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.

3.3.2. Number of research papers per teachers in the Journals notified on UGC website during the year

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S N	Title of paper	Name of the author/s	Department of the teacher	Name of journal	Year of publication	ISSN number	Link to the recognition in UGC enlistment of the Journal
1	Analyzing The Impact Of Social Media On Market Anomalies In Tier 2 Cities	Dr. S. B. Kadu, Dr. S. A. Chourasia	Commerce	Library Progress International,Vol.44, No.2s, Jul-Dec 2024: P.1905-1915	2023-2024	2320-317X	www.bpasjournals.com
2	Exploring the Frontier:- Unveiling Novel trends in E-Commerce for Future Growth and Innovation	Dr. Pratik. B Upase	Commerce	International Journal of Cultural studies And Social Sciences	2023-2024	2347-4777	https://tgi.org.in/journal-international-journal-of-cultural-studies-and-social-sciences/
3	Impact of Covid-19 on Indian Economy	Dr Devendra Shivdas Rangacharya	Department of Economics	Sanshodhak	2023-2024	2394-5990	https://ugccare.unipune.ac.in/Apps1/User/WebA/SearchList
4	Dr Panjabrao Deshmukh: Champion of Education in Rural India	Dr Devendra Shivdas Rangacharya	Department of Economics	Research Awakening: Contribution of Dr Panjabrao Deshmukh in Nation Building	2023-2024	2456-9504	NA

5	Behaviour of Bianchi Type V model In Modified Theory of Gravity With specific Form of Hubble Parameter	Dr. P. P. Khade	Mathematics	Jordan Journal of Physics	2023-2024	1994-7607	https://scopus.com/sourceid/21100871853
6	Bianchi Type V Cosmological Scenario in f(R,T) Gravity Theory With Special form of Scale factor	S. M. Warbhe, P. P. Khade, M. S. Palaspagar	Mathematics	Journal of Advanced Zoology	2023-2024	0253-7214	https://www.scopus.com/sourceid/22525
7	Bharatiy Sansadiy Shasan Pranali	A. P. Ingole	Political Science	Sanshodhak	2023-2024	2394-5990	NA
8	Coping Strategies and Positive Mental Health Among Frontline and Non-frontline Workers	S. D. Wakode	Psychology	Snshodhak	2023-2024	2394-5990	https://ugccare.unipune.ac.in/apps1/Content/Files/pdf/Sanshodhak-%20Dec.%2 02022.pdf
9	Emotional Maturity and Resilience:A Correlational Study	S. D. Wakode	Psychology	Snshodhak	2023-2024	2394-5990	https://ugccare.unipune.ac.in/apps1/Content/Files/pdf/Sanshodhak-%20Dec.%20 2022.pdf
10	Psychological Wellbeing Among Musicians	S. D. Wakode	Psychology	Snshodhak	2023-2024	2394-5990	https://ugccare.unipune.ac.in/apps1/Content/Files/pdf/Sanshodhak-%20Dec.%20 2022.pdf
11	Smartphone Addiction and Dark Personality Triad	S. D. Wakode	Psychology	Snshodhak	2023-2024	2394-5990	https://ugccare.unipune.ac.in/apps1/Content/Files/pdf/Sanshodhak-%20Dec.%202022.pdf
12	Effect of Zingiber officinale and Tinospora cordifolia on Freshwater Fish Ophocephalus striatus (Bloch 1973)	Dr. S. H. Rathod	Zoology	Research Journal for Agricultural Science	2023-2024	0976-1675	https://ugccare.unipune.ac.in/Apps1/User/WebA/SearchList

13	Bioinformatics Applications of Artificial Intelligence in Genomics and Proteomics	Dr. Y. D. Akhare	Zoology	African Journal of Biological Sciences (Scopus Indexing)	2023-2024	2663-2187	https://www.afjbs.com/issue-content/bioinformatics-applications-of-artificial-intelligence-in-genomics-and-proteomics-3359
14	Deep Learning for Automated Detection of Cancerous Cells in Medical Imaging	Dr. Y. D. Akhare	Zoology	African Journal of Biological Sciences (Scopus Indexing)	2023-2024	2663-2187	http+H4:H8s://www.afjbs.com/issue-content/deep-learning-for-automated-detection-of-cancerous-cells-in-medical-imaging-3360
15	A comparative quality evaluation o honey made by *A. dorsata* and *A. cerena indica* from the Melghat region of Maharashtra	Dr. Y. D. Akhare	Zoology	International Journal of Food and Nutritional Sciences (UGC Care)	2023-2024	2320 7876	https://ugccare.unipune.ac.in/Apps1/User/WebA/ViewDetails?JournalId=101000790&flag=Search
16	Growth Response of Juvenile Rohu (Labeo rohita) Exposed to Variying Amounts of Peppermint diet with Protein	Dr. Y. D. Akhare	Zoology	Gujrat Agricultural Universities Research Journal (UGC Care)	2023-2024	0250-5193	https://ugccare.unipune.ac.in/Apps1/User/WebA/ViewDetails?JournalId=101000790&flag=Search
17	Deep Learning-Based Diagnostic Models for Early Detection of Alzheimer's Disease Using MRI and Genetic Data	Dr. Y. D. Akhare	Zoology	Frontiers in Health Informatics (Scopus Indexing)	2023-2024	2676-7104	https://healthinformaticsjournal.com/index.php/IJMI/article/view/371
18	Hydrilla Sp.- Freshwater Thymes, As Novel Nano Factories for Metal Nanoparticles	Dr. Y. D. Akhare	Zoology	International Journal of Scientific Research in Science and Technology	2023-2024	2395-6011	https://ijsrst.com/home/issue/view/article.php?id=IJSRST2411117
19	Physical Education in Science	Dr. D. S. Wankhade	Physical Education	An International Multidisciplinary Half	2023-2024	2278-8158	NA

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20	Women Empowerment is necessary for over all development	Dr. D. S. Wankhade	Physical Education	International Journal of Advance and Applied Research	2023-2024	2341-7075	NA
21	SYNTHESIS, CHARACTERIZATION AND ANTIMICROBIAL ACTIVITY OF PLANT PATHOGENS: A STUDY OF 4,5-DIHYDRO ISOXAZOLE DERIVATIVEs	Shubhangi Deshmukh, Mithilesh Rathore, Nilesh Padole	Chemistry	INDIAN JOURNAL OF APPLIED RESEARCH	2023-2024	2249 - 555X|	https://www.worldwidejournals.com/indian-journal-of-applied-research-(IJAR)/
22	Synthesis and Biological Evaluation of Some New 3-Aryl-2-thioxo-2,3-dihydroquinazolin-4(1H)-ones and 3-Aryl-2-(benzylthio) quinazolin-4(3H)- ones as Antioxidants; COX-2, LDHA, - Glucosidase and - Amylase Inhibitors; and Anti-Colon Carcinoma and Apoptosis-Inducing Agents	El-Sayed NNE, Al-Otaibi TM, Barakat A, Almarhoon ZM, Hassan MZ, Al-Zaben MI, Krayem N, **Masand VH,** Ben Bacha A	Chemistry	Pharmaceuticals	2023-2024	1424-8247	10.3390/ph16101392
23	Leveraging nitrogen occurrence in approved drugs to identify structural patterns	Masand VH, Al-Hussain S, Alzahrani AY, El-Sayed NNE, Yeo CI, Tan YS, Zaki MEA	Chemistry	Expert Opinion on Drug Discovery	2023-2024	1746-0441	10.1080/17460441.2023.2266990
24	Design, synthesis, docking studies and biological screening of 2-pyrimidinyl-	Gawali R, Bhosale R, Nagesh N,	Chemistry	Journal of Biomolecular	2023-2024	1538-0254	10.1080/07391102.2023.2266766.

	2, 3-dihydro-1H-naphtho [1, 2-e][1, 3] oxazines as potent tubulinpoly- merization inhibitors	Masand VH, Jadhav S, Zaki MEA, Al-Hussain SA		Structure and Dynamics			
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27	Unveiling dynamics of nitrogen content and selected nitrogen heterocycles in thrombin inhibitors: a ceteris paribus approach	Vijay H. Masand, Sami Al-Hussain, Abdullah Y. Alzahrani, Aamal A. Al-Mutairi, Arwa Sultan Alqahtani, Abdul Samad, Ahmed M. Alafeefy, Rahul D.	Chemistry	Expert Opinion on Drug Discovery	2023-2024	1746-0441	www.tandfonline.com/journals/iedc20

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30	Synthesis, molecular modelling, and biological evaluation of novel quinoxaline derivatives for treating type II diabetes	Fatmah Ali S. Alasmary, Dalal A. Abdullah, **Vijay H. Masand**, Abir Ben Bacha, Abdelsattar Mansour Omar Ebeid, Moustafa E. El-Araby &	Chemistry	Journal of EnzymE InhIbItIon and mEdIcInal chEmIstry	2023-2024	1475-6366	www.tandfonline.com/journals/ienz20

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32	SYNTHESIS, CHARACTERIZATION AND PHARMACOLOGICAL EVALUATION OF SOME NOVEL PYRAZOLE AND ISOXAZOLE DERIVATIVES CARRYING 4-CHLORO 3-METHYL PHENOL (P-CHLORO-M-CRESOL) MOIETY	Sushil K. Pagariya* and Pravin S. Bodkhe	Chemistry	European Journal of Biomedical AND Pharmaceutical sciences ejbps, 2024, Volume 11, Issue 5, 399-409. Scopus Indexed peer reviewer IF 7.48	2023-2024	2349-8870	http://www.ejbps.com
33	SYNTHESIS, CHARACTERIZATION AND PHARMACOLOGICAL EVALUATION OF SOME 2-MERCAPTO- 4-SUBSTITUTED PHENYL, 6-(5-BROMO,2-HYDROXY PHENYL) PYRIMIDINES	Rajendra M. Pathade* and Pravin. S. Bodkhe	Chemistry	European Journal of Biomedical AND Pharmaceutical sciences ejbps, 2024, Volume 11, Issue 5, 174-179. Rajendra et al. Scopus Indexed	2023-2024	2349-8870	Sciences http://www.ejbps.com

34	Solvent Less Green Synthesis of Substituted Dihydropyrimidinones and their Sulfur Analogues Using Mild Organic Acids	Pradnya Nalawade	Chemistry	Journal of emerging technologies and innovative research	2023-2024	2349-5162	https://jetir.org/jetir%20ugc%20approval.pdf
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37	SYNTHESIS AND ANTIMICROBIAL STUDIES OF NEW 2-S TETRA-O-ACETYL-β-D-GLUCOPYRANOSYL-1-ARYL-5-HEPTA-O-ACETYL-β-D-MALTOSYL-2-ISOTHIOBIURETS	Jayant R. Bansod,Sanjay P. Mote, Aashish G. Sarap , Rahul P. Rahate , Rajesh R. Wankahade.	Chemistry	European Chemical Bulletin	2023-2024	3458 –3461	NA

38	Isocyanates: A review of Their Chemical Properties, Industrial Uses, And Health Effects	S. P. Mote, J. R. Bansod, A. G. Sarap	Chemistry	AAYUSHI INTERNATIONAL INTERDISCIPLINARY RESEARCH JOURNAL	2023-2024	2349-638x	NA
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52	Sol-Gel Synthesis and Characterization of SnO2-PPy Multilayer Thick Films	Bhuyar R.S., Raulkar K.B, Lamdhade G.T.	Physics	International Journal of Research in Science and Technology (IJRST)	2023-2024	2249-0604	http://www.ijrst.com
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54	Investigation of Frequency and Temperature Dependent Electrical and Structural Characterization of PVC-PMMA Thin Films with Salicylic Acid Doping	A.B.More, G.T.Lamdhade	Physics	International Journal of Research in Science and Technology (IJRST)	2023-2024	2249-0604	http://www.ijrst.com
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Analyzing The Impact Of Social Media On Market Anomalies In Tier 2 Cities

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Abstract
This study explores the impact of social media on market anomalies in Tier 2 cities, focusing specifically on Amravati. With the rise of social media platforms like Facebook, Instagram, and WhatsApp, consumer behavior in these cities is rapidly evolving, influenced by changing demographics and increased internet access. Market anomalies—such as sudden shifts in product demand and price fluctuations—are becoming more pronounced due to viral social media trends. This research employs a descriptive design, gathering data from 80 respondents through a systematic questionnaire distributed to over 100 customers in Amravati. The findings aim to assess the demographic profile of social media users, examine the influence of social media on purchasing decisions, and analyze how local businesses can adjust their marketing strategies to navigate the complexities of these digital-driven market dynamics. Despite limitations, including potential biases from convenience sampling and self-reported data, the study provides valuable insights into the interplay between social media and market behavior, highlighting emerging opportunities for businesses in Tier 2 cities.

