis of nanomaterials used bacteria, fungi, yeast, and plants. Due to their cost-effectiveness, these synthesis approaches have been the subject of widespread interest. The biologically synthesized nanoparticles have a wide range of applications in the field of contaminant remediation, as well as antibacterial, antifungal, high catalytic, and photochemical activity. Today's focus was on green synthesis, and with the help of plants, the NPs were very stable and in the proper form and size. Another benefit of green synthesis is that the chance of contamination is quite minimal. The plants contain many phytochemicals, which help in the production of nanomaterials and NPs. Plants provide a variety of phytochemicals that are commonly utilized and inexpensive in the synthesis of nanomaterials and nanoparticles. The phytochemicals also play an important role as they help at the time of photocatalytic activity applications. They help in the oxidation and reduction reactions at the photocatalytic activity time of the organic dyes [5].

TiO₂ NPs were synthesized using the facile green synthesis route from Jasmine flower extract acts as a reducing/capping agent. The jasmine flowers were purchased from the local market of Nagercoil, Tamilnadu. The jasmine flower extract was prepared by adding 50 g of jasmine

flower in 100 ml distilled water and boiled the mixture with a hotplate for 30 min. Then the aqueous solution has been filtered and stored for further tests. Take 50 ml of titanium tetra isopropoxide (TTIP) in a 100 ml beaker and add 20 ml of flower extract drop by drop to the above TTIP solution. The solution was stirred by 3 h at room temperature. The colour of the solution was changed from pure white to yellowish-grey. A change of colour confirms the formation of titanium dioxide nanoparticles. After that, the solution was Filter and dried at 110 °C for 5 h. Then the dried samples were calcined Muffle furnace at 500 °C for 2 h [6].
Diagrammatic representation of Green Synthesis of TiO₂ Nanoparticles

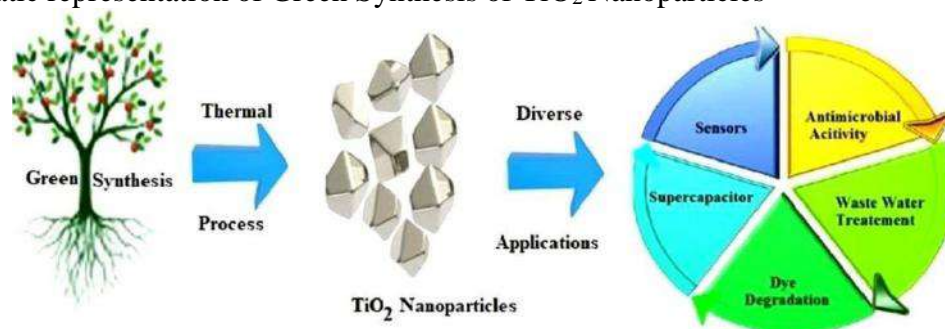


Figure 2

Characterization of TiO₂ nanoparticles (XRD):

X-ray diffraction (XRD) analysis of nanoparticles synthesized using plant extract is a rather new implementation of the technique to analysis the characteristic of synthesized nanoparticles. The XRD analysis is done to analyse the structure and crystalline size of synthesized nanoparticles. [7]. in their work characterized the synthesized silver (nano) using XRD. They concluded that the obtained data for 2θ positions identifies the sample as silver crystalline particles having hkl values corresponding to FCC silver. They estimated the crystalline size to be 20 nm, thus confirming the nano scale size of the synthesized particles. Various other workers such as Bykkam, Anandalakshmi, Ashraf & Abiola et al. have reported successful characterization of metallic nanoparticles synthesized using plant extracts. The result obtained from XRD analysis cannot be directly utilized in the study. It needs use of additional software packages such as PowderX, MATCH! Etc.

Presently the XRD is commonly used extensive technique for characterization of nanoparticles. XRD provides information regarding the crystalline structure, nature of the phase, lattice parameters and crystalline grain size. The latter parameter is estimated by using Scherrer equation using the broadening of the most intense peak of an XRD measurement for a specific sample. The nanoparticles are commonly analyzed in powder form after drying. The composition of the particles can be determined by comparing the position and intensity of the peaks with the reference patterns available from the international center for diffraction data (ICDD) [8].

Refer table 1 for particle size obtained from different plan extract.

Table 1

Sr. No.	Plant Extract	Shape	Size(nm)	Ref
1.	Ageratina altissima	Spherical	20–25	[9]
2.	Azadirachta indica leaves aqueous extract	Spherical	124	[10]
3.	Curcuma longa	Spherical	50–110	[11]
4.	Nyctanthes leaves Extract	Spherical	100–150	[12]
5.	Leaf aqueous extract of	Spherical shape and	32	[13]

	Psidium guajava	clusters		
6.	Aloe vera	Irregular	60	[14]
7.	Flower aqueous extract of Hibiscus rosasensensis	Monodispersed and spherical	7	[15]

Antimicrobial activity:

Harmful bacteria, such as *Staphylococcus aureus*, *Burkholderia cepacia*, *Pseudomonas aeruginosa*, *Clostridium difficile*, *Klebsiella pneumoniae*, *Escherichia coli*, *Acinetobacter baumannii*, *Mycobacterium tuberculosis*, and *Neisseria gonorrhoeae*, are responsible for bacterial infections that can cause serious diseases in humans year after year [16]. The principal solution is the use of antibiotics, antimicrobial and antifungal agents. Nevertheless, in recent years there has been an increase in the resistance of several bacterial strains to these substances, and therefore there is currently a great interest in the search for new antimicrobial substances. The antimicrobial nanoparticles have been studied due to their high activity, specifically the metal oxide nanoparticles [17, 18, and 19]. In this sense, titanium dioxide nanoparticles are one of the antimicrobial NPs whose study has gained interest during last year [20].

An antimicrobial is an agent that kills microorganisms (microbicide) or stops their growth (bacteriostatic agent). Antimicrobial medicines can be grouped according to the microorganisms they act primarily against. For example, antibiotics are used against bacteria, and antifungals are used against fungi. They can also be classified according to their function. The use of antimicrobial medicines to treat infection is known as antimicrobial chemotherapy, while the use of antimicrobial medicines to prevent infection is known as antimicrobial prophylaxis.

The antibacterial activity of titanium dioxide nanoparticles was tested by the agar diffusion method. First, the nutrient agar was uniformly spread in the Petri dish plate. Then fix the 6 mm diameter well, which is used to study the inhibition zone. Place 50 µl of TiO₂ NPs in 6 mm diameter well. The culture medium was incubated at 37 °C for 24 h under aerobic conditions. The zone of inhibition layer was measured using the millimeter region. The Zone of inhibition results in the antibacterial activity of TiO₂ NPs.

The antibacterial action of the synthesized TiO₂ nanoparticles were evaluated against the bacterial pathogens of *Bacillus subtilis* (*B. subtilis*) (ATCC 6051), *Escherichia coli* (*E. coli*) (MTCC-1677), *Enterococcus faecalis* (*E. faecalis*) (ATCC 2912), *Klebsiella pneumoniae* (*K. pneumoniae*) (NCTC 9633), *Staphylococcus aureus* (*S. aureus*) (MTCC-3160) and *Pseudomonas aeruginosa* (*P. aeruginosa*) (MTCC-4030) strains. Disc diffusion technique was adopted to monitor the antibacterial activity of synthesized titanium dioxide nanoparticles. Exponential bacterial cultures were seeded into Muller Hinton agar and impregnated with sterile discs. The discs were loaded with titanium dioxide nanoparticles with various concentrations (20, 30 and 40 µg/ml) and empty sterile disc was used as a control. The impregnated discs were kept on the surface of the agar and incubation of the plates was done overnight at room temperature. The experiment was performed in triplicates and the formation of the clear zone of inhibition was computed [21].

Future Scope:

Nanoscale materials serve as the building blocks for biomarkers and sensors that are more sensitive than ever before, allowing for the simultaneous and accurate diagnosis of more diseases in the early stages.

With improved targeting and chemical sensitivity, nanomedicine provides more accurate mapping of disease. Nanomedicine can be used more effectively to attack cells after a

diagnosis, reducing side effects and harm to healthy cells.

- Better preventive procedure
- Disease detection, Drug delivery & Diagnostics
- Detection of body oxygen using Nano sensors
- Economical healthcare
- Helpful for cardiovascular disease
- Fight against cancer
- Improve the efficiency of medicine
- Management of illness
- Nanobots
- Radiation therapy
- Tissue engineering and cell treatment

Conclusion:

Synthetic methods involving fungus, bacteria, and other organisms are complex due to strain separation and difficulties in growth. These processes are also difficult owing to the need to maintain the culture media, as well as the physical and chemical conditions. Plants are selected primarily since they are simple to extract and plentiful. This approach might be used to regulate the size, shape, and crystalline structure by adjusting the experimental parameters. Despite this, only a few plants are exploited in the phyto-synthesis of TiO₂ NPs, and additional study is urgently required in this field. These phyto-synthesized nanoparticles may be used safely not just in biomedical activities, but also in all other potential applications as they are similarly compatible with chemically produced nanoparticles. As previously stated, the crucial aspects of NP are determined by their size and shape. As a result, future difficulties will include figuring out how to leverage similar biological techniques to make various forms including triangular, cuboidal, truncated, ellipsoidal, pyramidal, decahedral, and oval. Scaling up NP production from the lab to the commercial-scale is a tough process with many challenges and unknowns. There

are two more obstacles to overcome. All across the production process, cost, dependability, waste, energy consumption, recycling possibilities, material safety, and hazard level should all be addressed. Furthermore, the properties of nanomaterials may change as they scale up. The amount of control may be diminished when dealing with large volumes.

References:

- [1] Devipriya Anbumani, Kayal vizhi Dhandapani, Janani Manoharan, Ranganathan Babujanathanam, A.K.H. Bashir, Karnan Muthusamy, Ahmed Alfarhan and K. Kanimozhi, April (2022), Green synthesis and antimicrobial efficacy of titanium dioxide nanoparticles using *Luffa acutangula* leaf extract *Journal of King Saud University – Science*, Volume 34, Issue 3, 101896
- [2] Natalia Vaou, Elisavet Stavropoulou, Chrysa Voidarou, Christina Tsigalou, and Eugenia Bezirtzoglou September (2021), Towards Advances in Medicinal Plant Antimicrobial Activity: A Review Study on Challenges and Future Perspectives, *Microorganisms*, Volume 2041, 34683362
- [3] Shiva Samhitha S., Raghavendra G., Camila Quezada, Hima Bindu P., November (2021), Green synthesized TiO₂ nanoparticles for anticancer applications: Mini review, *VIT-AP University, India*, Volume 54
- [4] Prammitha Rajaram, Ambrose Rejo Jeice and Kumarasamy Jayakumar, July (2023), Review of green synthesized TiO₂ nanoparticles for diverse applications, *Surfaces and Interfaces*, Volume 39, 102912
- [5] M. Aravind, M. Amalanathan M. Sony Michael Mary, March (2021), Synthesis of TiO₂

- nanoparticles by chemical and green synthesis methods and their multifaceted properties, Volume 3, article number 409,(2021)
- [6] Vishal Verma, Mawaheb Al-Dossari, Jagpreet Singh, Mohit Rawat, Mohamed G. M. Kordy, and Mohamed Shaban, April (2022), A Review on Green Synthesis of TiO₂ NPs: Photocatalysis and Antimicrobial Applications, *Polymers (Basel)*, 35406317
- [7] Manoj Kumar, Rakesh Ranjan, Sukumar Dandapat, Rohit Srivastava and Manoranjan Prasad Sinha, July (2022), XRD Analysis for Characterization of Green Nanoparticles: A Mini Review, *Ranchi University, Ranchi, Jharkhand*, Volume 10, 555779
- [8] Devipriya Anbumani, Kayal vizhi Dhandapani, Janani Manoharan, Ranganathan Babujanathanam, A.K.H. Bashir, Karnan Muthusamy, Ahmed Alfarhan and K. Kanimozhi, April (2022), Green synthesis and antimicrobial efficacy of titanium dioxide nanoparticles using *Luffa acutangula* leaf extract *Journal of King Saud University – Science*, Volume 34, Issue 3, 101896
- [9] Madadi Z., Bagheri Lotfabad T., April (2016), Aqueous Extract of *Acanthophyllum Laxiusculum* Roots as a Renewable Resource for Green Synthesis of Nano-sized Titanium Dioxide Using the Sol-gel method. *Adv. Ceram.* Volume 222631
- [10] Sankar R., Rizwana K., Shivashangari K.S., Ravikumar V, May (2014), Ultra-rapid photocatalytic activity of *Azadirachta indica* engineered colloidal titanium dioxide nanoparticles, *Appl. Nanosci.*, Volume, 132041403693.
- [11] Jalill R.D.A., Nuaman R.S and Abd A. N., July (2016), Biological synthesis of Titanium Dioxide nanoparticles by *Curcuma longa* plant extract and study its biological properties, *WSN*, 49204222.
- [12] Sundarajan M., Gowri S., August (2011), Green synthesis of titanium dioxide nanoparticles by *nyctanthes arbor-tristis* leaves extract, *Chalcogenide Lett.*, 447451.
- [13] Santhoshkumar T., Rahuman A.A., Jayaseelan C., Rajakumar G., Marimuthu S., Kirthi A.V., Velayutham K., Thomas J., Venkatesan J., Kim S.-K., July (2014), Green synthesis of titanium dioxide nanoparticles using *Psidium guajava* extract and its antibacterial and antioxidant properties, *Asian Pac. J. Trop. Med.*, 7968976
- [14] Technology C., February (2016), Green Synthesis of TiO₂ Nanoparticles Using Aloe Vera Extract, *Int. J. Adv. Res.*, 22834
- [15] Kumar P.S.M., Francis A.P., Devasena T, March (2014), Biosynthesized and Chemically Synthesized Titania Nanoparticles Comparative Analysis of Antibacterial Activity. *J. Environ, Nanotechnol*, 37381.
- [16] Jha AK, Prasad K., (2010), Biosynthesis of metal and oxide nanoparticles using lactobacilli from yoghurt and probiotic spore tablets. *Biotechnology Journal.*;5:285-291. DOI: 10.1002/biot.200900221
- [17] Raja S, Ramesh V, Thivaharan V., (2017), Green biosynthesis of silver nanoparticles using *Calliandra haematocephala* leaf extract, their antibacterial activity and hydrogen peroxide sensing capability. *Arabian Journal of Chemistry*; 10:253-261. DOI: 10.1016/j.arabjc.2015.06.023
- [18] Müller JC, Botelho GGK, Bufalo AC, Boareto AC, Rattmann YD and Martins ES, . (2009) *Morinda citrifolia* Linn (noni): In vivo and in vitro reproductive toxicology. *Journal of Ethnopharmacology*; 121:229-233. DOI: 10.1016/j.jep.2008.10.019
- [19] Pai AR, Kavitha S, Shweta Raj S, Priyanka P, Vrinda A and Vivin TS, (2015), Green synthesis and characterizations of silver nanoparticles using fresh leaf extract of *Morinda citrifolia* and its anti-microbial activity studies. *International Journal of Pharmacy and Pharmaceutical Sciences*. 7:459-461
- [20] Carol López de Dicastillo and Matias Guerrero Correa, January (2020), Antimicrobial Effect of Titanium Dioxide Nanoparticles, Chapter Metrics Overview, 105772
- [21] Devipriya Anbumani, Kayal vizhi Dhandapani, Janani Manoharan, Ranganathan Babujanathanam, A.K.H. Bashir, Karnan Muthusamy, Ahmed Alfarhan and K. Kanimozhi, April (2022), Green synthesis and antimicrobial efficacy of titanium dioxide nanoparticles using *Luffa acutangula* leaf extract *Journal of King Saud University – Science*, Volume 34, Issue 3, 101896

TiO₂ nanoparticles synthesized by sol-gel and green synthesis method for antimicrobial properties: Mini Review

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Abstract

With many uses in science, engineering, medicine, and other domains, nanotechnology is a rapidly developing field. The preparation of nanoparticles (NPs) often involves a range of physical and chemical techniques. More recently, simpler, more affordable, and more environmentally friendly green synthesis technologies have been created. In the preceding quarter, there was a lot of interest in the green/sustainable production of titanium dioxide nanoparticles, or TiO₂ NPs. Bioactive substances found in bacteria and plants aid in the processes of capping and bio-reduction. This review covers the various synthesis techniques and mechanistic viewpoints, along with the biogenic synthesis of TiO₂ NPs. The present review deals with the synthesis of titanium dioxide (TiO₂) nanoparticles using sol-gel synthesis method and green synthesis method. How the samples of TiO₂ are characterized using x-ray diffraction technique to study the particle size is demonstrated in this review. The antimicrobial potential of synthesized nanoparticles is explored. Titanium dioxide (TiO₂) is nontoxic metal oxide, by which it has wide applications in medical field such as targeted drug delivery, cancer treatment, etc.

Introduction

The creation of green nanoparticles has attracted a lot of attention in nanotechnology studies. This innovative approach aims to regulate, control, clean up, and remediate these substantial particles to make them more environmentally friendly. By reducing the harmful byproducts produced during the production of conventional nanoparticles, less dangerous and unsustainable commodities will be produced. For antibacterial activity, TiO₂ nanoparticles (NPs) were produced utilising the leaf extracts of *Artemisia vulgaris* and aerial portions of *Callistemon citrinus* [1]. TiO₂ nanoparticles were more useful in the study of chemistry and nanomedicine because of their distinctive chemical characteristics and antibacterial activities. TiO₂ NPs are utilised in cosmetic products, and lotions and ointments containing these nanoparticles are applied to the skin to delay skin ageing and avoid sunburns [2]. The scope of this work was to scrutinize the antimicrobial activity of synthesized TiO₂ NPs using leaf extract of *L. acutangula* against pathogens. The current work aims to utilize the biological route for the synthesis of TiO₂ NPs and characterized using various spectroscopic and microscopic methods for the analysis of structure, morphology, and optical properties [3].

Synthesis of TiO₂ NPs by Different Methods

1. Physical Method

2. Chemical Method

3. Biological Method

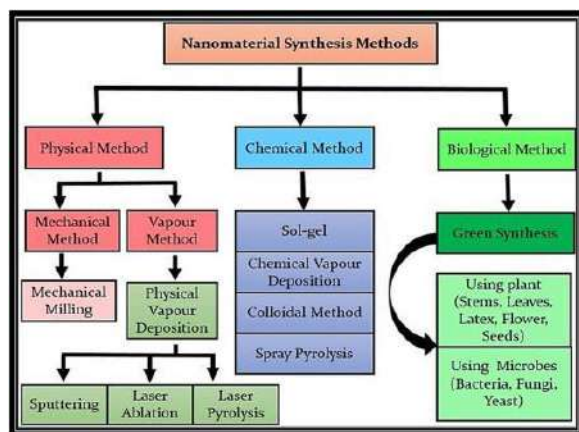
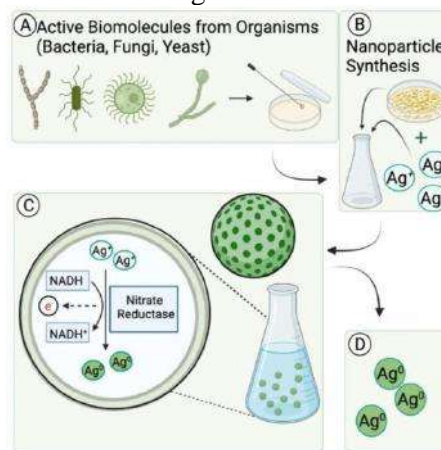


Figure 10: Methods for Synthesis Figure

Synthesis



11: Role of active molecules in Green

What is Green Synthesis?

Green synthesis employs a clean, safe, cost effective and environmentally friendly process of constructing nanomaterials. Microorganisms such as bacteria, yeast, fungi, algal species and certain plants act as substrates for the green synthesis of nanomaterials [figure 2]. Different active molecules and precursors, such as metal salt, determine the final morphology and size of the nanoparticle. Additionally, green synthesis provides nanomaterial benefits ranging from antimicrobial properties to natural reducing properties and stabilizing properties [4].

Preparation of TiO₂ nanoparticles by Green Synthesis Method

Aqueous extract of *E. purpurea* was prepared using 10 g herba boiled with 50 mL of double distilled water at 90 °C for 20 min. This extract was filtered through a medium filter. 1 mM TiO₂ (aq) solution was stirred for 2 h in 25 °C to prepare nanoparticles of TiO₂. 10 mL of the aqueous extract of *E. purpurea* were added to 20 mL of 1 mM TiO₂ at 25 °C, under stirring condition for 4 h. After 4 h, the color of the extract with TiO₂ nanoparticles changed to green. Figure 3 shows the schematic illustration of the green synthesis of TiO₂ nanoparticles using aqueous extract of the *E. purpurea* herba [5]

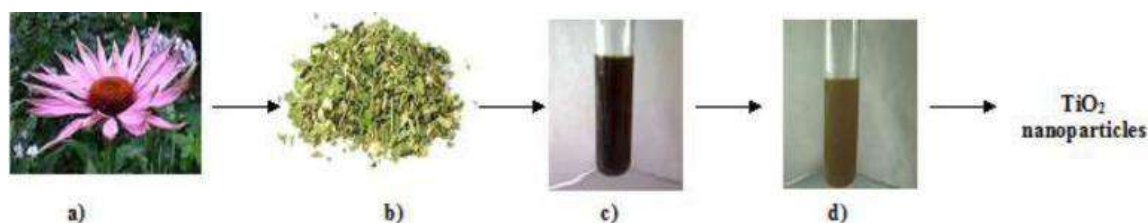


Figure 12

What is Sol-gel method?

In this chemical procedure, a "sol" (a colloidal solution) is formed that then gradually evolves towards the formation of a gel-like diphasic system containing both a liquid phase and solid phase. Removal of the remaining liquid (solvent) phase requires a drying process, which is typically accompanied by a significant amount of shrinkage and densification.

Preparation of TiO₂ nanoparticles by Sol-gel Method

For the sol-gel process, 150 ml ethanol was mixed with 10 ml deionized water under constant stirring. Further, 9 ml TTIP was mixed in the above solution under constant stirring while maintaining the temperature at 85 °C using paraffin oil bath upto 4 h. After forming the gel, it was dried in the hot-air oven at temperature 60 °C. The calcination was performed for 3 h at 400 °C and the prepared sample was named as 'SG'. With the same above chemical compositions, another solution was prepared for the solvothermal process which was transferred into Teflon lined autoclave followed by the hydrolysis process. The autoclave was placed in the hot-air oven for 2 h at temperature 200 °C. Later, the sample was collected from the autoclave and washed with ethanol. Finally, after drying at 80 °C for 1 h the collected particles were grinded and named as sample 'ST' [6].

Characterization of TiO₂ Nanoparticles

X-ray diffraction

X-ray diffraction (XRD) analysis of nanoparticles synthesized using plant extract is a rather new implementation of the technique to analysis the characteristic of synthesized nanoparticles [7-9]. The XRD analysis is done to analyse the structure and crystalline size of synthesized nanoparticles. The crystallinity and size of crystallites of the synthesized material was often characterized with the help of XRD pattern. The structural information was obtained for the comparison of diffraction pattern of X-rays with the pattern of standardized plane angles of the substance. For the confirmation of crystallinity, the obtained results are matched with the Joint Committee on Powder Diffraction Standards [10].

Antimicrobial Properties of TiO₂ Nanoparticles

Increasing numbers of NP variants and NP-based materials have been used as a new line of defense against microbial resistance and MDR. Different types of NPs have different mechanisms for combating microbial resistance. Various antibacterial mechanisms of NPs according to the metabolic process involved are presented in the “Antibacterial mechanisms of NPs” section [11, 12]. The antibacterial action of the synthesized TiO₂ nanoparticles were evaluated against the bacterial pathogens of *Bacillus subtilis* (*B. subtilis*) (ATCC 6051), *Escherichia coli* (*E. coli*) (MTCC-1677), *Enterococcus faecalis* (*E. faecalis*) (ATCC 2912), *Klebsiella pneumonia* (*K. pneumonia*) (NCTC 9633), *Staphylococcus aureus* (*S. aureus*) (MTCC-3160) and *Pseudomonas aeruginosa* (*P. aeruginosa*) (MTCC-4030) strains. Disc diffusion technique was adopted to monitor the antibacterial activity of synthesized titanium dioxide nanoparticles. Exponential bacterial cultures were seeded into Muller Hinton agar and impregnated with sterile discs. The discs were loaded with titanium dioxide nanoparticles with various concentrations (20, 30 and 40 µg/ml) and empty sterile disc was used as a control. The impregnated discs were kept on the surface of the agar and incubation of the plates was done overnight at room temperature. The experiment was performed in triplicates and the formation of the clear zone of inhibition was computed [13].

References

- [1] Tahir Rasheed, Muhammad Bilal, Hafiz M.N. Iqbal and Chuanlong Li, October (2017), Green biosynthesis of silver nanoparticles using leaves extract of *Artemisia vulgaris* and their potential biomedical applications *Colloids and Surfaces B: Biointerfaces*, Volume 158, 1, Pages 408-415
- [2] L Zhang, L Dai, X Li, W Yu, S Li and J Guan, (2022) 3D structured TiO₂ based aerogel photo catalyst for the high-efficiency degradation of toluene gas *New Journal of Chemistry*.
- [3] J. Rajkumari, C. Maria Magdalane, B. Siddhardha, J. Madhavan, G. Ramalingam, N.A. Al-Dhabi, M.V. Arasu, A.K.M. Ghilan, V. Duraipandiayan and K. Kaviyarasu, December (2019) Synthesis of titanium oxide nanoparticles using *Aloe barbadensis* mill and evaluation of its antibiofilm potential against *Pseudomonas aeruginosa* PAO1 *Journal of Photochemistry and Photobiology B: Biology* Volume 201, 111667
- [4] Sivaraj A., Kumar V., Sunder R., Parthasarathy K. and Kasivelu G., (2020), Commercial Yeast Extracts Mediated Green Synthesis of Silver Chloride Nanoparticles and their Anti-mycobacterial Activity. *J. Clust. Sci.*, 31:287–291. Doi: 10.1007/s10876-019-01626-4.
- [5] Renata Dobrucka, (2017), Synthesis of Titanium Dioxide Nanoparticles using *Echinacea purpurea* Herba, Poznan University of Economics, Poland, *Iran J Pharm Res.* Spring; 16(2): 756–762.
- [6] R.S. Dubey, Katta Venkata Krishnamurthy and Shyam Singh, September (2019), Experimental studies of TiO₂ nanoparticles synthesized by sol-gel and solvothermal routes for DSSCs application Volume 14, 102390
- [7] Dandapat S, Kumar M, Ranjan R and Sinha MP, (2022), *Ganoderma applanatum* extract mediated synthesis of silver nanoparticles. *Brazilian Journal of Pharmaceutical Sciences* 58: e19173
- [8] Kero Jemal, B. V. Sandeep and Sudhakar Pola, Mar (2017), Synthesis, Characterization, and Evaluation of the Antibacterial Activity of *Allophylus serratus* Leaf and Leaf Derived Callus Extracts Mediated Silver Nanoparticles, *Journal of Nanomaterials*, Volume 2017
- [9] Mehta BK, Chhajlani M, Shrivastava BD, (2017), Green Synthesis of silver nanoparticles and their characterization by XRD, *Journal of Physics*, 836(1):012050
- [10] J.M. Abisharani, S. Devikala, R.D. Kumar, M. Arthanareeswari and P. Kamaraj, (2019), Green synthesis of TiO₂ nanoparticles using *Cucurbita pepo* seeds extract, *Materialstoday*, Volume 14, Part 2, 2019, Pages 302-307
- [11] Singh R, Smitha MS, Singh SP., (2014), the role of nanotechnology in combating multi-drug resistant bacteria. *J Nanosci Nanotechnol.* ; Volume 14(7), Page No.4745–4756.
- [12] Emerson Danguy Cavassin, Luiz Francisco Poli de Figueiredo, José Pinhata Otoch, Marcelo Martins Seckler, Roberto Angelo de Oliveira, Fabiane Fantinelli Franco, Valeria Spolon Marangoni, Valtencir Zucolotto, Anna Sara Shafferman Levin & Silvia Figueiredo, (2015), Costa Comparison of methods to detect the in vitro activity of silver nanoparticles (AgNP) against multidrug resistant bacteria, *Journal of Nanobiotechnology* , volume 13, Article number: 64
- [13] Devipriya Anbumani , Kayal vizhi Dhandapani , Janani Manoharan , Ranganathan Babujanathanam , A.K.H. Bashir , Karnan Muthusamy , Ahmed Alfarhan and K. Kanimozh , April (2022), Green synthesis and antimicrobial efficacy of titanium dioxide nanoparticles using *Luffa acutangula* leaf extract, *Journal of King Saud University – Science*, Volume 34, Issue 3, 101896



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Photovoltaic applications of SnO₂ gas sensor

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Abstract

Tin oxide is a remarkable chemical in today's research because to its unique electrical and optical properties. Because of its huge band gap (3.6 eV), it is used as a core material in a wide range of important applications, including optoelectronics, spintronics, photovoltaics, thin-film transistors, photocatalysis, dielectrics, sensors, and transparent electronics. Thin film technology provides various advantages in the solar industry, including low cost, low material and energy consumption, and ease of use. Solar cells made from SnO₂ thin films have the potential to open up new technical paths for power production, with conversion efficiencies ranging from 15% to 20%. The authors examine and outline potential areas of SnO₂ research for photovoltaic and gas sensor applications. The data obtained will indicate the possibility of designing physical, chemical, magnetic, and optical characteristics of SnO₂ for sensing and photovoltaic applications.

Keywords: Tin oxide, Photovoltaic, Thin film, Gas sensors.

1. Introduction

Material science is the systematic investigation of any material to determine its varied characteristics and qualities. It covers a wide variety of applications, from manufacturing nanoscale gadgets to developing novel materials at the atomic level. In the current context, we are dealing with a number of difficulties linked to traditional energy sources, global warming, soil and water contamination, climate change, sanitation, and so on. Our primary objective is to alleviate these issues by bringing new technologies and advanced materials. Nanotechnology and thin films play an essential role in dealing with such challenges. As stated by [1], this can be used to enhance the performance of currently used materials and develop new functional materials. This is because they not only offer good opportunities to study the optical, electrical, and thermal properties in quantum confinement, but they also provide crucial understandings of the functional units involved in the fabrication of nanoscale electronic, optoelectronic, and magnetic devices.

ZnO, TiO₂, and SnO₂ are the most studied metal oxides due to their unique global uses. Tin oxide is the best option for photovoltaic investigations since it is plentiful, affordable, and non-toxic. The primary goal of this research is to learn more about the functioning of SnO₂ and to identify potential research topics for future applications in photovoltaics and gas sensors [2].

2. Overview of Tin Oxide and its Properties

From the past several decades semiconducting (Metal) oxides such as ZnO, TiO₂ and SnO₂ have been demonstrated to be an essential class of transparent conducting oxides (TCO) for use in solar cells and gas sensors. Tin oxide is the most common material used in optoelectronics because to its low electrical resistance and high transmittance in the visible range [3]. Tin oxide is a good option for these uses due to its large band gap (3.6 eV) and strong excitation binding energy (130 MeV). It is the only group-IV oxide that exhibits transparent properties and excellent conductivity in the visible range of (300–800 nm). Bulk

SnO_2 is unable to achieve effective UV emission because of the dipole-forbidden rule. Structural morphology, tetragonal structure of pure and SnO_2 thin films doped with TM of material is clearly visible by AFM measurements as shown in Fig.1.

3. Methodology

SnO_2 films may be grown using a variety of deposition processes, including chemical vapor deposition, spray pyrolysis, thermal evaporation, sol-gel, and sputtering. Recently, the Sol-Gel process was employed to create several high-quality thin films for photovoltaics and gas sensors.

3.1 Chemical deposition technique

3.1.1 Chemical vapor deposition (CVD)

CVD is a chemical approach for vacuum deposition in which gaseous precursors are transferred into a chamber with the substrate. At high temperatures, the chemical interaction between the precursor and the substrate can provide the needed thin layer thickness. This is a prominent method in the semiconductor industry for producing high-quality, high-performance semiconductors [4]. There are numerous CVD methods for producing thin films, including thermal chemical vapor deposition, APCVD (Atmospheric-pressure CVD), MOCVD (Metalorganic chemical vapor deposition), PECVD (Plasma-enhanced chemical deposition), LCVD (Laser Assisted Vapor Deposition), and PACVD (Photo-assisted chemical vapor deposition).

3.1.2 Atomic layer deposition (ALD)

The atomic layer deposition process is also known as vapor phase deposition. In this approach, the reactions between gaseous precursors and substrate occur one at a time. This process uses two or more gaseous precursors to produce a thin coating of the appropriate thickness. ALD is a step-by-step method in which precursors react exclusively with the available substrate and no further reactions occur after the surface is saturated. As a result, it is a slower process, but it allows for fine thickness control of the film even at lower temperatures [5,6].

3.1.3 Sol- Gel Method

Sol-Gel is a chemical solution deposition process in which precursor materials generate a solution known as 'sol'. This 'sol' was placed on the substrate using a carefully regulated method. The Sol-Gel approach comprises a gelation process in which the precursor material converts from a liquid 'sol' to a solid 'gel' form [6]. This solution is known as a sol-gel, which is a continual mixture of suspended precursor particles and substrate. The sol-gel process includes spin coating, dipping, and spraying. Table 1 is a brief summary of various ways for synthesizing a thin film for practical applications.

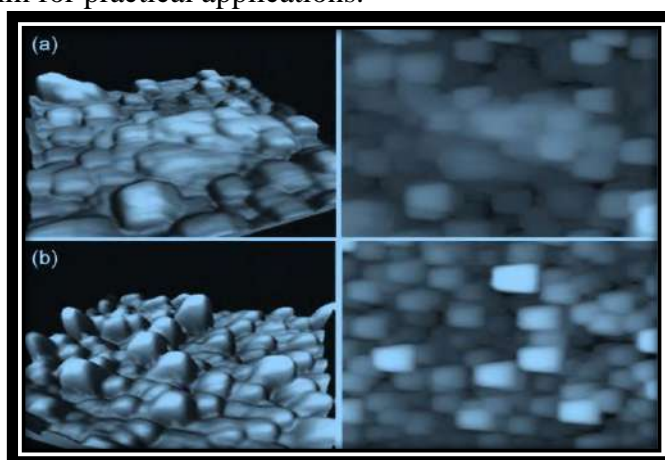


Fig. 1 — 3D AFM images of (a) pure SnO_2 and (b) doped $\text{Sn}_{0.095}\text{Mn}_{0.005}\text{O}_2$ thin films.

3.2 Physical deposition technique

3.2.2 Sputtering

Sputtering is a physical thin film deposition process in which surface atoms are liberated by blasting the surface of a target material with ions before coming to rest on the substrate. At low temperatures, the target material for this deposition process is Nobel gas Argon. Normally, Nobel gas is less reactive, thus it acts neutrally during any chemical reaction in the chamber, making it a quick and reliable approach. Sputtering is obviously an etching method, making it suitable for surface cleaning applications [7]. We grouped the sputtering process into four types: diode sputtering, reactive sputtering, bias sputtering, and ion beam sputtering.

3.2.3 Thermal evaporation

In thermal evaporation, the material is heated in a vacuum chamber until its surface atoms have sufficient energy to leave the surface. The evaporated material then condensed on the substrate for synthesis of thin film of desired thickness.

3.2.4 Spray pyrolysis deposition

Spray pyrolysis involves spraying a solution over a heated surface to form a thin layer. Spray pyrolysis is the chemical dissociation or evaporation of droplets containing a solute of the desired nanomaterial [8]. As a result, it has been adopted by both gas-phase and liquid-phase approaches. The spray pyrolysis technique works by creating an aerosol from a variety of precursor solutions, such as a metallic salt solution or a colloidal solution²⁵. It is a non-reversible method that achieves great efficiency.

4. Tin Oxide as Photovoltaic Cell

PV materials for photovoltaic applications work via the photoelectric effect. In this process, the exposed PV material turns electromagnetic energy (sunlight) into electrical energy. Photovoltaic cells are the most demanding renewable energy sources [9]. It offers several benefits over other sources of energy such as fossil fuels and petroleum. It is a viable and sustainable energy source that will meet growing energy demand without harming our environment. Zhu et al.[10] successfully used solution-processed SnO₂ nanocrystals to build an effective ETL for inverted thin film photovoltaic solar cells.

Table 1 — A glance of various preparation methods of thin film deposition of SnO ₂ material.				
Thin Films Deposition Techniques				
Chemical Process (Non-equilibrium reaction)		Physical Process (Equilibrium reaction)		
	↓			↓
Plating	Sol Gel	CVD	Evaporation	Sputtering
Electroplating	Dipping	MOCVD	Ion Plating	RF
Electrolysis	Spraying	PECVD	MBE	DC
Flame Hydrolysis deposition (FHD)	Spin Coating	ALD	Laser ablation & Electron Beam	Magnetron

They proposed that due to several unique features, SnO₂ is more suitable than ZnO and TiO₂. In their article, Dong et al. [11] investigated compact SnO₂ ESL and compact TiO₂ ESL, as well as their PCEs. Fabrication of thin films using the sol-gel technique. They characterized the films using SEM, J-V curves, PL, XRD, and IPCE. In their article, Roose et al. [12] detailed the UV instability of a perovskite solar cell employing my TiO₂. They came to the conclusion that employing a thin coating of m- SnO₂ may solve this instability. In their trials, they reached a high efficiency of around 16.4%. The solar cell is made from Ga doped SnO₂ film. The authors reported an approximate PCE of up to 23% for perovskite solar cells using the spin

coating and single gel procedures for deposition of SnO₂ thin films and examination of their characteristics by comparing thermally annealed SnO₂ TF (T-SnO₂) and P- SnO₂ TF [13-14].