Key Words: Social Media, Market Anomalies, Tier 2 Cities, Consumer Behavior, Influencer Marketing and Demographics

Introduction

Social media has become a powerful force in shaping markets and consumer behavior, even in smaller cities. In Tier 2 cities, where the pace of technological and economic development is increasing, social media plays a significant role in influencing how people shop, interact with brands, and make purchasing decisions. These cities, characterized by growing infrastructure, rising middle-class populations, and expanding internet access, are witnessing notable shifts in market dynamics due to the widespread use of platforms like Facebook, Instagram, and WhatsApp.

Market anomalies refer to unexpected patterns or trends that disrupt the normal functioning of markets. In Tier 2 cities, such anomalies may include sudden changes in product demand, price fluctuations, or unpredictable consumer preferences, often triggered by viral social media trends. For example, a product promoted by an influencer on social media can rapidly gain popularity in these cities, creating a surge in demand that local markets might struggle to meet.

The influence of social media on market anomalies in Tier 2 cities is a relatively new phenomenon, but it is rapidly reshaping the way businesses operate. Local businesses and even larger brands are now adjusting their marketing strategies to account for the unpredictable nature of social media-driven demand. While social media offers businesses a powerful tool for reaching consumers, it also introduces new challenges, such as maintaining inventory for products that might suddenly trend or managing consumer expectations driven by online perceptions.

This study aims to explore the impact of social media on market anomalies in Tier 2 cities, focusing on how businesses and consumers respond to this rapidly changing digital landscape. By understanding these influences, businesses can better navigate the complexities of social media-driven markets and take advantage of emerging opportunities.

Objectives

1. To assess the demographic profile of social media users in Tier 2 cities, including age, gender, educational background.
2. To examine how social media influences consumer behavior and market anomalies in Tier 2 cities.
3. To assess the impact of social media trends on purchasing decisions and unpredictable market patterns in Tier 2 cities.
4. To analyze how businesses in Tier 2 cities can adjust marketing strategies to leverage social media influence and mitigate market anomalies.

Research Methodology

A sample size of 80 respondents was selected from Amravati city using a convenient simple random sampling method. The study employed a descriptive research design, and data was collected from both primary and secondary sources. A systematic questionnaire was developed and distributed to over 100 customers in Amravati city. Following a data mining process, 80 valid responses were retained for final analysis.

Limitations and Scope of the Study

This study has several limitations. Firstly, a convenient simple random sampling technique was used, which may introduce bias and limit the generalizability of the findings beyond the sample of 80 respondents from Amravati city. Additionally, the reliance on self-reported data through questionnaires may lead to response bias, as participants might provide socially desirable answers. The geographical focus on Amravati city restricts the external validity of the findings, as social media usage patterns may differ in other Tier 2 cities or rural areas. Moreover, data collection occurred over a specific timeframe, which may not reflect changing social media trends. Despite these limitations, the study's scope is significant. It explores the relationship between demographic factors—such as age, gender, and educational background—and social media usage, offering valuable insights into digital behavior within Amravati. The findings can inform marketers and businesses in tailoring their social media strategies and provide a foundation for future research in similar contexts. Overall, this study aims to enhance understanding of social media engagement in Tier 2 cities, contributing to discussions on digital literacy and access among diverse demographic groups.

H0:- There is no significant association between demographic factors and social media usage among users in Tier 2 cities.

Table no. 1:- Respondents perspective towards social media for product recommendations

	Respondents	%
Always	11	13.75
Often	21	26.25
Sometimes	48	60
Total	80	100

The data presented in Table No. 1 reflects the respondents' views on using social media for product recommendations. Among the 80 respondents, a majority (60%) indicated that they "Sometimes" rely on social media for product recommendations. Additionally, 26.25% of respondents reported that they "Often" refer to social media for such recommendations, while a smaller group (13.75%) "Always" turns to social media for product recommendations. This suggests that although social media plays a role in influencing product choices, most respondents do not use it consistently but rather occasionally.

Table no. 2: - Respondents view on social media platform influences

	Respondents	%
Facebook	25	31.25
Instagram	17	21.25
YouTube	29	36.25
Twitter	9	11.25
Total	80	100

Table No. 2 illustrates the social media platforms that influence respondents' decisions. Among the 80 respondents, YouTube emerged as the most influential platform, with 36.25% of the respondents citing it as their primary source of influence. Facebook follows closely, influencing 31.25% of the respondents. Instagram accounts for 21.25%, while Twitter plays a relatively smaller role, influencing only 11.25% of the respondents. This indicates that video

content (YouTube) and social networking (Facebook and Instagram) are major drivers of influence, with Twitter having the least impact on product-related decisions among the respondents.

Table no. 3: - Respondents opinion regarding social media impact on purchasing decisions

	Respondents	%
I immediately consider buying the product	23	28.75
I research more before buying	17	21.25
It rarely affects my decisions	24	30
It does not affect my decisions	16	20.00
Total	80	100

Table No. 3 reveals how social media influences purchasing decisions among the 80 respondents. The largest group, 30%, indicated that social media rarely affects their decisions. However, 28.75% of respondents stated that they immediately consider buying the product based on social media influence, showing a direct and strong impact on a significant portion of the group. Another 21.25% of respondents preferred to research more before making a purchase, reflecting a cautious approach. Meanwhile, 20% of the respondents indicated that social media does not affect their decisions at all. This suggests that while social media has a considerable influence on purchasing behavior, many still rely on additional research or remain unaffected.

Table no. 4: - Respondents opinion for social media promotions

	Respondents	%
Yes, frequently	24	30
Yes, sometimes	11	13.75
Rarely	31	38.75
Never	14	17.50
Total	80	100

Table No. 4 presents respondents' views on social media promotions. The highest percentage, 38.75%, stated that they rarely engage with or notice social media promotions. Following this, 30% of the respondents indicated that they engage with social media promotions frequently, suggesting a substantial portion of individuals are regularly influenced by these promotions. 13.75% of respondents acknowledged they are influenced by promotions sometimes, while 17.5% of respondents claimed they never engage with or pay attention to such promotions. This data highlights that while social media promotions are impactful for many, there remains a significant portion of the audience that either rarely or never engages with them.

Table no. 5:- Respondents perspective towards social media influencers on decision to purchase a product

	Respondents	%
Greatly	21	26.25
Moderately	26	32.50
Slightly	19	23.75
Not at all	14	17.50
Total	80	100

Table No. 5 reveals the extent to which social media influencers impact respondents' purchasing decisions. The majority, 32.50%, feel moderately influenced by social media influencers when deciding to buy a product. 26.25% of respondents stated that influencers greatly affect their purchasing decisions, indicating that influencers have a strong impact on a significant segment of the population. 23.75% reported being slightly influenced, while 17.5% of respondents mentioned that influencers do not at all affect their decisions. These findings suggest that while influencers hold considerable sway over many consumers, there is still a notable portion of the audience that remains unaffected or only slightly influenced.

Table no. 6:- Respondents perspective towards social media promotions and trust in a brand

	Respondents	%
Increases trust significantly	14	17.5
Slightly increases trust	16	20.00
No impact on trust	28	35
Decreases trust	22	27.50
Total	80	100

Table No. 6 outlines how social media promotions affect respondents' trust in a brand. A significant portion, 35%, reported that social media promotions have no impact on their trust in a brand. However, 27.5% indicated that these promotions actually decrease trust, suggesting skepticism towards excessive or poorly executed social media marketing. On the positive side, 17.5% said promotions increase trust significantly, while 20% mentioned a slight increase in trust due to such promotions. These results indicate a diverse range of trust responses, where social media promotions can either build or erode brand credibility depending on execution and audience perception.

Table no. 7:- Respondents views on unusual price increases or product shortages due to social media trends

	Respondents	%
Yes, often	11	13.75
Yes, occasionally	21	26.25
Rarely	35	43.75
Never	13	16.25
Total	80	100

Table No. 7 presents the respondents' opinions on the impact of social media trends on unusual price increases or product shortages. The largest group, 43.75%, stated that they rarely experience such occurrences, suggesting that social media trends do not frequently lead to significant market disruptions in their view. However, 26.25% of respondents indicated that they observe such trends occasionally, and 13.75% believe these trends often cause price hikes or shortages. On the other hand, 16.25% reported that they have never noticed such effects. This suggests that while a majority do not perceive frequent disruptions, a notable portion of respondents are aware of the influence of social media on market conditions.

Table no. 8 :- Respondents perspective towards buying behavior

	Respondents	%
I buy more products	15	18.75
I buy the same amount	21	26.25
I buy less	21	26.25
It depends on the campaign	23	28.75
Total	80	100

Table No. 8 shows respondents' views on how social media influences their buying behavior. The largest portion, 28.75%, indicated that their purchasing behavior depends on the campaign, reflecting the significant role of marketing efforts on consumer decisions. Equal percentages (26.25%) reported that they either buy the same amount or buy less, suggesting that for many,

social media does not drastically alter their overall consumption patterns. Meanwhile, 18.75% of respondents mentioned that they buy more products due to social media influences, indicating a smaller group of consumers who are more susceptible to these campaigns. Overall, the results show a diverse range of responses, with campaigns playing a key role in influencing behavior for a notable share of consumers.

Table no. 9:- Respondents view on preferences

	Respondents	%

Through targeted ads	21	26.25
By engaging with customers	21	26.25
By offering promotions	25	31.25
They don't use social media	13	16.25
Total	80	100

Table No. 9 highlights respondents' preferences regarding how social media platforms influence their buying decisions. A significant portion (31.25%) of respondents prefer brands that use social media by offering promotions, indicating that discounts and special deals are a major motivator for consumer engagement. Equal shares (26.25%) of respondents appreciate brands that connect with them either through targeted ads or by engaging with customers, showing that personalized content and interaction are also highly valued. Meanwhile, 16.25% of respondents do not use social media, implying that a small segment of consumers remains unaffected by social media marketing strategies. This table shows that promotions and personalized approaches are key drivers of consumer preferences on social media.

Table no. 10:- Respondents view on sudden demand surges

	Respondents	%
They quickly restock products	17	21.25
They offer discounts to clear old stock	26	32.50
They take no action	11	13.75
I am not aware	26	32.50
Total	80	100

Table No. 10 presents respondents' views on how companies respond to sudden demand surges. The highest percentage of respondents (32.50%) noted that companies offer discounts to clear old stock, showing that price reductions are a common tactic in managing excess inventory. An equal share (32.50%) of respondents stated they are not aware of how companies handle such surges, reflecting a lack of consumer visibility into inventory management practices. Meanwhile, 21.25% of respondents observed that companies quickly restock products to meet the increased demand, indicating proactive supply chain responses. A smaller portion (13.75%) felt that companies take no action, suggesting that some businesses may struggle to manage demand fluctuations effectively. This table underscores varying levels of consumer awareness and perception regarding business responses to market demand.

H0:- There is no significant association between demographic factors and social media usage among users in Tier 2 cities.

Table no. 11:- Following table is showing frequency count of yes and no

Age Group	**Use Social Media (Yes)**	**Use Social Media (No)**	**Total**
18-24	25	5	30
25-34	20	5	25
35-44	10	15	25
Total	**55**	**25**	**80**

Formula for Expected Frequencies (E)

$$E = \frac{(Row\ total)(Column\ total)}{Grand\ total}$$

Table no. 12:- Following table is showing expected frequencies count of Expected Frequencies

	Yes	No

18-24	$E = \frac{(30)(55)}{80} = 20.625$	$E = \frac{(30)(25)}{80} = 9.375$
25-34	$E = \frac{(25)(55)}{80} = 17.1875$	$E = \frac{(30)(55)}{80} = 7.8125$
35-44	$E = \frac{(25)(55)}{80} = 17.1875$	$E = \frac{(25)(55)}{80} = 7.8125$

Age Group	**Use Social Media (Yes)**	**Use Social Media (No)**	Total
18-24	25 (20.625)	5 (9.375)	30
25-34	20 (17.1875)	5 (7.8125)	25
35-44	10 (17.1875)	15 (7.8125)	25
Total	55	25	80

Calculate Chi-Square Statistic:

$$x^2 = \sum \frac{(o - E)2}{E}$$

Table no. 13:- Following table is showing Chi-Square Statistic

Age Group	**Use Social Media (Yes)**	**Use Social Media (No)**
18-24	0.8921	1.9148
25-34	0.4375	0.7680
35-44	2.9301	6.6594

Summing gives:
$\chi 2 \approx 0.8921+1.9148+0.4375+0.7680+2.9301+6.6594 \approx 13.6019$

Degrees of Freedom:
df=(r−1)(c−1) =(3−1)(2−1)=2
The critical value for α=0.05 with df= 2 is **5.991**.
Since 13.6019>5.991, we **reject** the null hypothesis for age group.

Table no. 14:- Following table is showing frequency count of yes and no of gender
Demographic Factor: Gender

Gender	**Use Social Media (Yes)**	**Use Social Media (No)**	**Total**
Male	35	5	40
Female	20	20	40
Total	**55**	**25**	**80**

Formula for Expected Frequencies (E)

$$E = \frac{(Row\ total)(Column\ total)}{Grand\ total}$$

Table no. 15:- Following table is showing expected frequencies count of Expected Frequencies

	Yes	No
Male	$E = \frac{(40)(55)}{80} = 27.5$	$E = \frac{(40)(25)}{80} = 12.5$

Female	$E = \frac{(40)(55)}{80} = 27.5$	$E = \frac{(40)(55)}{80} = 12.5$

Gender	Use Social Media (Yes)	Use Social Media (No)	Total
Male	35 (27.5)	5 (12.5)	40
Female	20 (27.5)	20 (12.5)	40
Total	**55**	**25**	**80**

Calculate Chi-Square Statistic:

$$x^2 = \sum \frac{(o - E)2}{E}$$

Table no. 16:- Following table is showing Chi-Square Statistic

Gender	Use Social Media (Yes)	Use Social Media (No)
Male	2.5410	3.1875
Female	1.3333	4.2000

Summing gives:
$\chi 2 \approx 2.5410+3.1875+1.3333+4.2000 \approx 11.2618$

Degrees of Freedom:

$df=(r-1)(c-1)=(2-1)(2-1)=1$
The critical value for $\alpha=0.05$ with $df=1$ is **3.841**.
Since $11.2618>3.841$, we **reject** the null hypothesis for gender.

Table no. 17:- Following table is showing frequency count of yes and no of Educational Background
Demographic Factor: Educational Background

Education Level	Use Social Media (Yes)	Use Social Media (No)	Total
High School	10	10	20
Undergraduate	25	5	30
Postgraduate	20	10	30
Total	**55**	**25**	**80**

Formula for Expected Frequencies (E)

$$E = \frac{(Row\ total)(Column\ total)}{Grand\ total}$$

Table no. 18:- Following table is showing expected frequencies count of Expected Frequencies

	Yes	No
High School	$E = \frac{(20)(55)}{80} = 13.75$	$E = \frac{(20)(25)}{80} = 6.25$
Undergraduate	$E = \frac{(30)(55)}{80} = 20.625$	$E = \frac{(30)(25)}{80} = 9.375$

Postgraduate	$E = \frac{(30)(55)}{80} = 20.625$	$E = \frac{(30)(25)}{80} = 9.375$

Education Level	Use Social Media (Yes)	Use Social Media (No)	Total
High School	10 (13.75)	10 (6.25)	20
Undergraduate	25 (20.625)	5 (9.375)	30
Postgraduate	20 (20.625)	10 (9.375)	30
Total	55	25	80

Calculate Chi-Square Statistic:

$$x^2 = \sum \frac{(o - E)2}{E}$$

Table no. 19:- Following table is showing Chi-Square Statistic

Gender	**Use Social Media (Yes)**	**Use Social Media (No)**
High School	1.1563	2.8125
Undergraduate	0.9720	1.8294
Postgraduate	0.0195	0.0521

Summing gives:
$\chi 2 \approx 1.1563+2.8125+0.9720+1.8294+0.0195+0.0521 \approx 6.0418$

Degrees of Freedom:
$df=(r-1)(c-1)=(3-1)(2-1)=2$
The critical value for $\alpha=0.05$ with $df=2$ is **5.991**.
Since 6.0418>5.991, we **reject** the null hypothesis for educational background.

Findings
Table No. 1 indicates that among the 80 respondents, a significant majority (60%) rely on social media for product recommendations "Sometimes." Additionally, 26.25% of respondents "Often" utilize social media for such recommendations, while 13.75% "Always" turn to these platforms. This suggests that social media is a common but not universally relied-upon source for product recommendations.
In Table No. 2, YouTube is identified as the most influential platform, cited by 36.25% of respondents as their primary source of influence. Facebook follows closely with 31.25%, while Instagram is mentioned by 21.25% of respondents. Twitter, however, has a smaller impact, influencing only 11.25% of respondents. This indicates that video content and social networking sites play significant roles in shaping consumer decisions.
Table No. 3 reveals that 30% of respondents feel social media rarely affects their purchasing decisions. However, 28.75% indicated that they consider buying a product immediately upon seeing it on social media. A further 21.25% prefer to research more before making a purchase, while 20% stated that social media has no impact on their decisions. This shows a considerable influence of social media on purchasing behavior, though many respondents still seek additional information before committing to a purchase.
According to Table No. 4, the highest percentage of respondents (38.75%) reported that they rarely engage with social media promotions. However, 30% indicated they engage with these promotions frequently, suggesting a significant level of interaction with such marketing efforts. In contrast, 13.75% said they sometimes engage with promotions, while 17.5% claimed to never notice them. This highlights a notable portion of the audience that either rarely or never engages with social media promotions.
Table No. 5 illustrates that 32.50% of respondents feel moderately influenced by social media influencers when making purchasing decisions. Additionally, 26.25% indicated they are greatly influenced by these figures, while 23.75% reported slight influence. Meanwhile, 17.5% stated that influencers do not affect their decisions at all. This indicates a significant impact of influencers on a large segment of the consumer population, although some remain unaffected.
In Table No. 6, a substantial 35% of respondents reported that social media promotions have no impact on their trust in a brand. Conversely, 27.5% noted that such promotions could decrease trust, suggesting a degree of skepticism. On the positive side, 17.5% claimed that promotions significantly increase trust, while 20% said they slightly enhance trust. This showcases a diverse range of opinions regarding the impact of social media promotions on brand credibility.

Table No. 7 indicates that 43.75% of respondents rarely notice unusual price increases or product shortages linked to social media trends. Meanwhile, 26.25% indicated they occasionally observe such trends, and 13.75% believe these trends often lead to price hikes. Conversely, 16.25% reported that they have never noticed any effects. This suggests that while many do not perceive frequent disruptions, some respondents are aware of the influence of social media on market conditions.

According to Table No. 8, the largest segment of respondents (28.75%) stated that their purchasing behavior depends on the campaign, illustrating the importance of marketing efforts. Equal percentages (26.25%) indicated they either buy the same amount or buy less, suggesting that social media does not drastically change consumption patterns for many. Only 18.75% reported buying more products due to social media influences, indicating a varied range of responses regarding buying behavior.

Table No. 9 highlights that 31.25% of respondents prefer brands that offer promotions through social media. Additionally, equal shares (26.25%) appreciate brands that connect with them through targeted ads or customer engagement. Meanwhile, 16.25% of respondents do not use social media, suggesting that a small segment remains unaffected by these marketing strategies. This emphasizes the significance of promotions and personalized interactions in influencing consumer preferences.

In Table No. 10, 32.50% of respondents stated that brands offer discounts to clear old stock during sudden demand surges. A similar percentage (32.50%) reported being unaware of any actions taken by brands in response to such surges. Meanwhile, 21.25% indicated that brands quickly restock products, and 13.75% said brands take no action at all. This reflects a range of perceptions regarding how brands respond to unexpected increases in demand.

Based on the Chi-Square tests conducted for the associations between demographic factors (age, gender, and educational background) and social media usage among users in Tier 2 cities, the following findings can be derived:

11. Age Group:- The Chi-Square statistic calculated is approximately 13.6019, with 2 degrees of freedom. The critical value for $\alpha = 0.05$ is 5.991. Since $13.6019 > 5.991$, we reject the null hypothesis. This indicates a significant association between age group and social media usage, suggesting that different age groups utilize social media differently.

12. Gender: - The Chi-Square statistic calculated is approximately 11.2618, with 1 degree of freedom. The critical value for $\alpha = 0.05$ is 3.841. Since $11.2618 > 3.841$, we reject the null hypothesis. This shows a significant association between gender and social media usage, indicating that males and females have differing patterns of social media engagement.

13. Educational Background: - The Chi-Square statistic calculated is approximately 6.0418, with 2 degrees of freedom. The critical value for $\alpha = 0.05$ is 5.991. Since $6.0418 > 5.991$, we reject the null hypothesis. This reveals a significant association between educational background and social media usage, suggesting that the level of education influences social media usage patterns among individuals.

Suggestions:

1. Targeted Marketing Campaigns:

- Brands and marketers should consider the demographic insights gained from this study to design targeted marketing campaigns. For instance, campaigns aimed at younger age groups (18-24) could leverage platforms like Instagram or TikTok, which are popular among this demographic, while campaigns for older age groups (35-44) might utilize Facebook or LinkedIn more effectively.

2. Gender-Specific Content:

- Content and messaging should be tailored to resonate with different genders. Understanding the unique preferences and engagement patterns of male and female users can help in creating more effective content strategies that foster higher engagement and conversion rates.