5. Tin Oxide as Gas Sensors

Nowadays, gas sensors are the most exciting study topic because they are effective in monitoring environmental concerns based on the needs of physical, chemical, and biological processes in the Earth's atmosphere. Researchers want to increase its durability, responsiveness, and sensitivity. Gas sensors have an essential role in environmental monitoring, medical applications, breath analysis for medical diagnostics, industrial applications, food processing, and so on [15]. Gas sensors are primarily used to differentiate odors, detect gases, and monitor changes in specific gases in the atmosphere. Material selection has a significant impact on gas sensor performance.

Beniwal A et al. [15] explored a SnO₂ sensor for detecting low-concentration ammonia at ambient temperature. They synthesized SnO₂ thin films using the sol-gel process and characterized them using XRD, AFM, XPS, and SEM. They concluded

that it is a highly promising sensor for detecting Ammonia concentration at extremely low temperatures, and that it would have a wide range of applications in the future due to its outstanding stability, adequate recovery time, and good responsiveness. Gupta P et al. [16] proposed that doping Zn improves the gas sensing characteristics of SnO₂, such as surface shape, crystallinity, crystal size, and so on. They found that SnO₂ has higher sensitivity for O₂ gas sensing than pure and Zn doped SnO₂. Khuspe G D et al. [17] found in their investigation that SnO₂ is more sensitive and stable to NO₂ gas. They reported a higher sensor response of 19% and stability of 77.90%. Zhou Q et al. [18] found that Ni and Zn doped SnO₂ gas sensors recovered and responded more quickly than specific Zn or Ni doped SnO₂ nanomaterials did. They conducted several studies on the concentration of harmful CO gas and discovered improved sensitivity and stability.

6. Results and Discussion

The authors of the current study looked into recent improvements in tin oxide. A study on alternate methods for producing SnO₂ thin films in pure, composite, and doped with transition metals to exhibit structural and electrical properties has been presented. This article describes many methods of synthesizing SnO₂ films to highlight their merits and drawbacks, as well as numerous advances and their different effects and potential applications, notably in photovoltaics and gas sensors. With so many fascinating applications for SnO₂ thin films, we are concentrating on the most demanding ones: photovoltaics and sensors. Excellent charge collecting qualities in solar cells and a promising future for green energy technology are two of SnO₂'s many advantages. Pure SnO₂ thin films produced using a variety of techniques, including sol-gel, ALD, spin coating, PLD, and sputtering, had the highest PCE of 19.56% [14]. The PCEs of Nb doped SnO₂ thin film, Mg doped SnO₂ thin film, and Ga doped SnO₂ thin film, with doping of transition metals, are 17.57%, 14.60%, and 16.40%, respectively [35–37]. According to the inquiry, the Composite thin film of SnO₂-TiO₂ acquired the greatest PCE of 40% of all the studies, 21.10%. Comparably, pure SnO₂ thin films made using the Sol-gel process respond to ammonia (NH₃) gas with a 28% reaction and NO₂ gas with a 19% response [15, 17]. The authors have reported an enhanced high response and sensitivity of 37.6% for the monitoring of O₂ gas by doping of Zn in SnO₂ thin film [16]. Researchers used Ni and Zn doping in their studies to monitor CO gas, and they discovered that the responses were 7.28 and 5.90, respectively.

7. Conclusions

The fabrication of SnO₂ thin films using the Sol gel technique still has a lot of untapped potential. It is worth noting that, among the alternative synthesis technologies, the Sol gel technique is the most appropriate due to its clear advantages of precision, simplicity, flexibility, homogeneity, and uniformity. However, one of its advantages is that the manufacture of SnO₂ thin films by sol gel allows for essential characterizations such as XPS and VBS studies on SnO₂ materials. We hope that the study of this characterization technique may explore the new path of photovoltaic and gas sensor applications, which can be useful to achieve the desired efficiencies of solar cells for future aspects as well as excellent performance (gas response, selectivity, stability, sensitivity) in gas sensor.

8. References

1. Brinker C J & Ginger D, *Nanotechnol Res Dir Soc*, 2020 (2011) 261.
2. Das S & Jayaraman V, *Prog Mater Sci*, 66 (2014) 112.
3. Kim H & Pique, *Appl Phys Lett*, 84 (2004) 218.
4. Wang J T, *Modern Inorg Synth Chem*, 7 (2011)151.
5. George S M, *Chem Rev*, 110 (2010) 111.
6. Shim E, *Smart Text Protect*, 3 (2013) 87.
7. Kern W & Schuegraf K K, (Eds) *Handbook of thin film deposition, Process and Tech*, (Intel Corporation Santa Clara, California) 2002.
8. Ashik U P M, Kudo S & Hayashi J, *Synth Inorg Nanomater*, 2 (2018) 19.
9. Grama S, Massachusetts Institute of Technology, System Design and Management Program, (2007).
10. Zhu Z, Bai Y, Liu X, Chueh C, Yang S & Jen A, *Adv Mater*, 28 (2016) 6478.
11. Dong Q, Shi Y, Wang K, Li Y, Wang S, Zhang H, Xing Y, Du Y, Bai X & Ma T, *J Phys Chem C*, 119 (2015) 10212.
12. Roose B, Johansen C M, Dupraz K, Jaouen T, Aebi P, Steiner U & Abate A, *J Mater Chem A*, 6 (2018) 1850.
13. Ganchev M, Katerski A, Stankova S, Eensalu J S, Terziyska P, Gergova R, Popkirov G & Vitanov P, *IOP J Phys Conf Ser*, 1186 (2019) 01202.
14. Yu H, Yeom H I, Lee J W, Lee K, Hwang D, Yun J, Hwang D, Yun J, Ryu J, Lee J, Bae S, Kim S K & Jang J, *Adv Mater*, 30 (2018) 1704825.
15. Beniwal A, Srivastava V & Sunny, *Mater Res Express*, 6 (2019) 4.
16. Gupta P & Sharma S K, *Mater Res Express*, 4 (2017) 065010.
17. Khuspe G D, Sakhare R D, Navale S T, Chougule M A, Kolekar Y D, Mulika R N, Pawar R C, Lee C S & Patil V B, *Ceram Int*, 39 (2013) 8673.
18. Zhou Q, Chen W, Xu L, Kumar R, Gui Y, Zhao Z, Tang C & Zhu S, *Ceram Int*, 44 (2018) 4392.

Humidity Sensors: AlCl₂-Dipped Nanocrystalline Magnesium Oxide

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ABSTRACT

The investigation, magnesium oxide and AlCl₂ were combined in varying mol% w/w stoichiometry. Thick layers of humidity sensors are made using the screen printing method. After testing every humidity sensor device, it was determined that the sample T-1, which was kept at a constant temperature between 400 and 700 degrees Celsius, had a high sensitivity and a quick response time to humidity sensing at room temperature. Curves in the case of conductivity are often jumbled and congested. Relative humidity has a linear effect on sample film conductivity. When sensors are kept at room temperature and their surface oxygen vacancies operate as electron donors, the resistance of thick films reduces.

KEYWORDS: Thick films, MgO-AlCl₂, Sensitivity, and Humidity sensors.

1. INTRODUCTION

The operator can manage the temperature and relative humidity in these humidity chambers at predetermined levels via the front panel.[1-4] The chamber's air is continuously circulating, scheduled to be compared to predetermined points. Electric resistance heaters, which regulate temperature by turning on and off, produce heat. There is a refrigeration unit that runs constantly on units with cooling. A low-pressure vapor generator injects water vapor into the chamber via a tiny opening to achieve chamber humidification. At the blower discharge, the water vapor enters the chamber. Test chambers were programmable, and they could be networked or connected to the Internet. The goal of the current work is to create and characterize the structure of magnesium oxide nanoparticles using the liquid phase method, which has the advantage of producing a greater surface area in a shorter amount of time at room temperature. This approach is also the most straightforward, economical, and environmentally benign. Through XRD analyses of MgO nanoparticles, its impact on the nanocrystalline size structure is also investigated.[5–12]

2. EXPERIMENTAL METHOS:

All of the chemicals utilized in this work were 99.99% pure GR grade chemicals that were bought from Sd-fine chemicals, India. The sol-gel technique is utilized to synthesize MgO nanoparticles. There are several processes involved in the synthesis of MgO nanoparticles, including stirring, drying, filtration, mixing, and calcination. Ultimately, the powder is calcined for three hours at 300 °C to produce MgO in the form of nanoparticles.

In screen printing, a mesh is used to transfer ink onto a substrate, with the exception of places blocked with a blocking stencil to prevent ink from penetrating such areas. In order to fill the gaps in the mesh with ink, a substance or gel is pushed over the screen, and vice versa, causing the screen to briefly make contact with the substrate along a line of contact. When the screen springs back after the blade has passed, the material gets moist on the substrate and is drawn out of the mesh holes. Similar to this, we utilize glass slides as the substrate and a paste made of nanomaterials in place of ink. Thus, instead of using the glass slide that we are using here, we are using mesh that has a less permeable stencil area. First, we take the 90% nanomaterial and use a solid binder (10%) called ethyl cellulose to build a paste out of it. Drop by drop, liquid binder is added to a well-ground mixture of nanomaterial and solid binder. Making sure the right amount of liquid binder is added requires caution. Thus, the ideal thick nanomaterial paste is made. Next, we proceed to apply a paste made of permeable mesh for well-layered nanomaterials to substrates (glass slides) using a squeegee. First, we let these thick

sheets of magnesium oxide nanoparticles dry in the air while they are being made. After that, they spend an hour in a vacuum oven set at 80°C. After that, we heated these thick sheets for three hours at 250°C in a muffle furnace. These thick films are now dipped in aluminum chloride for varying lengths of time [13–16].

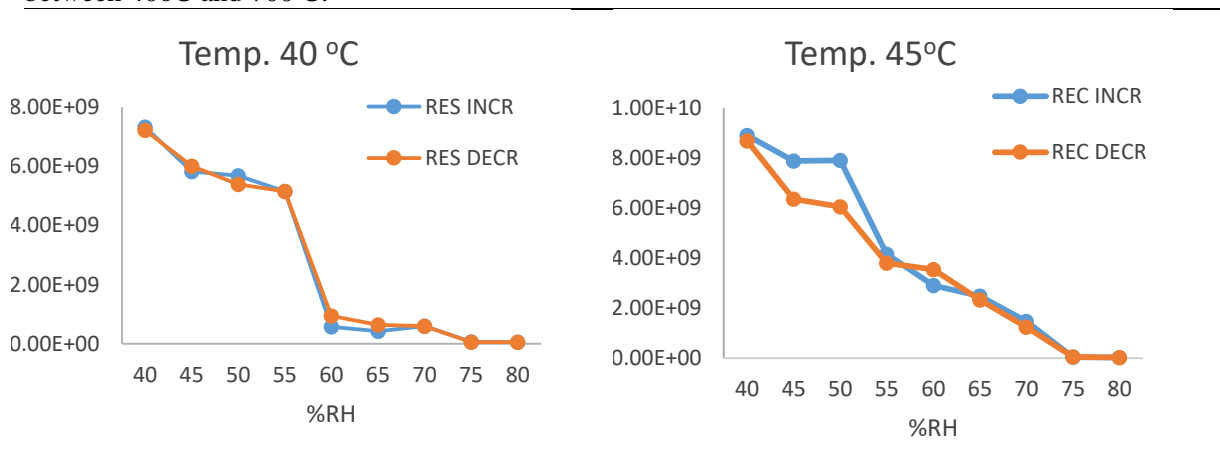
Aluminum and chlorine make up the bulk of aluminum chloride (AlCl₃). The substance is frequently mentioned as a Lewis acid. Aluminum chloride has been utilized in the dipping process by us. We produced an AlCl₃ solution and then dipped a thick layer of magnesium oxide for varying durations of time. After dipping the slides for one, two, or three minutes, we fire them for one hour at 250°C to create three thick film slides for varying dipping times, and one thick film slide is taken for purity.

A measurement of humidity indicates how much water vapor is present in a gas or the atmosphere. The relative humidity and the ambient temperature work together to determine the comfort level. Measuring humidity is crucial for using some pieces of equipment. As a general rule, maintain a relative humidity of about 50% RH at a typical room temperature of 20 to 25 degrees Celsius. This can range from as low as 40% RH in clean rooms to 60% RH in operating rooms of hospitals. Hygrometers are used to measure humidity. Sir John Leslie invented the first hygrometer. Measuring humidity is crucial for both controlling the indoor climate and forecasting the outdoor climate. [17–20]

3. RESULTS AND DISCUSSION:

3.1 Hysteresis:

Hysteresis is the term for the phenomena when changes in an effect cause a physical property's value to lag behind. Our current study, which uses MgO nonmaterial thick films for humidity sensing, displays the hysteresis plot of samples M-1, M-2, M-3, and M-0 at a constant temperature of 40°C. The hysteresis plot illustrates the change in the sample's resistance in relation to relative humidity in stages of 5% RH, from 40 to 80% RH, and in both increasing and decreasing orders. Using a Keithley 2400 source meter, the resistance was measured in increments of 10% RH at various constant temperatures between 40°C and 70°C.



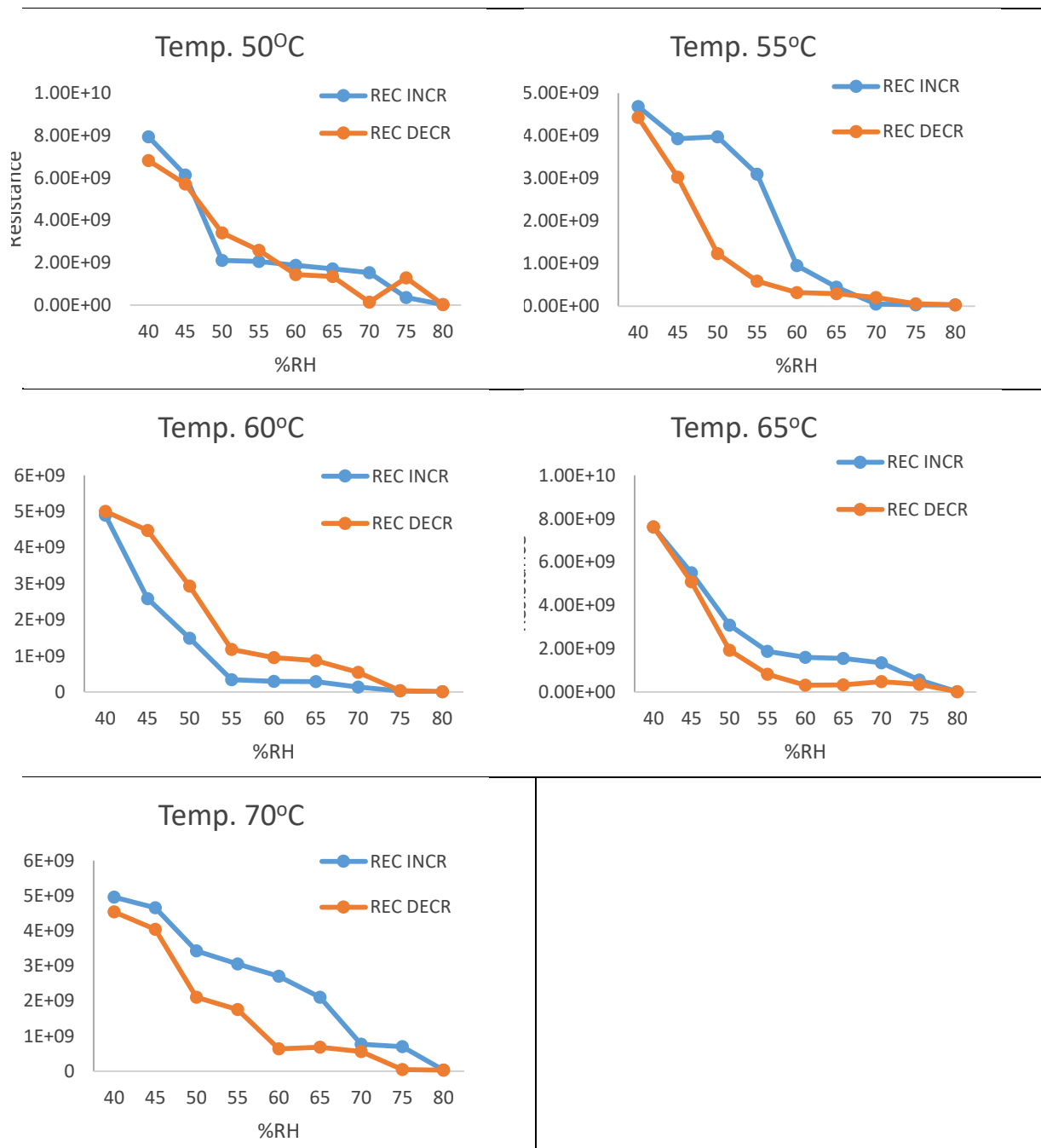


Figure 3.1 M-1 Metal oxide Thick Film (1-minute) hysteresis plot

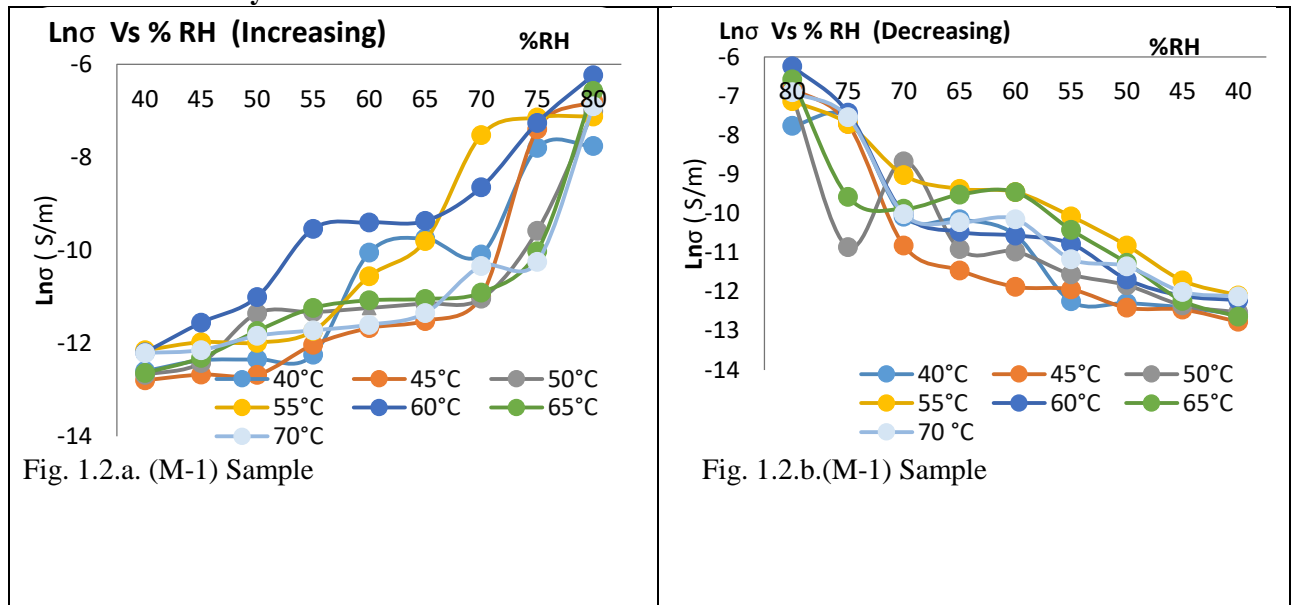
We may plot the graphs for the remaining samples in a similar manner. The hysteresis plot series of a sample, MgO nanomaterial film M-1, M-2, and M-3, dipped in aluminum chloride for varying dipping times, i.e., for 1, 2, and 3 minutes, respectively, and the hysteresis plot of a pure sample of MgO nanoparticle film at corresponding constant temperature are observed in the current work. It is evident from the hysteresis plot that relatively little hysteresis occurs during the forward (increasing) and reverse (decreasing) cycles of RH. The resistance value of the sample was found to have changed on average by a fairly substantial amount between 1010 and 108Ω.m. With the exception of sample M-1 (1 minute), the resistance value changes from 109 to 107Ω.m. between 40 and 80% RH. Sample M-1's resistance value noticeably changes from 40°C to 70°C at constant temperature.