3. Education-Based Strategies:

- Educational institutions and organizations can use these insights to promote digital literacy programs aimed at enhancing social media skills, particularly among those with lower education levels. This can empower individuals to leverage social media for professional networking and personal branding.

4. Engagement Initiatives:

- Businesses could implement community engagement initiatives that cater to various age groups, such as workshops, webinars, and events that promote social media usage in meaningful ways. This not only **increases brand awareness but also builds community ties.**

5. Further Research:

- Additional studies could explore the motivations behind social media usage across different demographics. Understanding what drives engagement—be it entertainment, information, or social interaction—can provide deeper insights for marketers and content creators.

Conclusion:

The analysis reveals significant associations between demographic factors—age, gender, and educational background—and social media usage among users in Tier 2 cities. The findings indicate that demographic characteristics are critical in understanding social media engagement patterns. As a result, businesses and organizations should leverage these insights to create more effective and targeted marketing strategies that resonate with specific demographic groups. By recognizing the diverse needs and preferences of users based on their demographics, brands can enhance their engagement efforts, foster stronger customer relationships, and ultimately drive business success in the evolving digital landscape.

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EXPLORING THE FRONTIER: UNVEILING NOVEL TRENDS IN E-COMMERCE FOR FUTURE GROWTH AND INNOVATION

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EXPLORING THE FRONTIER: UNVEILING NOVEL TRENDS IN E-COMMERCE FOR FUTURE GROWTH AND INNOVATION

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Abstract:
This research explores emerging trends in e-commerce, aiming to provide insights into the dynamic landscape of digital commerce and its implications for businesses, consumers, and society. Through a comprehensive literature review, key trends such as omnichannel retailing, mobile commerce, voice commerce, AR/VR shopping experiences, AI applications, sustainability initiatives, and direct-to-consumer brands are identified and analyzed. Theoretical frameworks, empirical evidence, and debates surrounding each trend are examined, highlighting their significance and potential impact on the e-commerce industry. Methodologies for data collection and analysis are outlined, encompassing desktop research on e-commerce trends from academic databases, industry reports, and market analyses. The identification of emerging trends involves systematic review, categorization, and thematic analysis of findings from the literature review. Subsequent analysis and discussion delve into the implications of each trend for businesses and consumers, exploring opportunities for innovation and challenges for implementation. The research concludes with a call to action for e-commerce stakeholders to embrace change, drive innovation, and adapt strategies to seize new opportunities in the dynamic digital commerce landscape.

Keywords:
E-commerce, digital commerce, emerging trends, mobile commerce.

Introduction:

In the rapidly evolving landscape of e-commerce, staying abreast of emerging trends is crucial for businesses to remain competitive and foster innovation. This section provides an overview of the research objectives and rationale for exploring emerging trends in e-commerce, highlighting the significance of identifying and understanding these trends for businesses.

Research Objectives and Rationale:

The primary objective of this research is to investigate and analyze the emerging trends shaping the e-commerce industry. By examining these trends, we aim to provide insights that can help businesses adapt their strategies, seize new opportunities, and navigate the evolving e-commerce landscape effectively. The rationale for exploring emerging trends stems from the dynamic nature of the e-commerce sector, characterized by rapid technological advancements, changing consumer behaviors, and evolving market dynamics. In this context, understanding emerging trends is essential for businesses to anticipate shifts in the market, capitalize on new opportunities, and mitigate potential risks.

Significance of Identifying and Understanding Novel Trends:

Identifying and understanding emerging trends in e-commerce is critical for businesses for several reasons. Firstly, it enables businesses to stay competitive by offering innovative products, services, and experiences that align with evolving consumer preferences and market trends. Secondly, understanding emerging trends allows businesses to anticipate changes in the competitive landscape and adjust their strategies accordingly to maintain their competitive edge. Thirdly, identifying novel trends provides businesses with insights into emerging opportunities and challenges, enabling them to proactively innovate and adapt to changing market conditions. Overall, staying attuned to emerging trends is essential for businesses to remain agile, responsive, and resilient in a rapidly changing e-commerce environment.

Key Research Questions:

To guide our exploration of emerging trends in e-commerce, the following key research questions will be addressed:

What are the emerging trends shaping the e-commerce landscape?

What are the drivers behind the adoption of these emerging trends?

How do these emerging trends impact various aspects of the e-commerce ecosystem, including consumer behavior, business strategies, and market dynamics?

What are the implications of these trends for businesses, and how can they leverage them to stay competitive and foster innovation?

By addressing these research questions, we aim to provide valuable insights into the emerging trends in e-commerce and their implications for businesses, enabling them to make informed decisions and seize new opportunities for growth and innovation.

Literature Review

Omnichannel retailing:

Omnichannel retailing has emerged as a dominant strategy in the e-commerce landscape, emphasizing seamless integration across online and offline channels to provide a unified shopping experience for consumers. This literature review provides an overview of recent studies, industry reports, and academic publications on omnichannel retailing, synthesizing key insights and identifying implications for businesses.

Consumer Expectations and Behavior:

Research by Kumar et al. (2020) highlights the evolving nature of consumer expectations, with shoppers increasingly demanding convenience, flexibility, and personalized experiences across channels. The study emphasizes the importance of omnichannel strategies in meeting these expectations, as consumers expect consistent interactions and seamless transitions between online and offline touchpoints. Similarly, studies by Verhoef et al. (2019) underscore the significance of omnichannel retailing in enhancing customer satisfaction and loyalty, as omnichannel shoppers tend to spend more and exhibit higher levels of engagement with brands.

Integration of Online and Offline Channels:

Omnichannel retailing involves the integration of various channels, including brick-and-mortar stores, websites, mobile apps, social media platforms, and call centers, to create a cohesive shopping journey for consumers. Research by Liang and Huang (2021) explores the challenges and opportunities associated with channel integration, emphasizing the need for seamless data integration, inventory visibility, and cross-channel communication. The study highlights successful examples of omnichannel retailers that have effectively integrated their online and offline channels to provide enhanced shopping experiences and drive sales.

Technology and Digital Transformation:

Advancements in technology play a crucial role in enabling omnichannel retailing, facilitating seamless interactions and transactions across multiple channels. Research by Xu et al. (2020) examines the role of digital technologies such as mobile devices, RFID tags, beacon technology, and cloud computing in supporting omnichannel strategies. The study discusses the potential of emerging technologies such as AI, IoT, and AR/VR to further enhance omnichannel experiences and personalize customer interactions. Industry reports from Gartner and Forrester Research emphasize the importance of investing in digital transformation initiatives to support omnichannel retailing and meet evolving consumer demands.

Supply Chain and Logistics Management:

Omnichannel retailing presents challenges in supply chain and logistics management, as retailers strive to fulfill orders efficiently and cost-effectively across multiple channels. Research by Chopra and Meindl (2019) examines the implications of omnichannel fulfillment on supply chain design and operations, highlighting the need for flexible and agile logistics networks. The study discusses strategies such as inventory optimization, distributed warehousing, and real-time inventory visibility to meet customer expectations for fast and reliable order fulfillment. Industry reports from Deloitte

Insights and McKinsey & Company discuss the importance of supply chain resilience and agility in supporting omnichannel retailing, particularly in the face of disruptions such as the COVID-19 pandemic.

Mobile Commerce (m-commerce):

Mobile commerce (m-commerce) has become increasingly prevalent in the e-commerce landscape, driven by the widespread adoption of smartphones and mobile devices. This literature review provides an overview of recent studies, industry reports, and academic publications on mobile commerce, synthesizing key insights and identifying implications for businesses.

Consumer Adoption and Behavior:

Research by Li et al. (2019) examines consumer adoption of mobile commerce and identifies factors influencing mobile shopping behavior. The study highlights the importance of convenience, usability, security, and trust in driving mobile commerce adoption. Similarly, studies by Lee et al. (2020) emphasize the role of perceived usefulness and perceived ease of use in shaping consumer intentions to use mobile commerce apps.

Mobile Optimization and User Experience:

The importance of mobile optimization and user experience in driving mobile commerce sales is underscored in research by Wang et al. (2021). The study explores the impact of mobile interface design, navigation, and loading speed on user engagement and conversion rates. Industry reports from eMarketer and Forrester Research highlight the significance of responsive design, fast loading times, and streamlined checkout processes in enhancing mobile shopping experiences and reducing friction points for consumers.

Mobile Payments and Security:

Mobile payments are a critical aspect of mobile commerce, with consumers increasingly using mobile wallets, digital payment apps, and contactless payment methods. Research by Jin et al. (2020) examines consumer perceptions of mobile payment security and identifies trust, privacy concerns, and perceived risk as key factors influencing adoption. The study emphasizes the importance of secure authentication mechanisms and encryption protocols in building consumer trust and confidence in mobile payments.

Location-Based Services and Personalization:

Location-based services and personalized recommendations play a significant role in enhancing the mobile commerce experience and driving sales. Research by Chen et al. (2019) explores the use of location-based marketing and geotargeting strategies to deliver targeted promotions and offers to mobile users based on their proximity to physical stores. The study discusses the potential of personalized recommendations and AI-driven algorithms in improving product discovery and increasing cross-selling and upselling opportunities in mobile commerce.

Emerging Technologies and Future Trends:

Advancements in emerging technologies such as augmented reality (AR), virtual reality (VR), and artificial intelligence (AI) are expected to further transform the mobile commerce landscape. Research by Park et al. (2021) examines the potential of AR/VR technologies in enhancing mobile shopping experiences and creating immersive virtual environments for consumers. Industry reports from Gartner and Deloitte Insights discuss the role of AI-powered chatbots, voice assistants, and visual search capabilities in driving mobile commerce innovation and personalization.

Voice Commerce

Voice commerce, enabled by voice-enabled devices and virtual assistants, has emerged as a transformative trend in the e-commerce landscape, offering consumers a convenient and hands-free shopping experience. This literature review synthesizes recent studies and industry reports on voice commerce, examining factors influencing consumer adoption, the role of convenience and personalization, and future growth prospects.

Consumer Adoption and Behavior:

Research by Khan et al. (2021) delves into consumer adoption of voice commerce and identifies key factors driving adoption. The study highlights the convenience and efficiency of voice-activated shopping experiences, emphasizing the role of virtual assistants in assisting users throughout the

purchase journey. Additionally, studies by Lee and Lee (2020) explore consumer perceptions and attitudes towards voice commerce, revealing a growing acceptance and willingness to use voice-enabled devices for shopping tasks.

Convenience and Personalization:

The convenience and personalization offered by voice commerce are key drivers of adoption among consumers. Research by Smith et al. (2019) underscores the role of voice-enabled devices in streamlining the shopping process, allowing users to make purchases quickly and effortlessly through natural language commands. Furthermore, studies by Chen and Wang (2021) highlight the potential of personalized recommendations and tailored shopping experiences delivered through virtual assistants, enhancing user engagement and satisfaction.

Industry Trends and Growth Projections:

Industry reports from Gartner and Forrester Research forecast a significant surge in voice commerce transactions, driven by the proliferation of smart speakers and virtual assistants in households worldwide. Gartner predicts that by 2023, voice commerce will represent a significant share of online sales, prompting businesses to invest in optimizing their voice shopping experiences. Moreover, Forrester Research anticipates continued growth in voice commerce adoption, fueled by advancements in natural language processing and voice recognition technologies.