Table 2.1 Sample Codes

Sr. No.	Sample	Thickness $\times 10^{-6}$ m	Material
1.	M-0	26	Pure MgO
2.	M-1	20	MgO +Dipped with AlCl_2 for 1 minutes dipping and after firing these slides for 1 hour at 250°C .
3.	M-2	21	MgO +Dipped with AlCl_2 for 2 minutes dipping and after firing these slides for 1 hour at 250°C .
4.	M-3	22	MgO +Dipped with AlCl_2 for 3 minutes dipping and after firing these slides for 1 hour at 250°C .

Because the processes of adsorption and desorption are not as quick at a given humidity, hysteresis was seen. The physisorbed water molecules are changed into chemisorbed by donating the surface electron at a constant temperature, as adsorption would not be effective and would result in a modest change in the value of resistance. Desorption necessitates a high activation energy. However, as we have shown, the sample in question exhibits a similar drop in resistance as the percentage RH increases, suggesting that conduction happens at the grain surface as a result of the release of electrons from the water molecule. As a result, the sample clearly demonstrates a shift in resistance between values in the humidity range of 40% to 80% RH. [21–28]

3.2 DC Conductivity



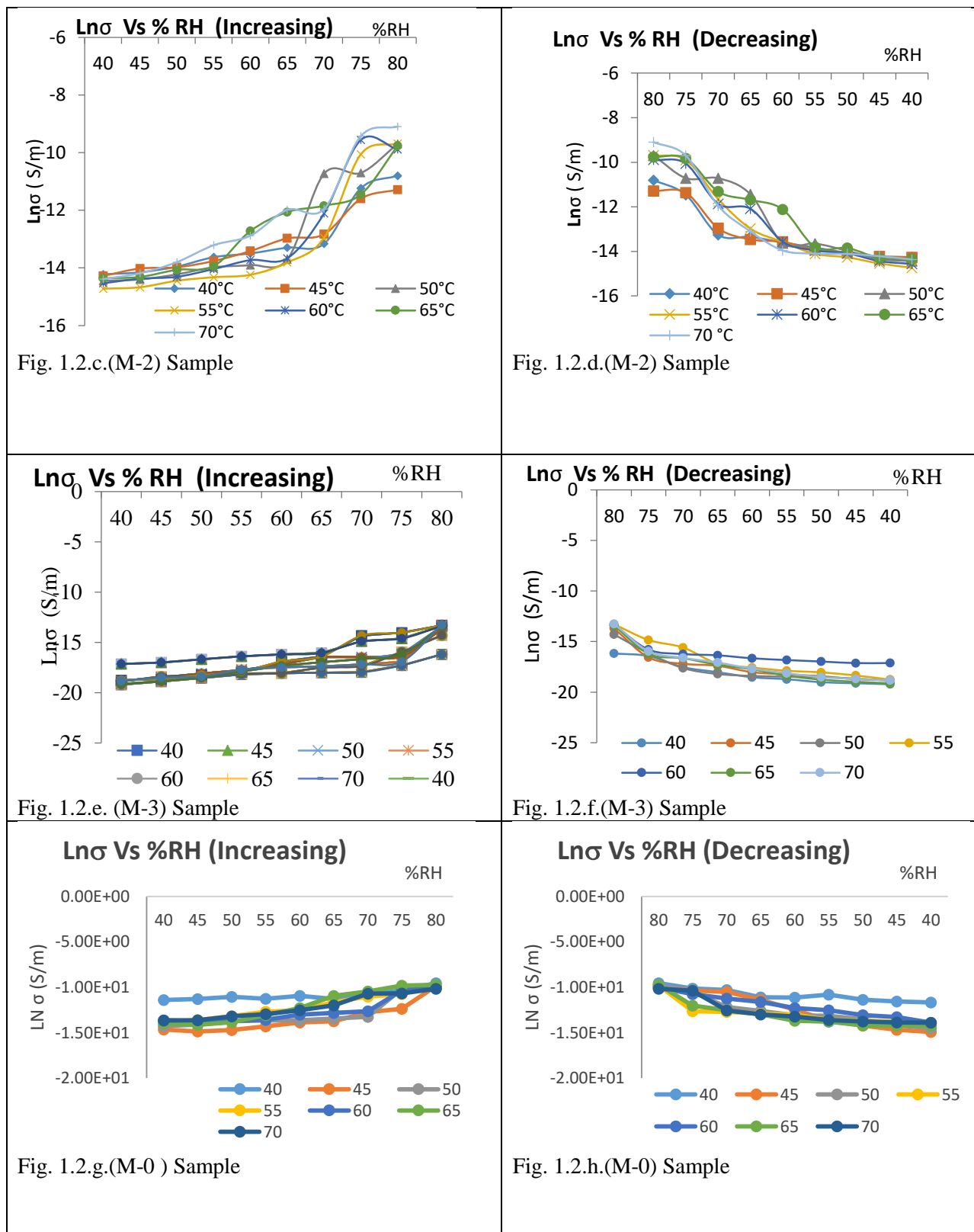


Fig. 1.2 Variation (a-d) $Ln\sigma$ Vs RH at different constant temperature (40°C to 80°C)

The $Ln\sigma$ fluctuation as the series sample's RH increases and decreases (from 40 to 80% RH and from 80 to 40% RH). correspondingly between 40°C and 70°C at constant temperature. From 40 to 80% relative humidity, it has been found that conductivity increases somewhat linearly and vice versa. The conductivity of sample M-1 rises in tandem with its temperature. The conductivity was found to be highest at high temperatures and lowest at 40°C for all sample series.[28–29]

3.2 XRD OF MAGNESIUM OXIDE

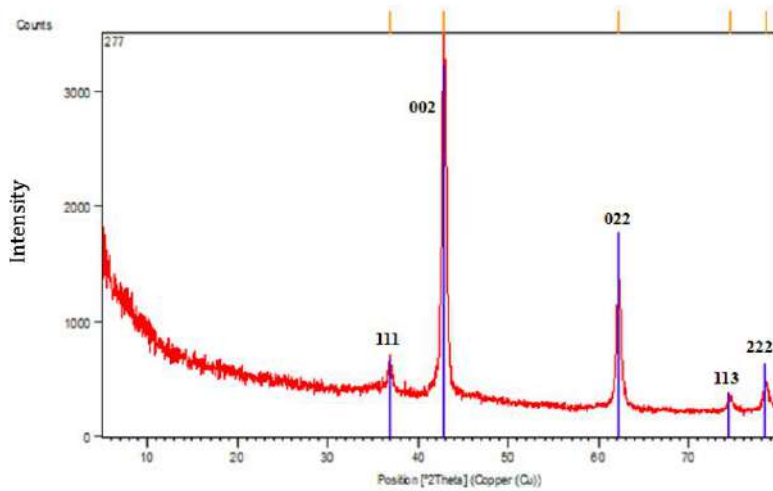


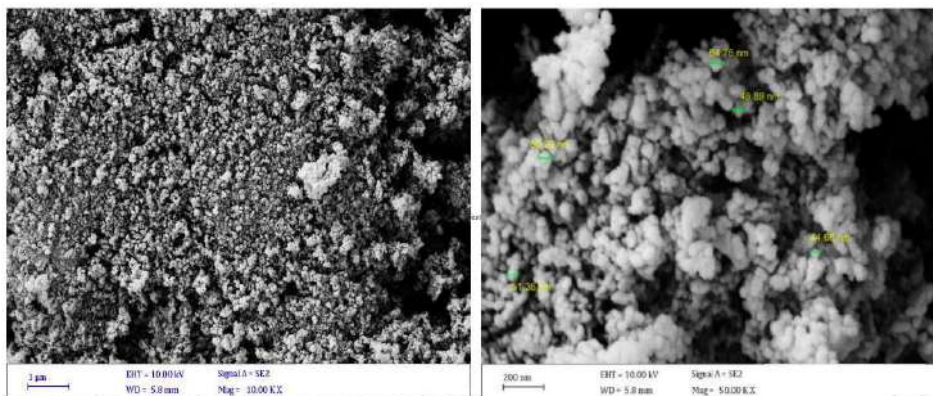
Fig. 1.3 XRD pattern of Periclase Magnesium oxide (MgO)

XRD peaks for sol-gel-synthesised MgO nanoparticles. These peaks, which are formed at (111), (002), (022), (113), and (222) planes, respectively, at $2\theta = 36.862, 42.824, 62.167, 74.516,$ and 78.443 degrees, are compared with the ICSD, powder diffraction card of MgO file No. 43-1022. Moreover, the $\text{Mg}(\text{OH})_2$ phase is absent from XRD patterns that highlight excellent purity. The diffraction peaks of the MgO nanoparticles made by sol-gel are slightly broadened, indicating a return to a tiny size of nanoparticles, but the sharp peaks in the XRD data for the microwave approach and the sol-gel route suggest uniform crystallinity. The Scherrer formula, found in Equation (1), was used to calculate the average crystalline size.

$$D = 0.9 \lambda \beta \cos \theta \dots (1)$$

Where D is the average crystalline size, λ is the X-ray wavelength, β is the Full Width at Half Maximum, and θ is the Bragg diffraction angle. D , on the other hand, stands for the average crystal size determined by the diffraction peaks. For the sample made using the sol-gel method, it is visible at 33 nm.[30]

3.3 SEM PICTURES:



(a) Under 1 μm and (10.00 KX) magnification

(b) Under 200 nm and (50.00 KX) magnification

SEM pictures of MgO.

The morphology of nanocomposites as revealed by FE-SEM reveals that the particles are tiny, spherically-shaped, and nanoporous. On the surface, one can observe the formation of porous and nanocrystalline magnesium oxide. The prepared sample has an aggregated appearance. Along with a range of shapes and sizes, grains also have a nanoporous structure and organization at the nanoscale. The large surface area of the structure and the micro capillary pore are expected to facilitate the adsorption and condensation of water molecules. This porosity allows for good response to and recovery from humidity.

4. CONCLUSIONS:

The investigation of humidity sensors has produced a novel detecting mechanism that may be used under many circumstances. The resistance value of the sample was found to have changed on average by a fairly substantial amount between 1010 and 108 ohm. Sample M-1's resistance value noticeably changes from 40°C to 70°C at constant temperature. When it comes to conductivity, curves are usually jumbled and packed. Sample film conductivity reacts to relative humidity in a linear fashion. The sample films demonstrate the noteworthy outcomes related to humidity sensing. The fact that every peak matches the MgO nanostructure exactly suggests that MgO nanoparticles were produced. Within the XRD instrument's detection limit, no more peaks were seen in the spectrum, showing the pure MgO Nanomaterial is synthesized.

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References

1. A. H. Wani and M. A. Shah, "A unique and profound effect of MgO and ZnO nanoparticles on some plant pathogenic fungi", *Journal of Applied Pharmaceutical Science* 02(03), 2012, pp. 40-44.
2. C. R Indulal, R Biju, D. Nand, R. Raveendran, "Optical and Antibacterial Studies of Zinc Magnesium Oxide Nanocomposite", *Journal of Chemistry*, 33, 2017, pp.1545-1549.
3. Anjali Mavya and Nada Bhatia, "Microwave assisted Sol-Gel Synthesis of Magnesium oxide (MgO)", *International Journal of Engineering Research and Development*, 13, 8, 2017, pp.1-6. IICESAT Conference, College of Material Engineering, University of Babylon, Iraq *Journal of Physics: Conference Series* 1973 (2021) 012104 IOP Publishing doi:10.1088/1742-6596/1973/1/012104 8
4. K. Mageshwari, Sawanta S. Mali, R. Sathyamoorthy and Pramod S. Platil, "Template-free synthesis of MgO nanoparticles for effective photocatalytic applications", *Powder Technology*, 249, 2013, pp. 456-462.
5. Iwayan Sutapa, Abdul Wahid Wahab, Paulina Taba and Nursiahila Nafie, "Synthesis and Structural profile analysis of the MgO Nanoparticles produced through the Sol-Gel method followed by Annealing process", *Oriental Journal of Chemistry*, 34., 2, 2018, pp.1016-1025.
6. K. P. Mckenna, D.koller, A. Sternig, N. Siedl, N. Govind and P. V. Sushko, "Optical Properties of Nanocrystal Interfaces in Compressed MgO Nanopowders", *ACS Nano* 5, 2011, 2003.
7. Manoj B.Gawande, Paula S. Branco, Kalpesh Parghi, Janhavi J. Shrikhande, Rajesh Kumar Pandey, C. A. A. Guhman, N. Bundaleski O. M. N. O. Teodoro and V. Radhajayaramcatal, "Synthesis and characterization of versatile MgO-ZrO₂ mixed metal oxide nanoparticles and their applications", *Science & Technology*, 1, 2011, 1653.
8. Mastuli, M. S., Kamarul Zaman, N. Nawawi, M. A., Mahat, A. M., Rusdi, R., Kamarudin, and N. *Nanoscale Research Letter*, 9, 2014, pp.134.
9. Lamdhade G. T. Agrawal R. M., Charpe S. D., and Raghuvanshi F. C, "Synthesis and Characterization of Magnesium oxide Nanoparticles with 1:1 molar ratio via Liquid-Phase Method", *IJAIEEM*, 4, 2015, pp. 141-145.
10. N. C. S. Selvam, R. T. Kumar, L. J. Kennedy, and J. J. Vijaya, "Comparative study of microwave and conventional methods for the preparation and optical properties of novel MgO-micro and nano-structures", *Alloys and Compounds*, 509, 2011, pp. 9809– 9815.
11. S. Saitzek, S. Villain and J. R. Gavarri, "Nanocrystalline CuOx-CeO₂ Systems: FTIR Analyses of Catalytic Reactions", *Mater Sci.*, 513, 2006, pp. 1-14.
12. Rezaei, Mehran, Majid Khajenoori, and Behzad Nematollahi. "Synthesis of high surface area nanocrystalline MgO by pluronic P123 triblock copolymer surfactant." *Powder technology* 205, 201, pp. 112-116.
13. Song, Guolin, et al. "Ultrasonic-assisted synthesis of hydrophobic magnesium hydroxide nanoparticles." *Colloids and Surfaces A: Physicochemical and Engineering Aspects* 364, 2010, pp. 99-104.
14. Richa Srivastava and B. C. Yadav (2012) *Nanomaterials and Sensors Research Laboratory*, Department of Physics, Lucknow University, Lucknow 226007, U. P., India, Department of Applied Physics, School for Physical Sciences, Babasaheb Bhimrao Ambedkar University, Lucknow 226025, U.P., India, doi: 10.5185/amlett.2012.4330.

15. N. K. Pandey, Karunesh Tiwari, and Akash Roy, (2011) Moisture Sensing Application of Cu₂O Doped ZnO Nanocomposites IEEE SENSORS JOURNAL, VOL. 11, NO. 9, doi: 10.1109/JSEN.2011.2112764, SEPTEMBER.
16. Y SHIMIZU, H ARAI and T SEIYAMA (1985) Theoretical Studies On The Characteristics Of Ceramic Sensors and Actuators, 0250 6874/85/ 30, 7 11 - 22 .
17. B.C. Yadav , Richa Srivastava & C.D. Dwivedi (2008) Synthesis and characterization of ZnO–TiO₂ nanocomposite and its application as a humidity sensor doi. /10.1080/14786430802064642.
18. D.G. Yarkin, (2003) Impedance of humidity sensitive metal/porous silicon/n-Si structures Sensors and Actuators A 107 doi:10.1016/S0924-4247(03)00231-0.
19. Vijay K. Tomer, Ritu Malik, Vandna Chaudhary ArabindaBaruahand Lorenz Kienle, (2019) Noble Metals Metal Oxide Mesoporous Nano hybrids in Humidity and Gas Sensing Applications doi. /10.1016/B978-0-12-814134-2.00014-0 .
20. Hamid Farahani, Rahman WagiranandMohd Nizar Hamidon (2014) Humidity Sensors Principle, Mechanism, and Fabrication Technologies: A Comprehensive Review Sensors, 14, 7881-7939; doi:10.3390/s140507881 .
21. Raid A. Ismail,*Ala Al-Naimi, and Alaa A. Al-Ani , (2006) Preparation and characteristics study of ZnO: (Al, Cu, I) thin films by chemical spray pyrolysis e-J. Surf. Sci. Nanotech. Vol. 4 636-639 DOI:10.1380/ejsnt.2006.636.
22. Wensheng Wang, Anil V. Virkar , (2004) A conductimetric humidity sensor based on proton conducting perovskite oxides, sensors and Actuators, B 98, 282–290, doi:10.1016/j.snb.2003.10.035.
23. Vijay K. Tomer, Surender Duhan, Parag V. Adhyapak, and Imtiaz S. Mulla (2014) Mn-Loaded Mesoporous Silica Nanocomposite: A Highly Efficient Humidity Sensor J. Am. Ceram. Soc., 1–7 ,DOI: 10.1111/jace.13383.
24. Nor Diyana Md Sin, Mohd Firdaus Malek, Mohamad Hafiz Mamat, Mohamad Rusop Bin Mahmood, (2014) International Journal of Materials Engineering Innovation , List of Issues , Volume 5, Issue 2 , DOI: 10.1504/IJMATEI.2014.060343.
25. Macagnano, V. Perri, E. Zampetti, A. Bearzotti, F. De Cesare,(2016) Sensors and Actuators B: Chemical, Volume 232, 16-27 .
26. Yuan Liu, Hui Huang, Lingling Wang, Daoping Cai, Bin Liu, Dandan Wang, Qihong Li, Taihong Wang, (2016) Sensors and Actuators B: Chemical, Volume 223 , 730-737. doi.10.1016/j.snb.2015.09.148.
27. Mohamad Izzat Azmer, Zubair Ahmad, KhaulahSulaiman, Abdullah G. Al-Sehemi, (2015) Sensors and Actuators B: Chemical 61 , 180-184.
28. Kyung Hyun Choi, Memoon Sajid, Shahid Aziz, Bong-Su Yang, (2015) Sensors and Actuators A: Physical, Volume 228, 40-49, doi.org/10.1016/j.sna.2015.03.003 .
29. Yang Li, Kaicheng Fan, Huitao Ban, Mujie Yang, (2016) Sensors and Actuators B: Chemical, Volume 222, 151-15, doi.org/10.1016/j.sna.2015.03.003.
30. Yuan Liu, Hui Huang, Lingling Wang, Daoping Cai, Bin Liu, Dandan Wang, Qihong Li, Taihong Wang, ,(2016) Sensors and Actuators B: Chemical, Volume 223, 2016, 730-737, doi. /10.1016/j.snb.2015.09.148.
31. Xiuping Han, Binghua Yao, Keying Li Wenjing Zhu, and Xuyuan Zhang (2020) Preparation and Photocatalytic Performances of WO₃/TiO₂ Composite Nanofibers |Article ID 2390486 | doi. /10.1155/2020/2390486.