Challenges and Opportunities:

While voice commerce presents opportunities for businesses to enhance customer engagement and drive sales, it also poses challenges related to privacy, security, and trust. Research by Jin et al. (2020) examines consumer concerns regarding privacy and data security in voice commerce transactions, highlighting the importance of transparent data practices and robust security measures. Additionally, studies by Li and Huang (2021) explore strategies for mitigating privacy risks and building consumer trust in voice-enabled shopping experiences.

AR/VR Shopping Experiences

Augmented Reality (AR) and Virtual Reality (VR) technologies have revolutionized the online shopping landscape, providing consumers with immersive and interactive shopping experiences. This literature review synthesizes recent studies and industry reports on AR/VR shopping experiences, exploring their impact on consumer behavior, purchase intentions, and the potential for enhancing e-commerce operations.

Consumer Engagement and Purchase Intentions:

Research by Park et al. (2020) investigates the influence of AR/VR technologies on consumer purchase intentions in online shopping contexts. The study highlights the role of experiential marketing strategies facilitated by AR/VR in enhancing consumer engagement and driving purchase decisions. Findings suggest that immersive shopping experiences enable consumers to visualize products more effectively, leading to higher levels of satisfaction and purchase likelihood.

Experiential Marketing and Engagement:

AR/VR technologies enable experiential marketing approaches that immerse consumers in virtual environments, fostering emotional connections and brand engagement. Studies by Chen and Lee (2019) explore the impact of experiential marketing on consumer perceptions and attitudes towards brands in AR/VR shopping experiences. The research emphasizes the importance of sensory stimuli, interactivity, and storytelling in creating memorable and impactful brand experiences.

Product Discovery and Exploration:

Industry reports from Deloitte Insights highlight the potential of AR/VR technologies in enhancing product discovery and exploration in e-commerce. By enabling virtual try-on experiences, 3D product visualization, and interactive product demonstrations, AR/VR technologies empower consumers to make more informed purchase decisions. Moreover, immersive product experiences reduce the likelihood of returns and improve overall customer satisfaction.

Customer Satisfaction and Loyalty:

Research by Kim and Forsythe (2021) examines the impact of AR/VR shopping experiences on customer satisfaction and loyalty. The study finds that consumers who engage with AR/VR-enabled shopping platforms report higher levels of satisfaction and are more likely to become repeat

customers. AR/VR technologies create memorable and enjoyable shopping experiences, leading to increased brand loyalty and positive word-of-mouth recommendations.

Future Trends and Applications:

As AR/VR technologies continue to evolve, their applications in e-commerce are expected to expand. Industry reports from Gartner and McKinsey & Company predict a surge in AR/VR adoption across various industries, including retail and e-commerce. Beyond product visualization, AR/VR technologies hold potential for enhancing customer service, virtual showroom experiences, and gamified shopping experiences, further enhancing consumer engagement and loyalty.

AI Applications in E-commerce

Artificial intelligence (AI) applications, such as chatbots, recommendation engines, and personalized marketing, are reshaping the landscape of e-commerce, transforming operations and customer interactions. This literature review synthesizes recent studies and industry reports on AI applications in e-commerce, examining their impact on customer service, personalized shopping experiences, and operational efficiency.

AI-Powered Chatbots for Customer Service:

Research by Wang et al. (2020) investigates the role of AI-powered chatbots in enhancing customer service and engagement in e-commerce settings. The study explores the use of natural language processing (NLP) and machine learning algorithms to enable chatbots to handle customer inquiries, provide product recommendations, and assist with order tracking. Findings suggest that AI-powered chatbots improve response times, reduce customer service costs, and enhance overall customer satisfaction.

Personalized Shopping Experiences:

Industry reports from McKinsey & Company highlight the potential of AI to drive personalized shopping experiences in e-commerce. By analyzing vast amounts of customer data, AI algorithms can generate personalized product recommendations, promotional offers, and marketing messages tailored to individual preferences and behaviors. This level of personalization enhances customer engagement, increases conversion rates, and fosters long-term customer loyalty.

Recommendation Engines:

AI-powered recommendation engines play a crucial role in guiding consumer purchase decisions and increasing average order values in e-commerce platforms. Research by Zhang et al. (2021) explores the effectiveness of recommendation algorithms in predicting consumer preferences and improving product discovery. The study finds that personalized recommendations generated by AI algorithms lead to higher levels of customer satisfaction and repeat purchases.

Operational Efficiency and Automation:

Beyond customer-facing applications, AI drives operational efficiency and automation in e-commerce operations. Industry reports from Deloitte Insights discuss the use of AI-driven analytics and predictive modeling to optimize inventory management, supply chain logistics, and pricing strategies. By leveraging AI algorithms to forecast demand, identify trends, and automate routine tasks, e-commerce businesses can reduce costs, minimize stockouts, and improve overall business performance.

Future Trends and Challenges:

As AI continues to evolve, its applications in e-commerce are expected to expand. Industry reports from Gartner predict a surge in AI adoption across various e-commerce functions, including customer service, marketing, and operations. However, challenges related to data privacy, algorithm bias, and ethical considerations must be addressed to ensure responsible AI implementation and mitigate potential risks to consumers and businesses.

Sustainability Initiatives in E-commerce

Sustainability initiatives are becoming increasingly important in the realm of e-commerce, as consumers seek out eco-friendly and socially responsible brands. This literature review synthesizes recent studies and industry reports on sustainability initiatives in e-commerce, examining their impact on consumer behavior, corporate social responsibility, and the business case for sustainability.

Impact on Consumer Purchase Decisions:

Research by Lee et al. (2021) investigates the influence of sustainability initiatives on consumer purchase decisions in e-commerce. The study explores how factors such as environmental consciousness, ethical sourcing, and product transparency affect consumer perceptions and preferences. Findings suggest that sustainability initiatives, such as eco-friendly packaging and fair trade practices, can positively influence consumer attitudes and drive purchasing behavior towards brands that demonstrate a commitment to sustainability.

Importance of Transparency and Corporate Social Responsibility (CSR):

Transparency and corporate social responsibility (CSR) play a crucial role in shaping consumer perceptions of sustainability initiatives in e-commerce. Studies by Jones and Singh (2020) highlight the importance of transparent communication and accountability in building trust and credibility with consumers. Brands that openly disclose their sustainability practices, environmental impact assessments, and CSR initiatives are more likely to gain consumer trust and loyalty, fostering long-term relationships and positive brand associations.

Business Case for Sustainability:

Industry reports from Nielsen emphasize the business case for sustainability in e-commerce, citing increased consumer demand for green products and ethical brands. Nielsen's research shows that sustainability-minded consumers are willing to pay a premium for products that align with their values and beliefs. Moreover, brands that prioritize sustainability initiatives stand to gain a competitive advantage, attract new customers, and enhance brand reputation and loyalty.

Challenges and Opportunities:

While sustainability initiatives present opportunities for e-commerce businesses to differentiate themselves and drive growth, they also pose challenges related to supply chain management, product sourcing, and cost implications. Research by Wu et al. (2021) examines the barriers to implementing sustainability practices in e-commerce operations, including issues such as limited supplier transparency, lack of standardized metrics, and competing business priorities. However, overcoming these challenges presents opportunities for innovation, collaboration, and value creation across the supply chain.

Future Trends and Outlook:

As consumer awareness of environmental and social issues continues to grow, sustainability initiatives are expected to play an increasingly prominent role in e-commerce. Industry reports from McKinsey & Company predict a shift towards sustainable consumption patterns and greater demand for eco-friendly products and services. E-commerce businesses that embrace sustainability as a core value proposition and integrate it into their business models are poised to succeed in a rapidly evolving marketplace.

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Discussion of the Key Theories, Concepts, and Debates in the Literature:

Omnichannel Retailing:

Theory: The omnichannel retailing theory emphasizes seamless integration and coordination across various sales channels (online, offline, mobile) to provide customers with a unified shopping experience.

Concepts: Concepts such as channel integration, inventory visibility, and unified customer data are central to omnichannel retailing strategies.

Debates: Debates revolve around the challenges of implementing omnichannel strategies effectively, including technological complexities, organizational silos, and channel conflicts.

Mobile Commerce (m-commerce):

Theory: Mobile commerce theory focuses on understanding consumer behavior and transaction patterns in mobile shopping environments, leveraging mobile devices for browsing, purchasing, and payment.

Concepts: Concepts such as mobile app design, mobile payment solutions, and location-based services are crucial for optimizing the mobile shopping experience.

Debates: Debates center on issues such as security concerns, user experience optimization, and the balance between mobile web and app-based strategies in m-commerce.

Voice Commerce:

Theory: Voice commerce theory explores the integration of voice-enabled devices and virtual assistants into the shopping process, enabling consumers to search for products, place orders, and receive recommendations using voice commands.

Concepts: Concepts such as natural language processing (NLP), voice recognition technology, and conversational commerce are fundamental to understanding voice commerce.

Debates: Debates focus on privacy implications, accuracy of voice recognition, and the role of voice commerce in driving customer engagement and loyalty.

AR/VR Shopping Experiences:

Theory: AR/VR shopping experiences theory examines the use of augmented reality (AR) and

virtual reality (VR) technologies to create immersive and interactive shopping environments, allowing customers to visualize products and simulate real-world interactions.

Concepts: Concepts such as 3D product visualization, virtual fitting rooms, and interactive product demonstrations are key to enhancing AR/VR shopping experiences.

Debates: Debates revolve around the adoption barriers, hardware limitations, and consumer acceptance of AR/VR technologies in mainstream e-commerce applications.

AI Applications:

Theory: AI applications theory focuses on leveraging artificial intelligence (AI) technologies, such as machine learning, natural language processing, and predictive analytics, to automate processes, personalize recommendations, and enhance customer service in e-commerce.

Concepts: Concepts such as AI-powered chatbots, recommendation engines, and predictive analytics algorithms are essential for understanding the role of AI in e-commerce.

Debates: Debates center on ethical considerations, algorithmic bias, and the impact of AI on job displacement and human-computer interactions in e-commerce environments.

Sustainability Initiatives:

Theory: Sustainability initiatives theory examines the adoption of environmentally and socially responsible practices in e-commerce operations, encompassing sustainable sourcing, eco-friendly packaging, and corporate social responsibility (CSR) initiatives.

Concepts: Concepts such as circular economy principles, carbon footprint reduction, and supply chain transparency are critical for implementing sustainability initiatives in e-commerce.

Debates: Debates focus on the trade-offs between sustainability and profitability, greenwashing accusations, and the role of regulatory frameworks in promoting sustainable practices in e-commerce.

Direct-to-Consumer (DTC) Brands:

Theory: Direct-to-consumer (DTC) brands theory explores the emergence of digitally native brands that bypass traditional retail channels to sell products directly to consumers online, leveraging e-commerce platforms, social media, and influencer marketing.

Concepts: Concepts such as brand authenticity, customer engagement, and vertical integration are fundamental to understanding the DTC business model.

Debates: Debates revolve around market saturation, competition with established brands, and the long-term viability of DTC brands in the e-commerce landscape.

Discussion of these key theories, concepts, and debates provides valuable insights into the evolving dynamics of the e-commerce industry, informing strategic decision-making and fostering innovation in digital commerce.

Summary of the Findings:

Omnichannel Retailing: The literature highlights the growing importance of omnichannel retailing in providing customers with seamless and integrated shopping experiences across multiple channels. Key findings include the significance of channel integration, the challenges of organizational alignment, and the potential benefits of omnichannel strategies for enhancing customer engagement and loyalty.

Mobile Commerce (m-commerce): Research on mobile commerce underscores the increasing reliance on mobile devices for shopping activities, with consumers expecting convenient and frictionless experiences on mobile platforms. Findings reveal the importance of mobile app design, mobile payment solutions, and personalized mobile experiences in driving m-commerce success.

Voice Commerce: Studies on voice commerce indicate a rising trend in the adoption of voice-enabled devices and virtual assistants for shopping purposes. Key findings include the potential of voice commerce to enhance accessibility, convenience, and personalization in the shopping process, alongside debates surrounding privacy concerns and user acceptance of voice technology.

AR/VR Shopping Experiences: Research on AR/VR shopping experiences highlights the transformative potential of immersive technologies in redefining the online shopping experience. Findings suggest that AR/VR technologies can improve product visualization, increase engagement,

and reduce purchase uncertainty, though adoption barriers and technological limitations remain areas of debate.

AI Applications: The literature on AI applications in e-commerce emphasizes the growing role of artificial intelligence in automating processes, personalizing recommendations, and enhancing customer service. Key findings include the benefits of AI-powered chatbots, recommendation engines, and predictive analytics in improving operational efficiency and driving customer satisfaction, alongside debates surrounding ethical considerations and algorithmic bias.

Sustainability Initiatives: Studies on sustainability initiatives in e-commerce highlight the increasing consumer demand for eco-friendly products and socially responsible brands. Findings reveal the importance of transparency, accountability, and supply chain sustainability in building consumer trust and loyalty, while debates center on the trade-offs between sustainability and profitability and the need for regulatory intervention to promote sustainable practices.

Direct-to-Consumer (DTC) Brands: Research on DTC brands underscores the rise of digitally native brands that bypass traditional retail channels to sell products directly to consumers online. Key findings include the importance of brand authenticity, customer engagement, and vertical integration in the success of DTC businesses, alongside debates surrounding market saturation and the long-term viability of the DTC model.

The findings from the literature review provide valuable insights into the emerging trends, challenges, and opportunities shaping the e-commerce landscape. By understanding and leveraging these trends, businesses can adapt their strategies, enhance competitiveness, and drive innovation in the dynamic digital commerce environment.

Conclusion:

The exploration of emerging trends in e-commerce reveals a dynamic landscape characterized by rapid technological advancements, shifting consumer preferences, and evolving market dynamics. Through a comprehensive review of the literature, this research has shed light on key trends such as omnichannel retailing, mobile commerce, voice commerce, AR/VR shopping experiences, AI applications, sustainability initiatives, and direct-to-consumer brands.

Each trend brings forth unique opportunities and challenges for e-commerce businesses seeking to stay competitive and foster innovation. Omnichannel retailing emphasizes the importance of seamless integration across multiple channels to deliver a unified shopping experience. Mobile commerce underscores the growing reliance on mobile devices for shopping activities and the need for optimized mobile experiences. Voice commerce introduces new possibilities for hands-free shopping and personalized interactions through voice-enabled devices. AR/VR shopping experiences transform online shopping by offering immersive product visualization and interactive experiences. AI applications drive efficiency and personalization in e-commerce operations through chatbots, recommendation engines, and predictive analytics. Sustainability initiatives respond to increasing consumer demand for eco-friendly products and socially responsible brands, while direct-to-consumer brands challenge traditional retail models by leveraging digital platforms to sell products directly to consumers.

Despite the potential benefits of these trends, challenges remain, including technological complexities, privacy concerns, ethical considerations, and market saturation. However, by embracing change, embracing change, and embracing change, and innovation, e-commerce businesses can navigate these challenges and capitalize on emerging opportunities to drive future growth and success.

This research underscores the importance of continuous adaptation, experimentation, and innovation in the e-commerce industry. By staying abreast of emerging trends, businesses can remain agile, responsive, and competitive in the dynamic digital commerce landscape. As we look to the future, collaboration, creativity, and customer-centricity will be key drivers of success, enabling e-commerce businesses to thrive in an ever-evolving marketplace.

Scope of Further Research:

Longitudinal Studies: Future research could involve longitudinal studies to track the evolution of emerging trends in e-commerce over time. By analyzing trends and patterns longitudinally, researchers can gain deeper insights into the trajectory of trends, their sustainability, and their long-term impact on the e-commerce landscape.

Cross-Cultural Analysis: Conducting cross-cultural analyses can provide valuable insights into how emerging trends in e-commerce vary across different regions and cultural contexts. By examining cultural influences on consumer behavior, technological adoption, and market dynamics, researchers can identify nuances and differences in trend adoption and implementation strategies.

Impact Assessment: Further research could focus on assessing the impact of emerging trends on various stakeholders, including businesses, consumers, and society as a whole. By examining outcomes such as financial performance, customer satisfaction, and societal well-being, researchers can evaluate the effectiveness and implications of trend adoption in e-commerce.

Technological Innovation: Research on technological innovation in e-commerce can explore emerging technologies and their potential applications for enhancing the e-commerce experience. Areas such as blockchain, augmented reality, artificial intelligence, and Internet of Things (IoT) present opportunities for innovation and disruption in the e-commerce industry.

Consumer Behavior Studies: Investigating consumer behavior in the context of emerging e-commerce trends can provide valuable insights into consumer preferences, motivations, and decision-making processes. By understanding how consumers interact with and respond to new technologies and trends, businesses can tailor their strategies to better meet consumer needs and preferences.

Policy and Regulation Analysis: Research on policy and regulation in e-commerce can explore the regulatory frameworks governing emerging trends and their implications for businesses and consumers. By examining issues such as data privacy, cybersecurity, and consumer protection, researchers can inform policy discussions and regulatory interventions to ensure a safe and fair e-commerce environment.

Business Strategy Development: Future research could focus on developing strategic frameworks and guidelines for businesses to navigate and capitalize on emerging trends in e-commerce. By providing actionable insights and best practices, researchers can empower businesses to adapt their strategies, innovate, and thrive in the rapidly evolving digital commerce landscape.

By addressing these areas of further research, scholars can contribute to a deeper understanding of emerging trends in e-commerce and their implications for businesses, consumers, and society. Ultimately, such research can inform strategic decision-making, drive innovation, and shape the future direction of the e-commerce industry.

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Impact of Covid-19 on Indian Economy

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Abstract :

With the number of COVID-19 cases leaning dangerously more than, 200,000 and worldwide death toll, crossing many more numbers, the WHO declared, the virus outbreak a Pandemic in the second week of March 2020, 4 months after the novel virus first made headlines. Countries are steadily going into lockdown and business across the globe are operating in fear and this situation, clubbed with sluggish economic growth in previous year specially in India, is leading to extremely volatile market conditions. So, let us understand how the CORONA virus is impacting Indian Economy and Business.

Keywords :

Pandemic, Sluggish Economic Growth.

1. Introduction :

The economic impact of COVID 19 Pandemic in India has been destructive in nature.

India's growth has been downgraded by the World Bank and Credit Rating Agencies and with the lowest figures, India has seen in three decades, since India's Economic Liberalization in 1990. The outcome of COVID-19, can be expressed in the following ways:

(a) Pandemic induced, market instability and lockdown. (b) sharp rise in unemployment. (c)stress on supply chains. (d) decrease in government income. (e) Collapse of Tourism Industry. (f) Collapse of hospitality industry. (g)reduced consumer activity. (h)plunge in fuel consumption.(i) rise in LPG sales.

The Indian Economy is expected to loose over Rs. 32,000 Crore (US$4.5 billion), every day, during the first 21 days of complete lockdown, which was declared, the

CORONA VIRUS outbreak. Upto 53% of business in the country, will be significantly affected. A large number of farmers around the country are also facing uncertainty. Various business such as hotels and airlines are cutting salaries and laying off employees. Major companies in India, such as Larson & Toubro, Bharat Forge, Ultratech Cement, Grasim Industries, Aditya Birla Group and Tata Motors have temporarily suspended or reduced operations. First moving consumer goods companies in the country, have significantly reduced operations and are focussing on essentials.

On 24th March, during Prime Minister's address he had said, that ' Jaan Hai, Jahaan

Hai', (if only there is life there will be livelihood). But on 11th April, our Prime Minister declared, 'Jaanbhi Jahaanbhi', i.e (both lives and lively hood, maters equally.) On 21st March, the Union Cabinet approved incentives, worth Rs.40995 crore i.e (US$5.7 billion) for manufacturing sector. On 24th March, our Prime Minister announced a. Rs.

15,000 crore (US$2.1 billion) fund for health care.

2. Objectives :

i) To evaluate critically, the impact of COVID-19, on Indian economy.

ii) To examine appropriate steps taken by government, to revive Indian Economy.

iii) To review the aftermath effect of COVID-19, on Indian economy.

3. Hypothesis :

Ho1 - Pandemic COVID - 19, has created positive impact on Indian Economy.

Ho2 - Pandemic COVID - 19, has created negative impact on Indian Economy.

H2 - Low growth of Indian economy is a symptom of lockdown situation in the country.

H3. - COVID-19 has increased social and emotional stigma among people.

4. Research Methodology :

This paper has been written on the basis of secondary data, where by data has been collected and analyzed in a standardized way. Suitable analytical strategies have been implemented to analyze data, which are collected from standard protocols.

Communicating statistics specially in hectic times during a pandemic is very challenging. Statisticians are encouraged to support this with clear and transparent statements. In pandemic situation, the research has gone through rapid and valid information flow and on the basis of that, study has been done. As a researcher it can be said that, creating specialized, publicly accessible collection of studies with original studies about COVID -19, can surely help in this.

This is basically an exploratory research to clarify and define, the nature of problem and at the same time, this analysis could not provide conclusive evidence. The researcher has initiated this research into a theoretical idea. On the basis of secondary data, the researcher has observed, something and seeks to understand more about it.

5. Detail Explanation of the Topic :

This pandemic is a rare event that has hurt both supply and demand across Globe through various channels.

Impact on supply chain

i) Factory Shutdowns :

a) The lockdowns has mandated, factory shutdown of non essentials commodities.

b) The non essentials activities such as transport, hospitality and education have also been halted.

ii) Logistical bottlenecks :

a) Restrictions of movement is creating bottlenecks in transport of goods and services from one part of the economy and other.

b) Disruptions in availability of inputs: Lockdown across the Globe have disrupted global supply chain affecting availability of inputs for several industries specially auto, electronics and pharmaceuticals industries.

iii) Labour shortage :

a) Reverse migration in India could temporarily lead it to a shortage of available workforce specially in informal sector.

iv) Drying of cash flows :

a) Loss of sales could crunch working capital, small and medium enterprises which could lead to shutdown.

b) The ability to raise capital, might get more restricted amid tightening financial condition.

Impact on Demand :

i) The cuts in consumer spending :

a) The lockdown has severely restricted spending on non essential goods and services.

b) Transport, Durable goods, recreation, restaurants and hotels are more affected.

c) India's urban economy has been badly affected

ii) Lower global demand :

a) Global GDP to decline 2.4 % in 20-20 worse than that during global financial crisis.

b) Lower external demand has begun to hurt India's export, which felt 34 percent on year in March. Exports comprise - 17% of India's GDP.

iii) Loss of income and employment :

a) Falling company profits may result in pay cuts and laying off employees.

b) The most vulnerable groups are workers is in the informal sector - a dominant part India's work force and low skilled workers who cannot work from home.

6. Interpretation of the Hypothesis :

After going through the entire analysis, the researcher has been able to prove Null hypothesis i.e Pandemic Covid 19 has created negative impact on Indian Economy, and also through this analysis, the researcher has able to prove that, due to Pandemic, Indian economy has resulted into low growth and also it has increased social and emotional stigma within all category of people irrespective of caste, creed, religion and races.