Advances and Perspectives in Nanotechnology: A Short Review

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Abstract:

The process of modifying the shape and size of structures, electronics, and systems at the nanometer scale, i.e., 1 nm to 100 nm (10⁻⁹m), is known as nanotechnology. The prefix nano derives from the Greek word "nano," which meaning "very little". Because of their small size, they have larger surface areas than bulk forms, better reactivity, and the ability to control numerous features. These unique qualities have fueled the expansion of nanoscience and the use of nanoparticles in a variety of sectors such as biomedicine, cosmetics, electronics, food analysis, environmental and remediation, and painting. Nanoscale science and engineering enable us to understand and control matter at the atomic and molecular levels [1,2].

Brief overview of nanotechnology's historical development

Nanotechnology's historical development traces back to a series of theoretical concepts and experimental observations. Here's a brief overview:

1. Early Concepts (1950s-1960s):

The term "nanotechnology" was first coined by physicist Richard Feynman in his 1959 lecture, "There's Plenty of Room at the Bottom," where he discussed the possibilities of manipulating individual atoms and molecules. Physicist Eric Drexler expanded on these ideas in the 1980s with his book "Engines of Creation," envisioning nanoscale machines and their potential applications.

2. Scanning Tunneling Microscopy (1981):

The development of the scanning tunneling microscope (STM) by Gerd Binnig and Heinrich Rohrer in 1981 revolutionized nanotechnology. It allowed researchers to visualize and manipulate individual atoms, opening the door to nanoscale exploration.

3. Fullerenes and Nanotubes (1985):

In 1985, the discovery of fullerenes (buckyballs) by Robert Curl, Sir Harold Kroto, and Richard Smalley introduced a new class of nanomaterials. Later, carbon nanotubes, cylindrical structures with remarkable properties, were identified.

4. Development of Nanolithography (1980s-1990s):

Advancements in nanolithography techniques, such as electron-beam lithography and photolithography, enabled precise control over nanoscale structures. This was crucial for the fabrication of nanodevices.

5. Nobel Prize in Chemistry (1996):

The Nobel Prize in Chemistry was awarded to Robert Curl, Sir Harold Kroto, and Richard Smalley for their discovery of fullerenes. This recognition significantly boosted interest and research in nanotechnology.

6. Bottom-Up Approaches (1990s-2000s):

Scientists increasingly explored bottom-up approaches, involving self-assembly and molecular manipulation to create nanoscale structures. This shift in focus led to the development of nanomaterials and nanodevices with unique properties.

7. Interdisciplinary Growth (2000s-Present):

Nanotechnology became a highly interdisciplinary field, incorporating knowledge from physics, chemistry, biology, and engineering. Collaborative efforts led to breakthroughs in various applications, including medicine, electronics, energy, and materials science.

8. Advancements in Nanomedicine (2000s-Present):

Nanotechnology has made significant contributions to medicine, with developments in targeted drug delivery, imaging, and diagnostics. Nanoparticles are engineered for precise interactions with biological systems, improving treatment efficacy and reducing side effects. Nanotechnology continues to evolve, with ongoing breakthroughs shaping its future applications and impact across diverse scientific and industrial domains.

9. Highlight major achievements and breakthroughs in the field.

1. Scanning Tunneling Microscopy (STM):

Gerd Binnig and Heinrich Rohrer's creation of the STM in 1981 enabled scientists to observe and manipulate individual atoms, marking a watershed moment in nanoscale observation and manipulation. [3-4]

2. Discovery of Fullerenes (1985):

The discovery of fullerenes, particularly buckyballs (C₆₀), by Robert Curl, Sir Harold Kroto, and Richard Smalley ushered in a new era of nanomaterials with distinct features, earning them the Nobel Prize in Chemistry in 1996. [5]

3. Carbon Nanotubes (1991):

Sumio Iijima's discovery and characterisation of carbon nanotubes gave rise to a new class of nanomaterials with exceptional mechanical, thermal, and electrical properties. [6]

10. Types of Nanomaterials:

NPs are divided into numerous classes based on their morphology, size, and chemical properties. Based on physical and chemical properties, some of the most well-known classes of NPs are mentioned below [7].

10.1. Carbon-based NPs.

Carbon nanotubes (CNTs) and fullerenes are two main groups of carbon-based NPs.

10.1.1. Fullerenes.

Fullerenes (C₆₀) are spherical carbon molecules composed of carbon atoms joined by sp² hybridization. The spherical structure consists of around 28 to 1500 carbon atoms, with diameters ranging from 8.2 nm for single layers to 4 - 36 nm for multi-layered fullerenes [8]. Fullerenes contain nanomaterials comprised of globular hollow cages, such as allotropic forms of carbon. Commercial interest has been generated by their electrical conductivity, high strength, structure, electron affinity, and flexibility [9].

10.1.2. Graphene.

Graphene is a kind of carbon. Graphene is a two-dimensional planar hexagonal honeycomb lattice network of carbon atoms. A graphene sheet typically has a thickness of 1 nm [10].

10.1.3. Carbon nanotubes (CNT).

Carbon nanotubes (CNT) are made from graphene nano sheets with a honeycomb structure of atoms arranged into hollow coils to form nanotubes with sizes as small as 0.7 nm for single-layered CNT and 100 nm for multi-layered CNT, with lengths ranging from a few micrometers to several millimeters. The ends can be empty or closed with half fullerene molecules [11]. These have a structure that is akin to a graphite sheet rolling on itself [12]. The rolled sheets are referred to as single-walled (SWNTs), double-walled (DWNTs), or multi-walled carbon nanotubes (MWNTs) since they can have one, two, or multiple walls. It is common to create carbon precursors by deposition, particularly atomic carbon precursors. Carbons are vaporized from graphite and deposited on metal particles using a laser or an electric arc. Recently, they have been produced using the chemical vapor deposition (CVD) method [13].

10.1.4. Carbon nanofiber.

Carbon nanofiber is created in the same way that graphene nano foil and carbon nanotubes are. The distinction is that instead of conventional cylindrical tubes, it is twisted into a cone shape [14].

10.1.5. Carbon black.

Amorphous carbon is typically spherical in shape, with diameters ranging from 20 to 70 nm. They aggregate because the particles interact quickly, resulting in roughly 500 nm agglomerates [15].

10.2. Metal NPs.

Metal-based nanoparticles are created by reducing metals to nanometric sizes through destructive or constructive processes. Almost all metals may be produced using nanoparticles [16]. Aluminum, cadmium, cobalt, copper, gold, iron, lead, silver, and zinc are often utilized in the synthesis of nanoparticles. Nanoparticles have unique characteristics such as diameters ranging from 10 to 100nm, surface characteristics such as pore size, high surface to volume ratio, surface charge with density, crystalline structures, spherical morphologies, color, reactivity, and sensitivity. Metal precursors are employed in the creation of metal nanoparticles. These NPs have distinct optoelectrical properties due to restricted surface plasmon resonance (SPR). In the solar electromagnetic spectrum, noble metal and alkali NPs such as Cu, Au, and Ag exhibit a notable absorption band. In today's cutting-edge materials, the synthesis of size and shape-controlled metal NPs is critical [17].

10.3. Metal oxide nanoparticles synthesis.

Metals such as Cu and Ag, for example, can be extremely toxic to bacteria in trace amounts. Metals have been widely used as antimicrobial agents in a variety of applications in industry, healthcare, and agriculture in general due to their biocidal influence. Metals, unlike other antibacterial agents, are stable under present manufacturing settings and can thus be employed as additives [58,59]. These metal-based additives are currently available in a variety of forms, such as particles, ions absorbed/exchanged in different carriers, salts, hybrid structures, and so on. Many metal oxide nanoparticles have been investigated for electrochemical detection of biomolecules, including ZnO, NiO, MnO₂, TiO₂, Fe₂O₃, and Co₃O₄. Furthermore, mixed metal oxides have gotten a lot of attention in this field. CuO-NPs have distinct properties that make them valuable in a variety of applications, including super-strong materials, sensors, antibacterial agents, and catalysts. Because of the large surface area to volume ratio, it can also interact with other nanoparticles. CuO-NPs have recently been proven to be more effective against E coli and B subtilis than Ag-NPs. Because they are polymer-coated, CuO-NPs are

extensively used as antibacterial agents in paints and textiles. TiO_2 and ZnO are often used because of their photolytic properties. Other fascinating metal-oxide NPs include CeO_2 , CrO_2 , MoO_3 , Bi_2O_3 , and LiCoO_2 . CeO_2 is increasingly being employed as a combustion catalyst in diesel fuels to improve emission quality. Under biological conditions, iron oxide NPs (IO-NPs) must be highly crystalline, monodisperse, and water-soluble, with high magnetization values, reproducible quality, and acceptable biocompatibility. The two forms of superparamagnetic IONP-based nanoparticles are superparamagnetic iron-oxide (SPIO) nanoparticles with a mean crystal size of 50-100 nm and ultra-small superparamagnetic iron-oxide (USPIO) nanoparticles with a size less than 50 nm.[18-20]

10.4. Ceramics NPs.

Ceramic nanoparticles (NPs) are nonmetallic inorganic solids formed by heating and cooling. They are available in a variety of shapes and sizes, including amorphous, polycrystalline, dense, porous, and hollow materials. Researchers are paying close attention to these NPs because to their use in applications such as catalysis, photo-degradation of dyes, photocatalysis, and imaging [21].

10.5. Semiconductor NPs.

Semiconductor materials have qualities that are halfway between metals and nonmetals, providing them a wide range of applications in the literature. Bandgap tuning resulted in considerable changes in the characteristics of semiconductor NPs due to their large bandgaps. As a result, they play an important role in photocatalysis, photo optics, and electronic devices. Several semiconductor NPs are very efficient in water splitting applications due to their ideal bandgap and band edge placements [22].

10.6. Polymeric NPs.

These are often organic-based NPs that are referred to in the literature as polymer nanoparticles (PNPs). They are often nano-spherical or nano capsular in shape. The former are matrix particles with a solid overall mass, whilst the other molecules are adsorbed at the spherical surface's outside edge. The solid mass is entirely enclosed within the particle in the later scenario. Because PNPs are easy to functionalize, they have a wide range of applications in the literature. Lipid nanotechnology is a subfield that focuses on the design and fabrication of lipid nanoparticles for a variety of applications, including drug delivery and RNA release in cancer.[23]

11. Conclusions

Nanoparticles with varying properties are a common form of nanomaterial that has contributed in the growth of nanotechnology. Scientists interested in such approaches have lately produced their nanocomposites as a result of recent advances in the properties of new nanomaterials and their applications. This article defined nanotechnology and explained the procedures used to create nanomaterials from metals, metal oxides, graphene oxides, and polymers. Green techniques, such as plant extracts and microorganism biomolecules, are promising possibilities for synthesis of nanoparticles with low or no toxicity when compared to other methods. This review opens up new avenues for the creation and application of different nanomaterials.

References:-

1. Farooqi, Z.U.R.; Qadeer, A.; Hussain, M.M.; Zeeshan, N.; Ilic, P. Characterization and physicochemical properties of nanomaterials. In *Nanomaterials: Synthesis, Characterization, Hazards and Safety*; Elsevier: 2021, 97-121, <https://doi.org/10.1016/C2020-0-00287-2>.
2. Salem, S.S.; Fouda, A. Green Synthesis of Metallic Nanoparticles and Their Prospective Biotechnological Applications: an Overview. *Biological Trace Element Research* 2021, 199, 344-370, <https://doi.org/10.1007/s12011-020-02138-3>.
3. Varghese, R.J.; Parani, S.; Thomas, S.; Oluwafemi, O.S.; Wu, J. Introduction to nanomaterials: synthesis and applications. In *Nanomaterials for Solar Cell Applications*; Elsevier: 2019, 75-95, <https://doi.org/10.1016/C2016-0-03432-0>.
4. Barik, T.K.; Maity, G.C.; Gupta, P.; Mohan, L.; Santra, T.S. *Nanomaterials: An Introduction. Nanomaterials and Their Biomedical Applications* 2021, 16, 1.

5. Singh, B.K.; Lee, S.; Na, K. An overview on metal-related catalysts: metal oxides, nanoporous metals and supported metal nanoparticles on metal organic frameworks and zeolites. *Rare Metals* 2020, 39, 751-766, <https://doi.org/10.1007/s12598-019-01205-6>.
6. Salem, S.S.; Fouda, M.M.G.; Fouda, A.; Awad, M.A.; Al-Olayan, E.M.; Allam, A.A.; Shaheen, T.I. Antibacterial, Cytotoxicity and Larvicidal Activity of Green Synthesized Selenium Nanoparticles Using *Penicillium corylophilum*. *Journal of Cluster Science* 2021, 32, 351-361, <https://doi.org/10.1007/s10876-020-01794-8>.
7. Khan, S.; Mansoor, S.; Rafi, Z.; Kumari, B.; Shoaib, A.; Saeed, M.; Alshehri, S.; Ghoneim, M.M.; Rahamathulla, M.; Hani, U. A review on nanotechnology: Properties, applications, and mechanistic insights of cellular uptake mechanisms. *Journal of Molecular Liquids* 2021, 118008, <https://doi.org/10.1016/j.molliq.2021.118008>.
8. Pérez-Hernández, H.; Pérez-Moreno, A.; Sarabia-Castillo, C.; García-Mayagoitia, S.; Medina-Pérez, G.; López-Valdez, F.; Campos-Montiel, R.; Jayanta-Kumar, P.; Fernández-Luqueño, F. Ecological Drawbacks of Nanomaterials Produced on an Industrial Scale: Collateral Effect on Human and Environmental Health. *Water, Air, & Soil Pollution* 2021, 232, 1-33, <https://doi.org/10.1007/s11270-021-05370-2>.
9. Singh, R.; Singh, S. Nanomanipulation of consumer goods: effects on human health and environment. In *Nanotechnology in Modern Animal Biotechnology*; Springer: 2019, 221-254, https://doi.org/10.1007/978-981-13-6004-6_7.
10. Pathakoti, K.; Goodla, L.; Manubolu, M.; Hwang, H.-M. Nanoparticles and Their Potential Applications in Agriculture, Biological Therapies, Food, Biomedical, and Pharmaceutical Industry: A Review. *Nanotechnology and Nanomaterial Applications in Food, Health, and Biomedical Sciences* 2019, 121-162.
11. Elkodous, M.A.; El-Husseiny, H.M.; El-Sayyad, G.S.; Hashem, A.H.; Doghish, A.S.; Elfadil, D.; Radwan, Y.; El-Zeiny, H.M.; Bedair, H.; Ikhdair, O.A.; et al. Recent advances in waste-recycled nanomaterials for biomedical applications: Waste-to-wealth. *Nanotechnology Reviews* 2021, 10, 1662-1739, <https://doi.org/10.1515/ntrev-2021-0099>, <https://doi.org/10.1515/ntrev-2021-0099>.
12. Bayda, S.; Adeel, M.; Tuccinardi, T.; Cordani, M.; Rizzolio, F. The history of nanoscience and nanotechnology: from chemical-physical applications to nanomedicine. *Molecules* 2020, 25, 112, <https://doi.org/10.3390/molecules25010112>.
13. Qiu, L.; Zhu, N.; Feng, Y.; Michaelides, E.E.; Żyła, G.; Jing, D.; Zhang, X.; Norris, P.M.; Markides, C.N.; Mahian, O. A review of recent advances in thermophysical properties at the nanoscale: From solid state to colloids. *Physics Reports* 2020, 843, 1-81, <https://doi.org/10.1016/j.physrep.2019.12.001>.
14. Chivere, V.T.; Kondiah, P.P.; Choonara, Y.E.; Pillay, V. Nanotechnology-based biopolymeric oral delivery platforms for advanced cancer treatment. *Cancers* 2020, 12, 522, <https://doi.org/10.3390/cancers12020522>.
15. El-Naggar, M.E.; Hasanin, M.; Hashem, A.H. Eco-Friendly Synthesis of Superhydrophobic Antimicrobial Film Based on Cellulose Acetate/Polycaprolactone Loaded with the Green Biosynthesized Copper Nanoparticles for Food Packaging Application. *Journal of Polymers and the Environment* 2021, <https://doi.org/10.1007/s10924-021-02318-9>.
16. Alvandi, N.; Rajabnejad, M.; Taghvaei, Z.; Esfandiari, N. New generation of viral nanoparticles for targeted drug delivery in cancer therapy. *Journal of Drug Targeting* 2021, 1-15, <https://doi.org/10.1080/1061186X.2021.1949600>.
17. Shaheen, T.I.; Fouda, A.; Salem, S.S. Integration of Cotton Fabrics with Biosynthesized CuO Nanoparticles for Bactericidal Activity in the Terms of Their Cytotoxicity Assessment. *Industrial and Engineering Chemistry Research* 2021, 60, 1553-1563, <https://doi.org/10.1021/acs.iecr.0c04880>.
18. Hasanin, M.; Hashem, A.H.; El-Rashedy, A.A.; Kamel, S. Synthesis of novel heterocyclic compounds based on dialdehyde cellulose: characterization, antimicrobial, antitumor activity, molecular dynamics simulation and target identification. *Cellulose* 2021, 28, 8355-8374, <https://doi.org/10.1007/s10570-021-04063-7>.
19. Hasanin, M.; Elbahnasawy, M.A.; Shehabeldine, A.M.; Hashem, A.H. Ecofriendly preparation of silver nanoparticles-based nanocomposite stabilized by polysaccharides with antibacterial, antifungal and antiviral activities. *BioMetals* 2021, 34, 1313-1328, <https://doi.org/10.1007/s10534-021-00344-7>.
20. Thakur, M.; Poojary, S.; Swain, N. Green Synthesis of Iron Oxide Nanoparticles and Its Biomedical Applications. *Nanotechnology Applications in Health and Environmental Sciences* 2021, 83-109, https://doi.org/10.1007/978-3-030-64410-9_5.
21. Hashem, A.H.; Al Abboud, M.A.; Alawlaqi, M.M.; Abdelghany, T.M.; Hasanin, M. Synthesis of Nanocapsules Based on Biosynthesized Nickel Nanoparticles and Potato Starch: Antimicrobial, Antioxidant, and Anticancer Activity. *Starch - Stärke n/a*, 2100165, <https://doi.org/10.1002/star.202100165>.
22. Elbasuney, S.; El-Sayyad, G.S.; Tantawy, H.; Hashem, A.H. Promising antimicrobial and antibiofilm activities of reduced graphene oxide-metal oxide (RGO-NiO, RGO-AgO, and RGO-ZnO) nanocomposites. *RSC Advances* 2021, 11, 25961-25975, <https://doi.org/10.1039/D1RA04542C>.
23. Shehabeldine, A.M.; Hashem, A.H.; Wassel, A.R.; Hasanin, M. Antimicrobial and Antiviral Activities of Durable Cotton Fabrics Treated with Nanocomposite Based on Zinc Oxide Nanoparticles, Acyclovir, Nanochitosan, and Clove Oil. *Applied Biochemistry and Biotechnology* 2021, <https://doi.org/10.1007/s12010-021-03649-y>.
24. Campisi, S.; Schiavoni, M.; Chan-Thaw, C.E.; Villa, A. Untangling the role of the capping agent in nanocatalysis: recent advances and perspectives. *Catalysts* 2016, 6, 185, <https://doi.org/10.3390/catal6120185>.
25. Sharaf, O.M.; Al-Gamal, M.S.; Ibrahim, G.A.; Dabiza, N.M.; Salem, S.S.; El-ssayad, M.F.; Youssef, A.M. Evaluation and characterization of some protective culture metabolites in free and nano-chitosan-loaded forms against common contaminants of Egyptian cheese. *Carbohydrate Polymers* 2019, 223, <https://doi.org/10.1016/j.carbpol.2019.115094>.