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7. Rational Of the Study :

Every country including India is either already deeply affected or is at the state of being more affected. It is not just confined to one sector or country, it encompasses the entire economy and the world. This is very much unprecedented in terms of it's immediate impact on the lives of Individuals from all walks of life. We have a few additional factors of India: and economy which relies very heavily on informal employment, so our reliance for peoples well being on the broader economy performing and market performing is high, whatever the role, the state may try to play, anything that, anybody tries to change in the functioning of the economy has, unintended effect.

8. Suggestions :

The economic slowdown has lasted four quarters and is unlikely to go away in hurry. The banking sector problems are deep rooted and though the reforms have began in right earnest, reviving credit flow will take time. No miracle man revive the economy without revitalizing credit cycle. For that, to happen credit lines is not sufficient. The structural reforms will be necessary that protects banks from more bad loans and loan frauds. So, what should the government do to avoid the impending recession.

1. Restructuring public sector banks with the private sector banks : government will have to restructure the public sector banks in line with public sector banks and take the burden off the ' The Branch Manager' in distributing credit to all category of the people. To ease loan facilities to all micro, medium and low medium level industries. To make loose money available in the account of all people in order to create demand in the market.

2. Prepare a health emergency : India need to prioratize fighting COVID -19, over stimulus packages, while the outbreak so far has not caused any casualty in India with over 1.3 billion population, it must ready for the worst test, it is caught napping.

3. Ready A Fiscal Contingency plan : While the government so far, has been physically conservative, even in its latest budget, in case COVID -19 drives, the global economy into the recession, it can no longer focus merely on keeping fiscal deficit under check.A robust fiscal plan to revive the economy should be kept.

4. Use the opportunity to push the structural reforms : COVID-19 in all livelihood will turn into a black event in the global economy. Coming close on the hills US- CHINA trade war, it could further turn foreign investors away from CHINA. India should truly be working itself and easier place to do business, including measures like simplifying the GST structure.

5. Push domestic demand : the government will have to restructure its policies to boost domestic demand, at a time global demand is set to remain tepid for a long period of time.

6. Some economists are of the opinion that, producing for larger section of the Indian society at affordable prices instead of only for the top hundred million people could make growth broad based.

7. Keeping monitory policy flexible : The Federal Reserve earlier this month cut its policy rate by 50 basis point citing revolving risk to economic activity posed by COVID 19 outbreak.

8. The RBI should also be ready to use all the tools at its disposal to provide financial stability while maintaining economic growth.

9. Government initiated various policies : during COVID -19 the government initiated various corrective measures to provide and promote helping hand specifically to poor migrant workers and also to poor people in the society: but there is a great question coming whether all these policy measures will be able to avail by the people in the society.

9. Limitations Of the Study :

This study has the constraints of generizability , application to practice and all utility of findings that may develop into complexities. The findings may result into unanticipated challenges, that may emerge in the economy.

10. Conclusion :

All the states are at the cutting edge of the development initiatives. They employ about 5 times more people and spend about one and a half times more than the centre. They also account for around 66 percent of overall government capital expenditure, there fore, the health of the state finances has a far reaching influence on the welfare and economic opportunities of Indians. At present, state finances are in dire straits on account of lockdown. About 35 % of their revenue comes GST collection, which has evaporated in the last 6 weeks. With no other options left in their hands, they have began to raise taxes on the fuel and alchohol, which contribute about 12 % and 8 % respectively of their revenue. The Pandemic, has been superimposed on an economic slowdown. The combined impact will make state finances a mess. This mess will follow earlier friction, between some states and centre over compensation, for shortfall in GST collection. This can result into politicisation of the fight against COVID-19, which must not be allowed.

Therefore, the centre should now quicken it's fiscal responses. The longer the lag in response, the greater will be the damage to the economy and to the spirit of revival Indian economy. I can end with quote" The lockdown is a Tripple Whammy After The Disustrous of Demonitisation and badly implemented GST". The human cost of economic devastation may ultimately outnumber virus fatalities."

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Dr. Punjabrao Deshmukh: Champion of Education in Rural India

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Abstract:

Dr. Punjabrao Deshmukh, a multifaceted leader and social reformer in India, dedicated his life to uplifting the rural masses, particularly through education. This paper explores his educational work and thoughts, analyzing their impact on the Vidarbha region and beyond. It examines Deshmukh's establishment of the Shri Shivaji Education Society, his advocacy for vocational training and rural development, and his vision for an equitable and inclusive education system. By delving into his speeches, writings, and initiatives, this paper aims to shed light on Deshmukh's enduring legacy as an education pioneer in India.

Keywords: Punjabrao Deshmukh, education, rural development, Shri Shivaji Education Society, vocational training, social justice, inclusive education, Vidarbha, legacy.

I. INTRODUCTION:

Dr. Punjabrao Deshmukh (1898-1965), a luminary in Indian history, was more than just a political leader; he was a visionary whose ideas and efforts transformed the educational landscape of rural India. Born into a time of nationalistic fervor and social reform, Deshmukh's life was a testament to the power of education as a tool for societal change. His tenure as the first Union Minister of Agriculture in newly independent India was marked by significant advancements in agricultural practices and policies, but it was his passion for education that left an indelible mark on the nation's heart and history.In the early 20th century, India was a nation in flux, grappling with the challenges of colonial rule, social inequality, and economic hardship. Rural areas, in particular, faced acute educational disparities, with limited access to schools and a high rate of illiteracy. It was within this context that Deshmukh emerged as a beacon of hope for the marginalized rural populace of Vidarbha, a region that was especially close to his heart. His belief in education as the cornerstone of development was not just theoretical but deeply personal, shaped by his own experiences and the stark realities he witnessed.

Deshmukh's vision for education went beyond mere literacy. He understood that for education to be truly transformative, it needed to be holistic, inclusive, and accessible to all, regardless of social or economic status. This vision was revolutionary at a time when education in India was largely elitist and urban-centric, leaving vast swathes of the rural population in darkness.

The establishment of the Shri Shivaji Education Society (SSES) in 1932 was a bold step towards realizing Deshmukh's dream of an educated and empowered rural India. Starting with a single school, the SSES became a catalyst for change, expanding to hundreds of institutions and becoming a model for rural education across Maharashtra and beyond. Deshmukh's efforts were not just about building schools; they were about nurturing communities, promoting vocational training, and ensuring that education served as a ladder for economic and social mobility.As the first Union Minister of Agriculture, Deshmukh leveraged his position to further his educational objectives, integrating agricultural development with educational reform. His policies and programs aimed at uplifting the rural economy were intertwined with the ethos of education for empowerment. This holistic approach was groundbreaking and highlighted his understanding that agricultural prosperity and educational advancement were two sides of the same coin.Deshmukh's legacy is a testament to the transformative power of education. His life's work continues to inspire generations, serving as a guiding light for educators, policymakers, and social reformers. As we delve deeper into his contributions and the impact of his work, it becomes evident that Dr. Punjabrao Deshmukh was not just a champion of education in rural India but a visionary leader whose ideals and actions have shaped the course of Indian society towards a more equitable and enlightened future.

II. ESTABLISHMENT OF THE SHRI SHIVAJI EDUCATION SOCIETY:

The founding of the Shri Shivaji Education Society (SSES) in 1932 by Dr. Punjabrao Deshmukh was a watershed moment in the history of educational reform in India, particularly in the rural heartlands of Maharashtra. In an era marked by colonial rule and social stratification, access to education was predominantly reserved for the urban elite, leaving the vast majority of India's rural

population without the means to pursue learning. Against this backdrop, Deshmukh's initiative was not just revolutionary; it was a beacon of hope for countless marginalized communities.Deshmukh, deeply moved by the dire state of rural education and inspired by the legacy of Shivaji Maharaj—a symbol of valor and justice—established the first SSES school in Amravati with a vision that was both bold and inclusive. He named the society after Shivaji to embody the Maratha warrior king's principles of bravery, fairness, and progress. The goal was clear and ambitious: to democratize education, making it accessible to everyone, irrespective of their caste, gender, or economic status. This was a radical idea at the time, challenging the prevailing social norms and barriers that had kept education out of reach for the majority of India's rural populace.

Under Deshmukh's leadership, SSES quickly grew from a single school into a vast network of educational institutions spread across Maharashtra. Today, with over 269 branches, it serves as a testament to Deshmukh's vision and unwavering commitment to educational equity. The society offers a broad spectrum of educational programs, from primary education to professional courses, ensuring that students from rural backgrounds have the opportunity to pursue their academic and career aspirations without the need to migrate to urban centers.The impact of SSES extends beyond the mere provision of education. It has been a transformative force in rural Maharashtra, catalyzing social and economic development, and fostering a culture of learning and innovation. By integrating vocational training and agricultural education into the curriculum, SSES has equipped students with practical skills relevant to their local economies, thereby enhancing employability and entrepreneurial capabilities. This approach has not only contributed to individual growth but has also spurred community development and upliftment.

Furthermore, Deshmukh's emphasis on inclusivity and social justice through education has had profound societal implications. By breaking down barriers to education for women, Dalits, and other marginalized groups, SSES has played a crucial role in promoting gender equality, social mobility, and empowerment. This inclusive ethos has nurtured generations of leaders, thinkers, and change-makers who continue to drive positive change in their communities and beyond.

In establishing SSES, Dr. Punjabrao Deshmukh laid the foundation for a more equitable and just society. His vision of using education as a tool for rural development and social reform has left an enduring legacy, making SSES a model of educational excellence and inclusivity. As SSES continues to evolve and expand, it remains a living tribute to Deshmukh's pioneering spirit and his deep-seated belief in the transformative power of education.

III. ADVOCACY FOR VOCATIONAL TRAINING AND RURAL DEVELOPMENT:

Dr. Punjabrao Deshmukh's advocacy for vocational training and rural development marked a significant shift in the educational paradigm, especially within the context of India's rural landscape. Recognizing the limitations of traditional academic education in addressing the unique needs and challenges of rural communities, Deshmukh championed the integration of vocational training into the educational framework. This section delves into the philosophy behind his advocacy, the implementation of vocational training through the Shri Shivaji Education Society (SSES), and the impact of these initiatives on rural development.

Philosophical Underpinnings

Deshmukh's approach was rooted in a pragmatic understanding of the socio-economic fabric of rural India. He observed that the majority of rural populations were engaged in agriculture and local industries, yet lacked the formal education or skills training to optimize their productivity or diversify their income sources. Traditional academic education, while valuable, did not necessarily translate into improved livelihoods for these communities. Deshmukh believed in education as a means of empowerment—whereby equipping individuals with practical, vocational skills could directly contribute to their ability to improve their economic circumstances and achieve self-sufficiency.

Implementation through SSES

The Shri Shivaji Education Society became the vehicle for Deshmukh's vision, integrating vocational training into its curriculum across its vast network of schools and colleges. This initiative was groundbreaking, offering courses designed to meet the specific needs of rural economies. Key areas of focus included:

- **Agriculture:** Courses in modern farming techniques, crop management, and animal husbandry were introduced, aiming to enhance agricultural productivity and sustainability.

• **Carpentry and Construction:** Training in carpentry and construction addressed the local demand for skilled labor, enabling individuals to contribute to their communities' infrastructure development.
• **Spinning and Weaving:** By offering training in traditional crafts such as spinning and weaving, SSES not only preserved these cultural practices but also opened up avenues for artisanal entrepreneurship.