Synthesis and Characterization of NB-UVB emitting Yttrium phosphate phosphor

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Abstract

For the treatment of psoriasis, vitiligo, atopic dermatitis (eczema), and other photo responsive skin conditions, narrowband UVB has emerged as the preferred phototherapy option. The narrowband UVB emitting polycrystalline sample YPO_4 doped with Gadolinium (Gd^{3+}) was prepared by the Re-crystallization method. The phase formation of the samples was investigated by X-ray powder diffraction (XRD) measurement. The optical property of sample such as photoluminescence (PL) was carried by fluorescence spectrophotometer. The surface morphology of as prepared phosphor was studied by Scanning Electron Microscope (SEM). The photoluminescence spectra showed that the sharp narrow band UVB emission maxima of $\text{YPO}_4:\text{Gd}^{3+}$ is observed at 312 nm, which is in accordance with the ${}^6\text{P}_1 \rightarrow {}^8\text{S}_{7/2}$ optical transition of Gd^{3+} ions. The Stokes shift of the synthesized materials was measured from obtained wavelength of excitation and emission. Because of narrow band UVB emission, this phosphor can be served as a prime candidate for phototherapy application.

Keywords: Narrowband UVB, Stoke shift, Phototherapy, XRD, SEM.

1. INTRODUCTION

The development of luminescent materials has been the subject of extensive research in the past few decades. Luminescent materials in the form of nanostructures have shown some interesting optical properties. These materials have implications in development of a novel type of phosphors for phototherapy applications. The spectrum of electromagnetic radiation is consisted of different wavelengths ranging from 100 nanometers (nm) in the ultraviolet (UV) range to 1 millimeter (mm) in the infrared (IR) range. The division of whole electromagnetic spectrum occupied by ultraviolet radiations (UVR). The convenient partition of ultraviolet radiation take place according to their Biological and Physical characteristic such as UV-C: the rays that do not pass through the earth's atmosphere (200-290 nm) UV-B: the rays responsible for nearly all biological effects following sun light exposure including tanning, burning and skin cancer, (290-320 nm) and UV-A: those rays closest to the visible spectrum that pass-through glass and are the least harmful to the skin (320-400nm) [1]. Ultraviolet radiation (UVR) is well established for treating the more than 40 skin diseases such as psoriasis [2], or vitiligo [3], which could be treated by UV-B radiation, and lichen sclerosus [4], morphea [5] scleroderma [6], cutaneous T-cell lymphoma, lupus erythematosus [7], which could be treated by UV-A radiation. In the treatment of hyperbilirubinemia [8], commonly known as infant jaundice.

Ultraviolet B (UVB) has become the phototherapy treatment of choice for Psoriasis, Vitiligo, Atopic dermatitis (eczema) and other photo-responsive skin disorders. UVB can be divided as narrow-band UVB and broadband UVB. Broadband UVB radiation has been used for the treatment of Psoriasis for decades [9]. Various investigations imply that the Narrowband

ultraviolet-B (NB-UVB) (311-313 nm) is the most favorable range phototherapy than the Broad band ultraviolet-B radiation.

The commercial phosphor $\text{LaB}_3\text{O}_6:\text{Gd}^{3+}$, Bi^{3+} and $\text{CeMgB}_5\text{O}_{10}:\text{Gd}^{3+}$ is used for narrow UVB phototherapy lamps. In our previous work we have reported some UV emitting phosphor materials such as $\text{Na}_2\text{La}_2\text{B}_2\text{O}_7$ [10], $\text{Sr}_2\text{Mg}(\text{BO}_3)_2:\text{Pb}^{2+}$, Gd^{3+} [11], $\text{KCa}_4(\text{BO}_3)_3:\text{Pb}^{2+}$ [12], YBO_3 [13] and $\text{Sr}_2\text{Mg}(\text{BO}_3)_2:\text{Pr}^{3+}$, Gd^{3+} [14].

2. EXPERIMENTAL

2.1 Synthesis of material

The phosphor Gd^{3+} doped YPO_4 was prepared by Re-crystallization method. The stoichiometric amounts of high purity Y_2O_3 (AR) and Gd_2O_3 (AR) were dissolved in to concentrate HNO_3 with deionized water. The resulting solution was considered as $\text{Y}(\text{NO}_3)_3:\text{Gd}^{3+}$. The solution of di-ammonium orthophosphate was added dropped by dropped in formed nitrate solution. The entire homogenous solution was then placed on a hot plate at 70°C for slow evaporation of excess water. The dried precursor was finally crushed and heated at 900°C for 2hr to get white crystalline powder of $\text{YPO}_4:\text{Gd}^{3+}$. The resultant powder sample was then characterized using powder XRD and Spectrophotometer.

2.2. Characterization of samples

The phase purities of $\text{YPO}_4:\text{Gd}^{3+}$ sample was studied using Rigaku miniflex II X-ray Diffractometer with scan speed of 6.000_/min and Cu K α ($k = 1.5406 \text{ \AA}$) radiation in the range 10 - 90° . PL and PL excitation (PLE) spectra were measured on (Hitachi F-7000) fluorescence spectrophotometer at room temperature. The parameters such as spectral resolution, width of the monochromatic slits (1.0 nm), photomultiplier tube (PMT) detector voltage and scan speed were kept constant throughout the analysis of samples.

3. RESULT AND DISCUSSIONS

3.1 Structural properties

The formation crystalline phase of the YPO_4 prepared by Re-crystallization was confirmed by XRD pattern, as shown in Fig. 1. The $\text{YPO}_4:\text{Gd}^{3+}$ XRD pattern and the standard data from the ICDD file (01-084-0335) matched quite well.

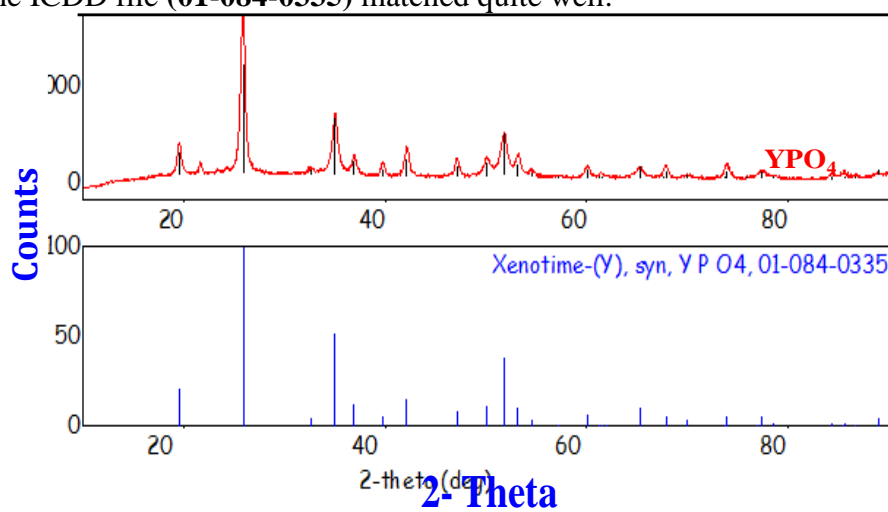


Fig 1. XRD pattern of YPO_4 doped with Gd^{3+} ion.

Additionally, the XRD show that the formed material was completely crystalline and was in single phase, where $a = b = 6.8817$ and $c = 6.0177 \text{ \AA}$. The space group for YPO_4 was $I41/amd$ (141). Furthermore, as the figure illustrates, the addition of the dopant had no

discernible impact. The ionic radii of Y^{3+} ion (0.9\AA) and Gd^{3+} ion (0.93\AA) are quite similar. Therefore, we can deduce that Gd^{3+} ions will substitute for Y^{3+} ions.

3.2 Morphological Study

Fig. 2 shows the FE-SEM images of $\text{YPO}_4:\text{Gd}^{3+}$ powder prepared at $900\text{ }^\circ\text{C}$. The heating at a high temperature caused the phosphor to become strongly agglomerated. It was found that the average particle size was between $1 - 5\ \mu\text{m}$. The findings demonstrate that phosphors have a low sinter temperature and good crystallinity.

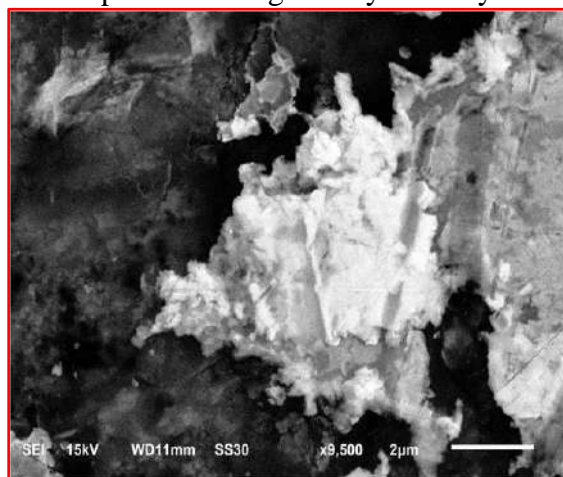


Fig 2. FE-SEM image of $\text{YPO}_4:\text{Gd}^{3+}$ phosphor

3.3 Photoluminescence Analysis

It is well recognized that the ultraviolet radiations mainly those in the UVB ($280 - 320\ \text{nm}$) region are useful for phototherapy. The Gd^{3+} ion doped phosphors which give emission in the narrow UVB region ($280 - 320\ \text{nm}$) are used in phototherapy lamps; therefore it is usually useful for the treatment of many skin diseases such as psoriasis, vitiligo, atopic dermatitis, etc.

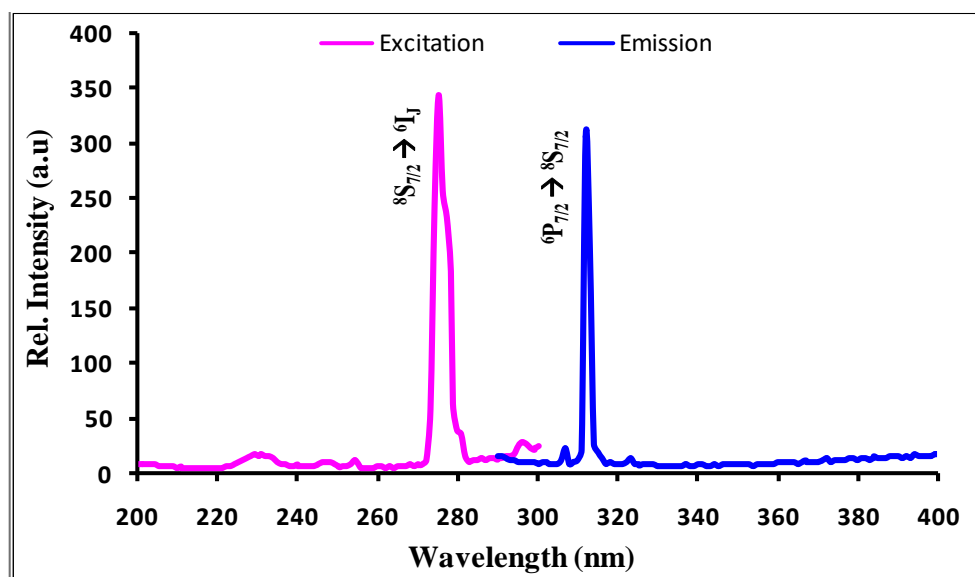


Fig 3. Photoluminescence spectra of Gd^{3+} ion activated YPO_4 phosphor.

Fig 3. represents the room temperature Photoluminescence spectra for sample of composition $\text{Y}_{0.99}\text{Gd}_{0.01}\text{PO}_4$. The phosphor gives sharp narrow emission in the UVB region around $312\ \text{nm}$ corresponding to ${}^6\text{P}_{7/2} \rightarrow {}^8\text{S}_{7/2}$ transition under the excitation of $276\ \text{nm}$. In the emission spectra there was a weak line observed at $304\ \text{nm}$. These lines correspond to the ${}^6\text{P}_{5/2} \rightarrow {}^8\text{S}$ transitions of the Gd^{3+} ion. Finally, the stoke shift was calculated to be $4312\ \text{cm}^{-1}$

4. CONCLUSIONS

The low-cost, low-temperature Re-crystallization approach was successfully used to synthesize the inorganic narrow UVB emitting YPO₄:Gd³⁺ phosphor. The prepared sample's XRD pattern was determined to be fully crystalline and to be in conformity with the corresponding ICDD data. The study of photoluminescence qualities led to the conclusion that phosphor exhibits UV emission, making it useful for phototherapy lamps. The SEM image demonstrates the processes of agglomeration and uneven grain size. The photoluminescence spectra show that, when excited to 275 nm, the YPO₄:Gd³⁺ produces sharp, narrow UVB emission at 312 nm which shows this phosphor is a potential candidate for phototherapy lamp phosphor for treating many skin diseases.

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6. REFERENCES

- [1] Hoare, C., Po, W., Li, A., and Williams, H. 2000. Systematic review of treatments for atopic eczema. *Health Technol. Assess.*, 4, 88.
- [2] H. Honigsmann, W. Brenner, W. Rauschmeier, *Am. Acad. Dermatol.*, 10, (1984), 238.
- [3] L. Scherschun, J.J. Kim, W.H. Lim, *J. Am. Acad. Dermatol.*, 44, (2001), 999.
- [4] A. Kreuler, T. Jansen, M. Stucker, M. Herde, K. Hoffmann, P. Altmeyer, G. Vonkobyletzki, *Clin. Exp. Dermatol.*, 26, (2001), 30.
- [5] J. Hawk, *Radiat. Prot. Dosim.*, 91, (2000), 143.
- [6] A. Morita, K. Kobayashi, I. Isomura, T. Tsuji, J. Krutmann, *J. Am. Acad. Dermatol.*, 43, (2000), 670.
- [7] T. Millard, J. Hawk., *Lupus* 10, (2001), 185.
- [8] C. Dani, E. Martelli, M.F. Reali, G. Bertini, G. Panin, F. Rubaltelli, *J. Pediatr.*, 138, (2001), 438.
- [9] M. Weichenthal, T. Schwarz., *Photodermatol. Photoimmunol. Photomed.*, 21, (2005), 260.
- [10] P. Nagpure, S. Omanwar., *J. Lumin.*, 132, (2012), 2088.
- [11] S. Bhagat, A. Gawande, S. Omanwar, *Opt. Mater.*, 40, (2015), 36.
- [12] A. Gawande, R. Sonekar, S. Omanwar, *J. Lumin.*, 149 (2014) 200.
- [13] A. Gawande, R. Sonekar, S. Omanwar, *Combust. Sci. Technol.*, 186, (2014), 785.
- [14] A. Gawande, R. Sonekar, S. Omanwar, *Mater. Res. Bull.*, 60, (2014), 285.

Photoluminescence Studies of Eu (III) activated YBaB₉O₁₆ phosphor

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Abstract :-

The trivalent Eu³⁺ doped YBaB₉O₁₆ phosphors were synthesized using the traditional solid state diffusion process and were characterized by X-ray diffraction (XRD), photoluminescence (PL) excitation and emission measurements. Under UV stimulation, strong orange emission was seen, with the dominant peak of the radiation coming from the ⁵D₀ → ⁷F₁ transitions of Eu³⁺ ions at 590 nm.

Keyword: - XRD, Photoluminescence, Solid State reaction, UV Excitation.

1. INTRODUCTION

REBa₉O₁₆ phosphors were first reported by Fouassier and co-workers [1, 2]. They studied luminescence of europium in these systems for rare earth (RE = La, Gd or Y). These compounds contain two different kinds of cations RE³⁺ and Ba²⁺ by doping with different rare earth ions, such as Eu²⁺, Tb³⁺ and Eu³⁺, efficient blue, green and red colour phosphors can be obtained, respectively in a single host. Therefore, these materials are considered to be suitable candidates as universal hosts of the luminescent materials for tri-color lamps. Subsequent research focused on YBaB₉O₁₆ since a number of yttrium compounds provide suitable hosts for rare earth luminescence [3–7], and GdBaB₉O₁₆, in context of the role of Gd³⁺ as ‘sensitizer intermediate’ as well as for PDP application [8].

NdBaB₉O₁₆ has also been investigated as a potential laser material [9]. REBaB₉O₁₆ (RE= La, Gd or Y) possesses a property like low alkaline earth content, they show a high chemical stability, favorable for use in fluorescent lamps [10]. Among Ln-doped materials, Eu³⁺-doped materials found much interesting due to simple lower energy levels scheme of Eu³⁺ ions as well as its applications as the red emitting phosphor by its intense, narrow and monochromatic red emission around 610 nm as a result of ⁵D₀ - ⁷F₂ transitions [11, 12].

Strong broad band luminescence is typically seen in Eu-doped solid-state materials, with decay times of between 600 and 1500 ns. From the ultraviolet to the red part of the electromagnetic spectrum, luminescence can occur, however it is very reliant on the host lattice. The intensity of the Eu emission is high enough to find significant industrial uses, such as in LEDs, electroluminescent lamps and display devices, X-ray imaging detectors, scintillation detectors, and fluoride doped with europium [13 - 16].

Due to their intense, narrow, and monochromatic ⁵D₀ → ⁷F₂ emission in the red spectral region, trivalent rare earth (Eu³⁺) doped yttrium-based phosphors with non centrosymmetric site have found widespread use in display panel applications of various types, including plasma display panels, light emitting diodes, and field emission displays. The reflecting layer, dielectric layer, black matrix, phosphors, and their blending gas mixture are some of the factors that affect the luminescence efficiency of fluorescent lamps [17, 18, 19]. Because of their resonant radiation of He-discharge (253.7 nm) and the excited state of molecular He ions, yttrium-based phosphors should exhibit good luminous qualities under ultraviolet (UV) light [20].

2. EXPERIMENTAL

The $\text{YBaB}_9\text{O}_{16}:\text{Eu}^{3+}$ phosphor was prepared by the Conventional solid state diffusion method. The starting raw material were stoichiometric mixture of reagent grade Y_2O_3 (S.D. fine), $\text{Ba}(\text{NO}_3)_2$ (Loba 99.9%), H_3BO_3 (Loba 99.9%), Eu_2O_3 (Loba 99.9%). The raw material yttrium oxide and Eu_2O_3 was boiled in HNO_3 (S.D. fine) and evaporated to dryness, so as to convert it into respective nitrate. The stoichiometric amounts of the ingredients were added in formed yttrium nitrate solution. These materials were thoroughly mixed in an Agate mortar with the help of pestle on adding a little amount of acetone and then transferred into china clay basin. After that the material was dried at 120°C for 1 h and sintered at 900°C for 4 h and then allowed to cool down to room temperature (RT). The prepared samples were again grinded and taken for characterizations.

3. RESULT AND DISCUSSION

3.1 XRD

The formation of the crystalline phase was confirmed by X-ray diffraction. Fig. 1 shows XRD pattern obtained for $\text{YBaB}_9\text{O}_{16}:\text{Eu}^{3+}$ powder prepared by Conventional solid-state method. The XRD patterns for samples sintered at 900°C agree well with ICDD card No. 00-055-0792. According to the standard X-ray diffraction pattern ICDD card No. 00-055-0792, the $\text{YBaB}_9\text{O}_{16}:\text{Eu}^{3+}$ lattice possesses Monoclinic structure with a space group $\text{P2}/m(10)$ with lattice parameters $a = 15.5720 \text{ \AA}$, $b = 3.892 \text{ \AA}$ and $c = 6.7427 \text{ \AA}$.

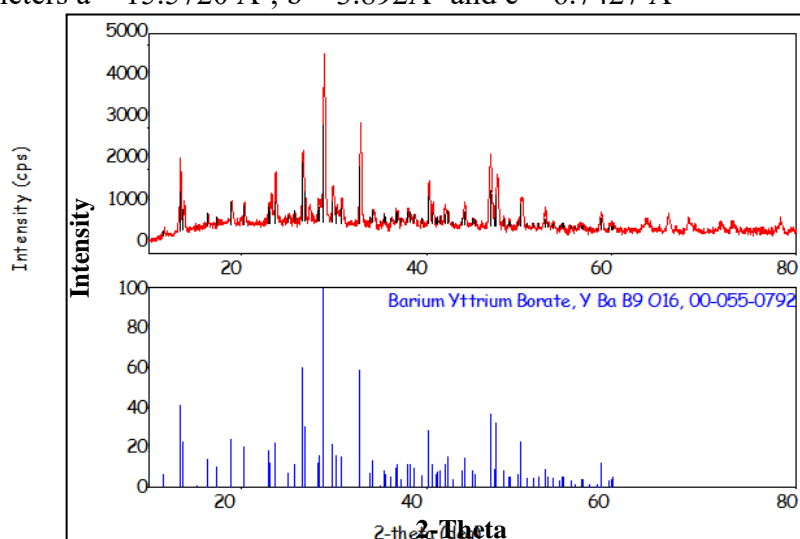


Figure 4 XRD pattern of $\text{YBaB}_9\text{O}_{16}:\text{Eu}^{3+}$ and matched with the ICDD card No. 00-055-0792.

3.2. Photoluminescence

Europium can act as an activator in two forms viz. Eu^{2+} and Eu^{3+} , because $\text{YBaB}_9\text{O}_{16}$ substitutional sites for both these varieties are available, respectively at Ba^{2+} and La^{3+} positions. Eu^{3+} or Eu^{2+} can be identified from the characteristic photo luminescence they exhibit.

Fig. 3 shows the emission spectra of $\text{YBaB}_9\text{O}_{16}:\text{Eu}^{3+}$ exhibits intense yellow emission at 590 nm under UV excitation which is excited by 231 nm. The emission spectrum consists of higher intensity peak at 590 nm under UV excitation which corresponds to the ${}^5\text{D}_0 \rightarrow {}^7\text{F}_1$ transition of Eu^{3+} . The other weak peak at 613 nm occurs which corresponds to the ${}^5\text{D}_1 \rightarrow {}^7\text{F}_2$ transition of Eu^{3+} ions.

Fig. 2 shows the photoluminescence excitation (PLE) spectra measured at 590 nm emission. The excitation spectrum shows that $\text{YBaB}_9\text{O}_{16}:\text{Eu}^{3+}$ has broad band absorption from 200 to 280 nm peaking at 231nm.

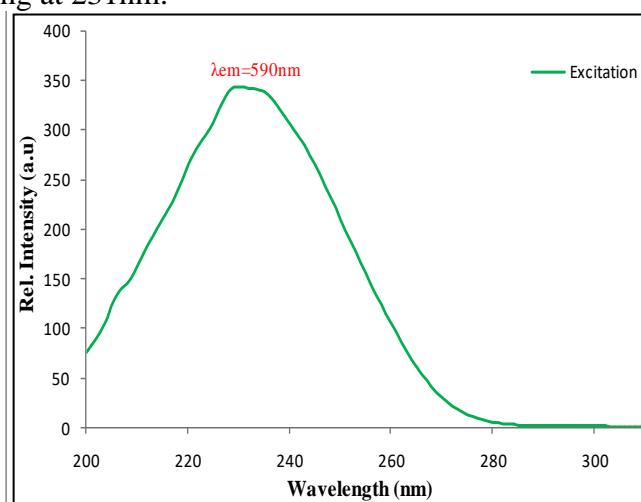


Figure 5 Excitation spectra of $\text{YBaB}_9\text{O}_{16}:\text{Eu}^{3+}$

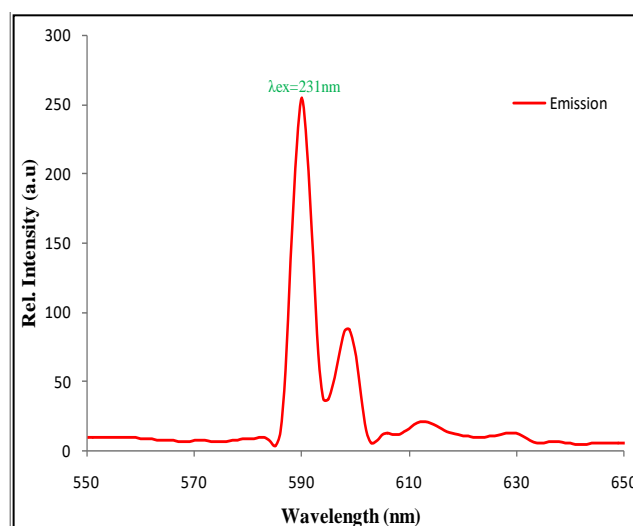


Figure 6 Emission Spectra of $\text{YBaB}_9\text{O}_{16}:\text{Eu}^{3+}$

4. CONCLUSION

The Eu^{3+} doped $\text{YBaB}_9\text{O}_{16}$ phosphor were successfully prepared by conventional solid state diffusion method. This phosphor shows a pure phase of $\text{YBaB}_9\text{O}_{16}:\text{Eu}^{3+}$. The study of the luminescence of Eu^{3+} doped $\text{YBaB}_9\text{O}_{16}$ shows optimum emission at 590nm under the 231nm UV excitation.

5. REFERENCES

1. W. T. Fu; C. Fouassier; P. Haggemuller, *Mater. Res. Bull.*, 23, **1989**, 389.
2. W. T. Fu; C. Fouassier; P. Haggemuller, *Mater. Res. Bull.*, 22, **1987**, 899-909.
3. A. M. Srivastav; M. T. Sobteraj; R. Geiger; E. Banks, *Mater. Chem. Phys.*, 21, **1989**, 327.
4. Z. Yang; J. H. Lin; M. Z. Su; L. P. You, *Mater. Res. Bull.*, 35, **2000**, 2173.
5. Z. Yang; J. H. Lin; M. Z. Su; Y. Tao; W. Wang, *J. Alloys. Compd.*, 308, **2000**, 94.
6. X. Z. Li; X. L. Chen; J. K. Lian; L. Wu; Y. P. Xu; Y. G. Cao, *J. Alloys. Compd.*, 365, (1-2), **2004**, 277-280.

7. W. Park; C. J. Summers; Y. R. Do; H. G. Yang, *J. Mater. Sci.*, 37, **2002**, 4041
8. H. You; X. Wu; X. Zeng; G. Hong; C. Kim; C. Pyun; C. Park; *Mater. Sci. Eng.*, B86, **2001**, 11.
9. Y. Ji; J. Liang; S. Xie; X. Wu, *J. Cryst. Growth*, 137, **1994**, 521.
10. W. T. Fu; C. Fouassier; P. Hagemuller, *Mat. Res. Bull.*, Vol. 22, 899-909, **1987**.
11. X. Guo; Y. Wang; J. Zhang, *J. Cryst. Growth*, 311, **2009**, 2409.
12. L. Li; S. Zhou; S. Zhang, *Solid State Sci.*, 10, **2008**, 1173.
13. F. C. Palilla; B. E. O'Reilly, *Journal of the Electrochemical Society*, Vol. 115(10), **1968**, 1076-1081.
14. G. Fasol, *Science*, Vol 272, (5269), **1996**, 1751- 1752.
15. M. K. Crawford; L. H. Brixner, *J. Lumin.*, Vols. 48-49, **1991** 37-42.
16. H. Heinz; V. Saggern, *Crystal Lattice Defects and Amorphous Materials*, Vol. 18, 1989, 399.
17. Z. Lu; T. Wanjun, *Cer. Inter.* 38, **2012**, 837.
18. P. A. Nagpure; S. K. Omanwar; *International Journal of Self-Propagating High-Temperature Synthesis*. 22 (1) **2013**, 32-36
19. H. S. Gong; H. G. Kim, *Cur. Appl. Phy.* 13, **2013**, 453.
20. A. P. Zambare; K. V. R. Murthy, *Arch. Phy. Res.* 2(3), **2011**, 46-50.

Synthesis and characterization of SnO₂ nanoparticles by Sol-gel Method

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Abstract:

This Research paper devoted to SnO₂ nanoparticles synthesis by using sol-gel method. This article examines the advancements made in SnO₂ nanomaterials for CO₂ gas sensors the material compositions, sensing methods, and characteristics based on SnO₂ nanomaterial's. X-ray diffraction was used to examine the powders. X-ray diffraction was used to characterise the films' structural integrity, confirming that they are crystalline and have a tetragonal structure.

Keyword: Nanomaterials, XRD, Gas sensors.

1. Introduction:

SnO₂ nanoparticles have been synthesised using a variety of techniques, such as sol-gel, molten-salt synthesis, microwave approach, Carbothermal reduction, chemical precipitation, laser-ablation synthesis, hydrothermal method. In this work, SnO₂ nanoparticles were synthesised using a straightforward sol-gel approach [1]. The purpose of this work is to synthesise SnO₂ nanoparticles using the sol-gel method and to investigate their particle nature [2]. These nanomaterials have unique sizes and morphologies. Because of their fascinating properties and captivating potential in the aforementioned domains, materials smaller than 100 nm have piqued the curiosity of scientists and engineers once again Semiconducting metal oxides, such as ZnO and SnO₂, are an efficient class of materials that have made significant contributions to several fields of science and industry due to their controllable size and shape [4]. Solid-state gas sensors find extensive applications in the production of semiconductors, environmental sensing, medical diagnostics, personal safety, and national security [5]. They are among the essential technologies of the modern era. Materials that exhibit property changes in response to surrounding gases may find application as gas sensing materials. The concentrations of the gases can be detected via optical or electrical signals. The colour of an optical gas sensor changes in proportion to the amount of gases it detects [6]. When using an electrical gas sensor, the concentration of the gas can be found either by applying a temperature gradient that is produced by a chemical reaction on a thermoelectric sensing material, or by varying the output voltage as a result of the gas reacting with chemisorbed oxygen at the sensing material's surface [7]. By changing their electrical characteristics, several transition metal oxides show sensitivity to oxidising and reducing gases. Typically, variations in electrical conductance in response to ambient gases are tracked. For example, the conductivities of all the following oxides exhibit a gas response [8]. However, due to its appropriate physicochemical characteristics and cheaper cost when compared to actual materials available for similar applications, SnO₂ is currently the most extensively utilised material for detecting various gases. At moderate temperatures, it is sensitive to a wide range of gases and vapours, including ethanol, H₂, O₂, CO, NO, NO₂, and NH₃. This articles SnO₂ examine the CO₂ gas sensor [9].

2. Experimental Process: Synthesis of SnO₂ Nanomaterials:

Sol-gel method is a combination of two words sol and gel. Sol is a colloid formed from solid particles suspended particles in continuous liquid. Gel is a solid macro-molecule which is dissolved in solvent. Due to simplicity, sol-gel method is the most preferred bottom-up method for the synthesis of nanoparticles [10-11]. It is the method in which suitable chemical solution act as precursor. We employed the effective and straightforward sol-gel approach to prepare the nanoparticles for our SnO₂ nanoparticle manufacturing experiment. Chemical reagents including

sodium hydroxide (NaOH), methylene blue, isopropyl alcohol, and tin (II) chloride dihydrate (SnCl_2) were taken. These substances were bought from M/s Merck and had a high purity of 99.99%. Different amounts of precursor materials such as $\text{SnCl}_4 \cdot 5\text{H}_2\text{O}$ and isopropyl alcohol were taken into consideration. 50 millilitres of isopropyl alcohol were combined with $\text{SnCl}_4 \cdot 5\text{H}_2\text{O}$ solution [12-15]. In a stirrer, the finished mixture was left to stir for two hours. We were able to get a homogeneous solution by this procedure. The pH of the solution was adjusted to around 9–11 by mixing it with 0.1 M NaOH solution poured out of a burette drop by drop. The solution was agitated for an additional thirty minutes in the same stirrer after we had given it two to three hours to settle. The precipitates were cleaned with acetone and distilled water, then dried at 80°C [16-18].

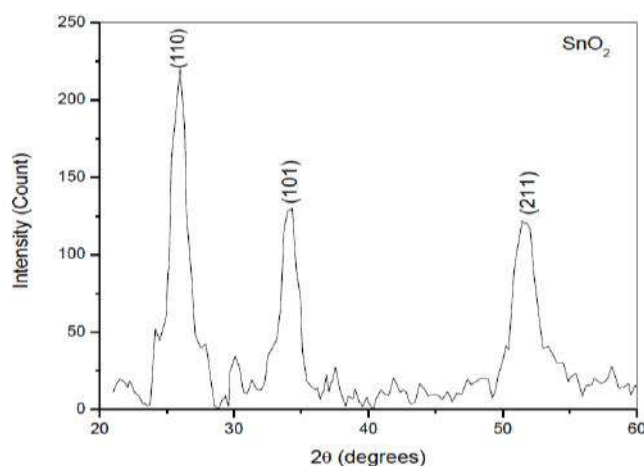


Fig 1: XRD diffraction pattern of SnO_2 Nanoparticles

3. Results and discussion:

XRD patterns of the samples were recorded in an ambient environment using a Holland Philips X-ray powder diffract meter ($\text{CuK } \alpha$, $\lambda = 1.5406 \text{ \AA}$). The phase and purity of the as prepared SnO_2 nanoparticles were determined by XRD pattern of the as prepared SnO_2 samples at 450°C for 1 hour has shown in Fig.1. All the diffraction lines were assigned to tetragonal rutile crystalline phases of tin oxide. The XRD pattern is in excellent agreement with a reference pattern (JCPDS No. 41-1445) of tin oxide [19]. The crystallite size of the prepared powders calculated from XRD line broadening using Debye–Scherer equation, $d = K \lambda / \beta \cos \theta$, where λ is the wavelength of the X-ray radiation ($\text{Cu} - \text{K } \alpha = 1.5406 \text{ \AA}$), K is a constant taken as 0.89, β full width at half maximum height (FWHM in radian) and θ is the diffraction. To estimate average crystallite sizes of SnO_2 the three most intense indexed peaks, as (110), (101), (211) were used, giving d -values of 32.9, 29.7, and 25.4 nm respectively, with the average size of 29.3 nm [20]. The SnO_2 nanoparticles consist of uniform tetragonal particles of 22 – 31 nm size. This is in agreement with the results obtained from the XRD analysis. Thus, the sol – gel method could be employed to synthesize the SnO_2 nanoparticles with narrow size distribution. In this method, it is observed that the speed of the oxide particle precipitation can be modulated by controlling the concentration of the PEG [21].

4. Application of SnO_2 nanoparticles :

Gas sensors work on the principle of transforming the gas adsorption effects on the surface of the active material into a detectable signal in terms of its changed electrical, optical, thermal, mechanical, magnetic (magnetization and spin), and piezoelectric properties. There is a close association between their surface chemical activity and gas sensitivity since gas sensing procedures heavily depend on these reactions [22-23].

Metal oxide nanomaterials exhibit intriguing characteristics that have several uses in a wide range of scientific and technological fields, including paint, sunscreen, antimicrobial coatings, memory drives, LEDs, sensors, solar cells, and wastewater treatment [24].

The general principle of gas detection applicable to the most of metal-oxide gas sensor is the variation in the electrical conductivity. The variation in electrical conductivity is brought by the interaction between the gas molecules and oxygen (adsorbed) on the metal oxide surface. Due to the adsorption of oxygen on the surface of metal oxide, the trapping of electrons take place resulting in an increase or decrease in the concentration of free charge carriers depending upon the n or p type of semiconductor [25].

References

- [1] A. Ciuciumis, I. Cernica CAS (2005). 'Proceedings Synthesis and characterization of indium tin oxide and cerium dioxide thin films by Sol-Gel method', International Semiconductor Conference, volume. 2, Pages 425-428.
- [2] S.S.Park, J.D. Mackenzie (1995). 'Sol-gel-derived tin oxide thin films' Thin films solids, Volume 258(1–2), Pages 1-359.
- [3] Azam Anaraki Firooz, Ali Reza Mahjoub, Abbas Ali Khodadadi (2008). 'Preparation of SnO₂ nanoparticles and nanorods by using a hydrothermal method at low temperature', Materials Letters, Volume 62(12–13), Pages 1747-2042.
- [4] E. R. Leite , I. T. Weber , E. Longo | J. A. Varela (2000). 'A New Method to Control Particle Size and Particle Size Distribution of SnO₂ Nanoparticles for Gas Sensor Applications', Advanced Materials, Volume 12(13), Pages 935-998.
- [5] R.E. Hester, R.M. Harrison, and C.Royal Society (2007). 'Nanotechnology: consequences for human health and Environment.' Cambridge: Royal Society of Chemistry, Volume 24, No. of Pages 148.
- [6] Nicholas S. Wigginton, Kelly L. Haus, Michael F. Hochella Jr (2007). 'Aquatic environmental nanoparticles', Environmental Monitoring, J. Environ. Monit., Volume 9, Pages 1306-1316.
- [7]. L. J. Zhou, G. N. Wu, P. Tang, H. L. Wang, and C. Su, (2006). 'Model of semiconductor gas sensor for monitoring dissolved gases in insulation oil', Automation of Electric Power Systems, volume 30(10), Pages 75–79.
- [8] J.Huang, N. Matsunaga, K. Shimanoe, N. Yamazoe, and T. Kunitake, (2005). 'Nanotubular SnO₂ templated by cellulose fibers: synthesis and gas sensing', Chemistry of Materials, volume 17(13), Pages 3513–3518.
- [9] Azra Parveen , Syed Afzal Ahmad, Shraddha Agrawal , Ameer Azam (2017). 'Room temperature variation in dielectric and electrical properties of Mn doped SnO₂ nanoparticles,' International Conference on Recent Trends in Engineering and Material Sciences (ICEMS-2016), Volume 4(9), Pages 9429–9433.
- [10] Paulo G. Mendes , Mario L. Moreira, Sergio M. Tebcherani , Marcelo O. Orlandi , J. Andre´s, Maximu S. Li ,Nora Diaz-Mora , Jose´ A. Varela , Elson Longo (2012), "SnO₂ nanocrystals synthesized by microwave-assisted hydrothermal method: towards a relationship between structural and optical properties ", J Nanopart Res, Vol.14,750.
- [11] Feng Gu , Shu Fen Wang , Chun Feng Song , Meng Kai L u , Yong Xin Qi ,Guang Jun Zhou , Dong Xu , Duo Rong Yuan (2003), "Synthesis and luminescence properties of SnO₂ nanoparticles", Chemical Physics Letters, Vol. 372,Pages 451–454.
- [12] D. G. Shah and P. M. Trivedi (2012) "Preparation, characterization of nanometer SnO₂" , Pelagia Research Library , Der Chemica Sinica, Vol.3, Pages 1002- 1008,.
- [13] A. Feinle, M. S. Elsaesser, N. H using, (2016). ' Sol-gel synthesis of monolithic materials with hierarchical porosity," Chemical Society Reviews, volume 45(12), Pages 3377–3399,.
- [14] A. Feinle, M. S. Elsaesser, N. H using, (2016). ' Sol-gel synthesis of monolithic materials with hierarchical porosity," Chemical Society Reviews, volume 45(12), Pages 3377–3399,.
- [15] Yile Liao, Yang Xu, Yanthai Chan (2013), 'Semiconductor nanocrystals in sol-gel derived matrices ' Physical Chemistry Chemical Physics, volume 15(33), Pages 13694-13704.
- [16] G. J. Owens, R. K. Singh, F. Foroutan et al (2016) "Sol-gel based materials for biomedical applications," Progress in Materials Science, volume 77, Pages 1–79,
- [17] Madzlan Aziz, Saad Saber Abbas, Wan Rosemaria Wan Baharom, Wan Zuraidah Wan Mahmud (2012), ' Structure of SnO₂ nanoparticles by sol–gel method' Materials Letters, Volume 74, Pages 62-64.

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- [18] Madzlan Aziz, Saad Saber Abbas, Wan Rosemaria Wan Baharom (2013). ' Size-controlled synthesis of SnO₂ nanoparticles by sol–gel method', Materials Letters, Volume 91, Pages 31-34.
- [19] Fredy Kurniawan and Rahmi Rahmi (2017). 'Synthesis of SnO₂ Nanoparticles by High Potential Electrolysis' Bulletin of Chemical Reaction Engineering & Catalysis, Volume 12(2), Pages 281-286.
- [20] M. S. Pereira, F. A. S. Lima, C. B. Silva, P. T. C. Freire, I. F. Vasconcelos (2017). 'Structural, morphological and optical properties of SnO₂ nanoparticles obtained by a proteic sol–gel method and their application in dye-sensitized solar cell ', Journal of Sol-Gel Science and Technology Volume 84, pages 206–213
- [21] Hyo-Jin Ahn, Hyun-Chul Choi, Kyung-Won Park, Seung-Bin Kim, Yung-Eun Sung (2004). "Investigation of the Structural and Electrochemical Properties of Size-Controlled SnO₂ Nanoparticles", J. Phys. Chem. B, Vol.108, Pages 9815-9820.
- [22] G. Korotcenkova and B.K. Cho (2017). 'Metal oxide composites in conductimetric gas sensors achievements and challenges', Sensors and Actuators B Chem, Volume 244, Pages 182-210.
- [23] Detlev Möller, Manfred Decker, Jens Zosel, Wolfram Oelßner (2019). 'Carbon dioxide in general. In Carbon Dioxide Sensing', Fundamentals Principles, and Applications, Wiley-VCH: Weinheim, Germany, Pages 39–40.
- [24] Prakash Viswanathan , Ashish Kumar Patel, Jayant Pawar, Amit Patwardhan, Rabinder Henry (2018). 'Fabrication of Tin Oxide Nanoparticles for CO₂ Gas Sensing Layer'. IETE Journal of Research, Volume 66, Pages 460–465
- [25] Jong-Heun Lee (2009). 'Gas sensors using hierarchical and hollow oxide nanostructures: overview', Sensors and Actuators B: Chemical, Volume 140(1), Pages 319-336.

Review of synthesis of nanoparticles by various methods

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Abstract

This review paper we have to highlights on the various methods use for synthesis of different materials. Synthesis means by procedure we have to make nanoparticles from core materials. For making nanoparticles there are number of methods like Physical Method, Biological Method and Chemical Method. In these articles we have to focus on various type of above methods and there process for synthesized nanoparticles. Top- down approach, Bottom–up approach, Synthesis of Nanoparticles from Microbes and plants, Chemical deposition method, Sol-gel method these methods are briefly discussed in these articles. It includes a wide range of materials with at least one dimension between 1 and 100 nm. Reasonably designed nanomaterials can have exceptionally large surface areas. Outstanding magnetic, electrical, optical, mechanical, and catalytic capabilities that differ significantly from their bulk counterparts can be created in nanomaterials.

1. Introduction:

Over the past century, there has been a substantial growth in the field of nanotechnology. Furthermore, nanotechnology is now directly or indirectly related to a wide range of academic subjects. Nanotechnology is the invention, synthesis, characterisation, and use of materials and devices by size and form manipulation at the nanoscale." "Nano" is a prefix that appears as a term in all streams, even product advertisements [1-2]. The word "nano" actually comes from the Latin word nanus, which meaning "dwarf," or the Greek word nanos. It brings together the disciplines of material science, biosciences, chemistry, and solid state physics. Thus, one needs to possess a thorough understanding of physics, chemistry, material science, solid state physics, and the biosciences rather than just being well-versed in one area. Nanotechnology is being used more and more in almost every branch of science and technology. Recently, the production of metal nanoparticles with specific properties has attracted a lot of attention as a subject of study. Many methods have been put forth for the synthesis of these materials: ball milling in the solid phase; chemical vapour condensation, arc discharge, hydrogen plasma—metal reaction, and laser pyrolysis in the vapour phase; microemulsion, hydrothermal, sol-gel, sonochemical, and microbial processes in the liquid phase. The features of metal nanoparticles are largely determined by the synthesis techniques employed. This study covers the principles, advantages, and disadvantages of each synthesis technique [3-4].

2. Techniques for synthesis of Nanomaterials

- 1) Top- down approach
- 2) Bottom–up approach
- 3) Physical Method
- 4) Biological Method
- 4) Chemical Method

2.1 Top-down approach: In a top-down method, the bulk material is broken down into particles or structures that are nanoscale. Techniques for creating micron-sized particles have been expanded upon by top-down synthesis. Top-down methods are less complex and rely on splitting or removing bulk material to create the right structure with the right characteristics [6].

2.2 Bottom-up approach: The "bottom-up" strategy is an alternative that may result in less waste and be more cost-effective. The term "bottom-up approach" describes the process of building a substance from the bottom up, either molecule by molecule, cluster by cluster, or atom by atom. A large number of these methods are either in the early stages of development or are just starting to be applied in the commercial manufacturing of nanopowders [7].

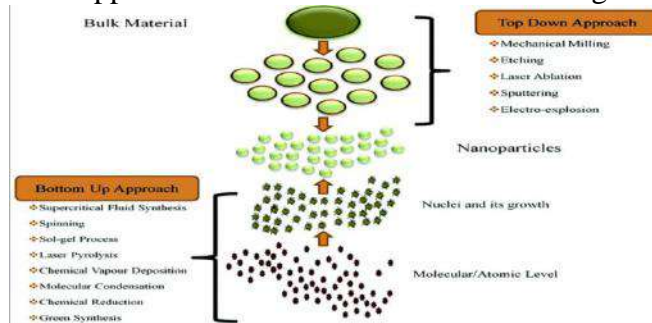


Fig 2: Bottom up & Top Down approach Method

2.3 Physical methods: Physical synthesis techniques have several advantages over chemical ones, such as uniform nanoparticle distribution and clean thin film generation without solvent contamination. There are significant disadvantages to the physical creation of nanoparticles at atmospheric pressure. The tube furnace, for example, requires a large amount of space, energy to raise the temperature surrounding the source material, and time to establish thermal stability. Furthermore, a typical tube boiler requires more energy than a few kilowatts to warm up for several tens of minutes before reaching a constant operating temperature. It was demonstrated that silver nanoparticles may be synthesised using a tiny ceramic heater with a localised heating area. Utilising, the primary materials were vaporised by using the tiny ceramic heater [8-9].

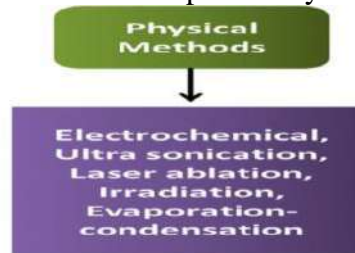


Figure 3: Physical methods

2.4 Biological Method

2.4.1 Synthesis of Nanoparticles from Microbes: Nanoparticles play a major role in materials chemistry. It can be used to control bacteria, fungi, and other microbes (Figure 1). In biosynthesis, physical or chemical methods can be applied. Different nanostructures may appear depending on the region. For example, the *Pseudomonas stutzeri*, which is isolated from silver ores, may accumulate silver particles with a diameter of 27 nm and a length ranging from 16 to 40 nm, and decrease Ag ions. Magneto tactic bacteria are a further example; they can generate magnetite Fe_3O_4 or reagent Fe_3S_4 . Around 650 different types of harmful germs can be killed by the antibacterial substance silver [10].

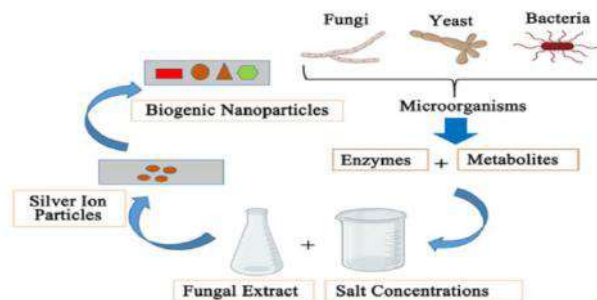


Figure 4.1: Synthesis of Nanoparticles from Microbes

2.4.2 Synthesis of Nanoparticles from Plants: Because they don't require complex cell culture and preservation procedures, plant extracts—which are used as reducing agents in the production of nanoparticles—are preferable to biological processes (Figure 4.2). Various plant components, such as bark, fruit, root, and pericarp extracts, are used to manufacture silver, gold, platinum, and titanium nanoparticles in a range of sizes and shapes. Gathering the required plant parts, washing them in distilled water to remove any epiphytes and necrotic matter, cleaning and drying the plant source for ten to fifteen days, pulverising it with a household mixer, and boiling ten grammes of the dried powder in one hundred millilitres of deionized distilled water are the steps involved in producing different types of nanoparticles [11-12].

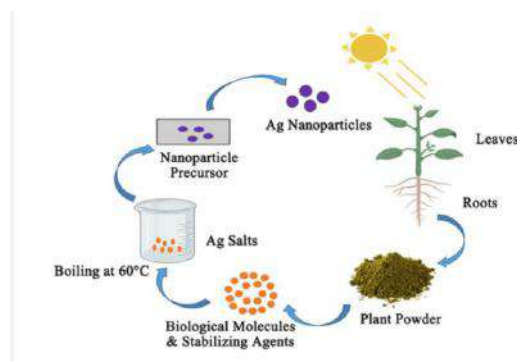


Figure 4.1: Synthesis of Nanoparticles from Plants

5) Chemical Method: Nanoparticles are produced via the following chemical processes: Vapour synthesis, solvothermal, hydrothermal, thermal breakdown, precipitation, and chemical vapour deposition (CVD) are a few examples. The particles formed by converting gases in furnace reactors or hot walls are generally quite clean, despite forming agglomerated particles.

5.1) Chemical Vapour Deposition Method: Chemical vapour deposition is the term used to describe any process that creates a thin solid layer on a substrate by the interaction of adsorbed precursors from the gas phase mediated by the surface. Due to their reactive nature, CVD procedures differ from PVD physical processes such as sputtering and evaporation. A mechanism known as "surface-mediated" creates the solid film when a heterogeneous reaction occurs at the substrate surface..

A schematic similar to the one in Figure 5.1 can help you understand the various roles that a CVD reactor plays. Chemical vapour deposition methods can be broken down into multiple discrete phases: The precursor chemicals need to be given to the CVD reactor beforehand. It is necessary to transfer precursor molecules from the reactor's inside to the substrate's surface, often by combining fluid transport and diffusion. Reaction pressure and reactor configuration are often process-specific and can change significantly, so we won't be thinking about them at this time [13-14].

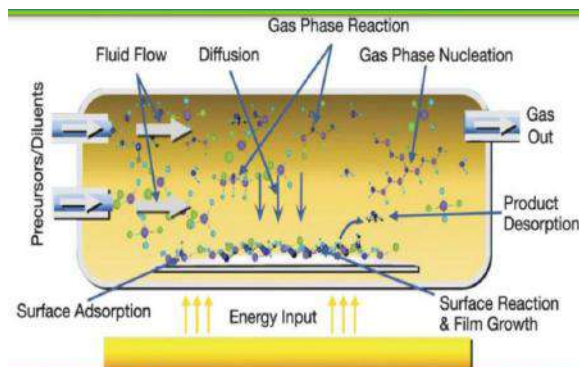


Figure 5.1: Schematic representation of Chemical Vapour Deposition Method

2.5 Sol-gel method: The terms "sol" and "gel" combine to form the term "sol-gel method." Sol is a colloid that is made up of suspended solid particles in a liquid that is continuous. Gel is a macromolecule that is solid and dissolves in a liquid. The most popular bottom-up method for creating nanoparticles is the sol-gel method because of its ease of use. This process uses an appropriate chemical solution as a precursor. In the sol-gel process, metal oxide and chloride are commonly utilised as precursors. The precursor is distributed throughout the host liquid by employing a variety of techniques, including shaking, sonication, and stirring. The final solution is made up of a liquid and solid phase that is separated to recover the nanoparticles using various methods like centrifugation, sedimentation, and filtration. The sol-gel method's schematic diagram is displayed in Figure 5.2. The experimental set up is very simple. Sol is obtained by either hydrolysis or polymerization reactions by adding suitable reagents in the precursor solution. The sol can be deposited onto preferred substrates as thin films using two techniques, viz. (1) spin coating and (2) dip coating [15-16].

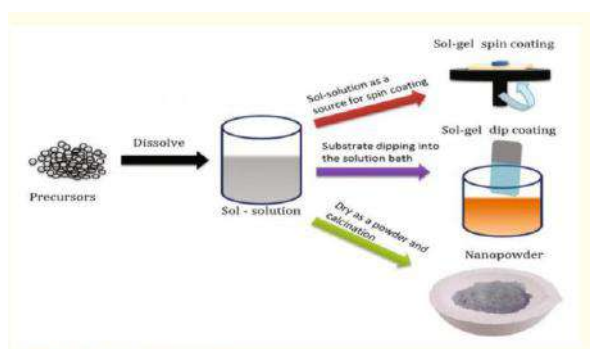


Figure 5.2: Schematic representation of Sol-gel Method

References :

1. Shaban Abdul, Telegdi Judit, Molnár Nikolett, Felhősi Ilona (2018). ' Chapter 16 - Functional thin films and nanostructures for sensors', *Fundamentals of Nanoparticles*, Pages 485-519
2. Amit Rastogi, Poonam Singh, Farid A. Haraz, Ahmed Barhoum (2018). ' Chapter 19 - Biological synthesis of nanoparticles: an environmentally benign approach', *Fundamentals of Nanoparticles*, Pages 571-604
3. Mansoori G., Fauzi Soelaiman T. (2005). ' Nanotechnology—An Introduction for the Standards Community'. *Jornal ASTM Int.* ;Volume 2: Pages 1–22.
4. Jaison Jeevanandam, Ahmed Barhoum, Yen S. Chan, Alain Dufresne and Michael K. Danquah (2018). ' Review on nanoparticles and nanostructured materials: history, sources, toxicity and regulations', *Volume 9*, Pages 1050–1074.
5. Pratim Biswas, Chang-Yu Wu (2005). ' Nanoparticles and the Environment', *Air & Waste Management Association*, Volume 55, 708 –746
6. S Anu Mary Ealia and M P Saravanakumar (2017). ' A review on the classification, characterisation, synthesis of nanoparticles and their application '. *IOP Conf. Series: Materials Science and Engineering*, Volume 3, Pages
7. Namita Rajput (2015). ' Methods of Preparation of Nanoparticles – A Review'. *International Journal of Advances in Engineering & Technology*, Volume 7(4), Pages 1806-1811.
8. Abdul wasy zia, Martin Birkett, Mohsin Ali Badshah, Munawar Iqba (2021). ' Progress *in-situ* synthesis of graphitic carbon nanoparticles with physical vapour deposition', *Progress in crystal growth and characterisation of materials*, Volume 67(3), Pages 100534
9. Surender and OAjay Gahlot (2021). ' Physical Methods of Nanoparticles Preparation – An Overview', *International Journal of Advances in Engineering and Management (IJAEM)*, Volume 3(12), Pages 812-816.
10. Nasrollahzadeh M, Sajadi SM, Sajjadi M, Issaabadi Z (2019). ' An introduction to nanotechnology'. *Interface Sci Technology*, Volume 28, Pages 1–27.
11. Elmer W, White JC (2018). ' The future of nanotechnology in plant pathology'. *Annual Review of Phytopathology*, Volume 25(56), Pages 111–133
12. Lalitha A. Kolahalam , I.V. Kasi Viswanath , Bhagavathula S. Diwakar , B. Govindh , Venu Reddy , Y.L.N. Murthy (2019). ' Review on nanomaterials: Synthesis and applications'. *Materials today Proceeding*, Volume 18(6), Pages 2182-2190.
13. T. Satyanarayana and S. Sudhakar Reddy (2018). ' A Review on Chemical and Physical Synthesis Methods of Nanomaterials', *International Journal for Research in Applied Science & Engineering Technology (IJRASET)*, Volume 6(1).
14. M.C. Roco (2005). ' Chapter - International Perspective on Government Nanotechnology Funding'. *Journal of Nanoparticle Research*, Volume 7(6).
15. Madzlan Aziz, Saad Saber Abbas, Wan Rosemaria Wan Baharom (2013). ' Size-controlled synthesis of SnO₂ nanoparticles by sol-gel method', *Materials Letters*, Volume 91, Pages 31-34.
- [16] Fredy Kurniawan and Rahmi Rahmi (2017). 'Synthesis of SnO₂ Nanoparticles by High Potential Electrolysis' *Bulletin of Chemical Reaction Engineering & Catalysis*, Volume 12(2), Pages 281-286.