These vocational programs were carefully crafted to ensure relevance to the local economic context, thereby increasing the likelihood of employment or entrepreneurial success for graduates.

Impact on Rural Development

The impact of Deshmukh's advocacy for vocational training on rural development has been multifaceted:

• **Economic Empowerment:** Individuals equipped with vocational skills were better positioned to secure employment, start their own businesses, or enhance the productivity of their agricultural practices. This led to improved incomes and economic resilience.
• **Social Mobility:** Vocational education opened up new opportunities for individuals and communities, breaking cycles of poverty and enabling social mobility.
• **Sustainable Development:** Training in sustainable agricultural practices and local industries promoted environmental stewardship and the sustainable use of resources.
• **Community Strengthening:** By fostering a skilled workforce within rural areas, these initiatives helped to stem the tide of urban migration, ensuring that communities remained vibrant and economically viable.

Dr. Punjabrao Deshmukh's foresight in advocating for vocational training as a complement to traditional academic education has had a lasting impact on rural development in Maharashtra and beyond. By aligning education with the economic and social realities of rural life, Deshmukh's approach has empowered generations, transforming not just individual lives but the fabric of rural society itself. This holistic vision of education as a tool for personal and community development remains a cornerstone of SSES's mission and a testament to Deshmukh's enduring legacy in the field of education and rural upliftment.

IV. VISION FOR AN EQUITABLE AND INCLUSIVE EDUCATION SYSTEM:

Dr. Punjabrao Deshmukh's vision for an equitable and inclusive education system was a cornerstone of his educational philosophy and efforts. He sought to dismantle the barriers that hindered access to education for various sections of society, particularly those historically marginalized. Deshmukh's advocacy went beyond mere rhetoric, translating into tangible initiatives and reforms that aimed to create a more inclusive educational landscape. This section explores the key components of his vision and the strategies he employed to realize it.

❖ Holistic Approach to Social Justice and Equality

Deshmukh's commitment to social justice and equality was deeply influenced by his understanding of the transformative power of education. He recognized that for education to be truly impactful, it needed to be accessible to everyone, irrespective of their caste, gender, or socioeconomic status. His vision was not just about opening doors to education but ensuring that once inside, all students had the support and resources they needed to succeed.

❖ Promotion of Girls' Education

One of Deshmukh's critical areas of focus was girls' education. He understood that educating girls was one of the most effective ways to empower women, uplift families, and, by extension, transform communities. Deshmukh advocated for the establishment of schools and colleges that were welcoming to girls and equipped with the facilities necessary to support their learning. He also worked to change societal attitudes towards girls' education, promoting the idea that educated women were crucial to the nation's progress.

❖ Championing the Education of Tribal and Marginalized Groups

Deshmukh was particularly concerned with the educational exclusion faced by tribal communities and other marginalized groups. He recognized that these communities faced unique challenges, including geographical isolation, economic deprivation, and cultural barriers to education. To address these challenges, Deshmukh pushed for the establishment of schools and educational programs specifically designed to meet the needs of these groups. This included the creation of

scholarship programs, mobile schools, and vocational training centers that could provide relevant and accessible education.

❖ **Bridging the Gap in Educational Opportunities**

Deshmukh's efforts to bridge the educational gap were multifaceted. He believed in creating an education system that was flexible and adaptive, capable of meeting the diverse needs of India's population. This included integrating local languages and cultures into the curriculum to make education more relevant and engaging for students from different backgrounds. Deshmukh also advocated for the use of technology and innovative teaching methods to reach students in remote or underserved areas.

❖ **Legacy and Continuing Influence**

The impact of Deshmukh's vision for an equitable and inclusive education system is evident in the numerous initiatives and institutions that continue to embody his principles. The Shri Shivaji Education Society, under his guidance, became a model for inclusive education, offering diverse programs that cater to the needs of all students. Deshmukh's legacy is also reflected in the ongoing efforts of educators, policymakers, and social reformers who continue to work towards a more just and equitable educational landscape in India.

V. IMPACT AND LEGACY:

The impact and legacy of Dr. Punjabrao Deshmukh's contributions to education in India, particularly through his establishment and nurturing of the Shri Shivaji Education Society (SSES), have been both profound and enduring. Deshmukh's holistic approach to education reform, which emphasized accessibility, inclusivity, and practicality, has left an indelible mark on the Vidarbha region and the broader educational landscape of India. This section aims to elaborate on the multifaceted impact of his work and its lasting legacy.

➔ **Transforming Lives Through Education**

The foundation of SSES under Deshmukh's leadership has been pivotal in transforming the educational landscape of Maharashtra, especially in the Vidarbha region. By establishing over 269 branches, SSES has made quality education accessible to thousands of students who might otherwise have been left out of the educational system. This widespread access to education has played a crucial role in transforming lives, enabling students to pursue higher education and professional careers, thereby fostering social mobility and breaking cycles of poverty.

➔ **Fostering Economic Development Through Vocational Training**

Deshmukh's foresight in integrating vocational training into the curriculum of SSES schools addressed a critical gap in rural education. By equipping students with practical skills in agriculture, carpentry, spinning, and weaving, among other vocations, the initiative has significantly contributed to economic development in rural areas. Graduates of these programs have been able to apply their skills to improve agricultural practices, start small businesses, or find employment in local industries, thus boosting the rural economy and reducing the urban migration rate.

➔ **Inspiring a Vision for an Inclusive Education System**

Dr. Deshmukh's advocacy for an inclusive education system has resonated widely, inspiring educators and policymakers across India and beyond. His vision of an education system that caters to all segments of society, regardless of socioeconomic background, gender, or caste, has influenced national education policies and practices. Initiatives aimed at promoting girls' education, integrating marginalized communities into the mainstream education system, and providing equal opportunities for all have been inspired by Deshmukh's work and ethos.

➔ **Legacy and Continuing Influence**

The legacy of Dr. Punjabrao Deshmukh extends beyond the immediate outcomes of his initiatives. It lies in the enduring principles of equity, inclusivity, and the transformative power of education that he championed. His work has inspired subsequent generations of social reformers, educators, and policymakers who continue to draw on his vision and values in their efforts to reform the education system. The principles he espoused continue to guide discussions and decisions regarding educational reforms in India, ensuring that his impact is felt long after his passing.

VI. CONCLUSION:

Dr. Punjabrao Deshmukh's impact on education in rural India, particularly through the establishment of the Shri Shivaji Education Society, is a testament to the power of visionary leadership

in social reform. His emphasis on vocational training, inclusive education, and social mobility has not only transformed lives but also contributed to the economic development of rural areas. As we continue to face challenges in education globally, Deshmukh's legacy serves as a beacon, reminding us of the transformative potential of education when it is accessible, inclusive, and aligned with the needs of the community. His work remains a source of inspiration for all those committed to creating a more equitable and just society through education.

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ARTICLE

Behaviour of Bianchi Type-V Dark Energy Model in $f(\mathrm{R},\mathrm{T})$ Gravity with a Specific Form of Hubble Parameter

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Abstract: In this paper, we have constructed a Bianchi type V cosmological model, in the presence of bulk viscous fluid and within the framework of $f(\mathrm{R},\mathrm{T})$ theory of gravity with an appropriate choice of the functional $f(\mathrm{R},\mathrm{T})$in the form $f(\mathrm{R},\mathrm{T}) = R + 2f(T)$, where R and T are respectively Ricci scalar and trace of energy momentum tensor. In order to obtain a deterministic solution, we have considered two general forms of hyperbolic scale factors. The different forms of scale factors considered here produce time-varying deceleration parameters in all the cases that simulate the cosmic transition. The state finder diagnostic pair is found to be in the acceptable range. The physical parameters are constrained from different representative values to build up a realistic cosmological model aligned with the observational behaviour.

Keywords: Bianchi type V, Dark energy, $f(\mathrm{R},\mathrm{T})$ gravity, Variable deceleration parameter.

1. Introduction

In recent years, several modified gravity theories, like $f(R)$ gravity, $f(G)$ gravity, $f(T)$ gravity and so on, were investigated by many researchers. A large class of cosmological models has explained the acceleration of the universe in terms of a component with negative pressure, the so-called dark energy (DE). The limitations of general relativity in providing a satisfactory explanation of this phase of evolution have led cosmologists to adopt hypotheses and study their implications in this context. The hypotheses include those assigning (I) the time–dependence of the gravitational constant and cosmological term (II) some other geometries or physical fields associated with the universe and (III) modified or alternative theories of gravity. Modified gravity theories certainly provide a way of understanding the problem of DE and the possibility to reconstruct the gravitational field theories that would be capable to reproduce the late–time acceleration of the universe. In an effort to address the cosmic speed-up issue, Harko et al. [1] introduced a modified gravity theory known as $f(\mathrm{R},\mathrm{T})$ gravity. Several studies were made in this theory addressing different contexts, such as energy conditions (Alvarenga et al. [2]; Kiani & Nozari [3]), wormhole solution (Azizi [4]; Moraes et al. [5]), anisotropy cosmology (Sharif & Zubair [6]; Mishra et al. [7-8]), higher dimensions (Troisi [9]) and non-interacting Chaplygin gas (Shabani [10]; Shabani & Farhoudi [11]). Sharma and Singh [12] have studied the string cosmological model with magnetic field in Bianchi Type II space-time. With a rescaled functional of $f(\mathrm{R},\mathrm{T})$gravity, extensive investigations were carried out in Bianchi type VIh space-time to understand the dynamical behaviour of the aniotropic universe (Mishra et al. [13-14]). Zubair et al. [15] have investigated the anisotropy source with the dynamical analysis of cylindrically symmetric space-time, whereas Mishra and Vadrevu [16] have constructed a cylindrically symmetric

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model with the exact solution. Aktas and Aygun [17] have shown that magnetized field vanishes in FRW universe for $f(\mathrm{R},\mathrm{T})$gravity. Many more Bianchi type cosmological models have been developed in recent past (Shamir [18]; Chaubey & Shukla [19]; Pawar [20-23]; Samanta [24] ; Reddy et al. [25-27]; Shri Ram [28]; Nasr Ahmed [29]). The extraordinary phenomena of $f(\mathrm{R},\mathrm{T})$gravity may provide some significant signatures and effects which could distinguish and discriminate between various gravitational models. Therefore, this theory has attracted many researchers to explore different aspects of cosmology and astrophysics in isotropic and in anisotropic space-times (See for example Khade and Wasnik [30]; Chakraborty [31]; Houndjo et al. [32]; Pasqua et al.[33]; Singh and Singh [34]; Baffou et al. [35]; Santos and Ferst [36]; Noureen et al. [37]; Shamir [38]; Singh and Singh [39]; Alhamzawi and Alhamzawi[40]; Yousaf et al. [41]; Alves et al. [42]; Zubair et al. [43]; Sofuoglu [44]; Momeni et al. [45]; Das et al. [46]; Salehi and Aftabi [47]; Singh and Beesham [48]; Srivastava and Singh [49]; Sharif and Anwar [50]; Tiwari and Beesham [51]; Shabani et al. [52]; Rajabi and Nozari [53]; Baffou et al. [54]; Lobato et al. [55]; Tretyakov [56]; Elizalde and Khurshudyan [57]; Ordines and Carlson [58]; Maurya and Tello-Ortizb [59]; Esmaeili [60] and references therein).

Bulk viscosity is the only dissipative phenomenon occurring in FRW models and is significant in causing the accelerated expansion of the universe known as inflationary phase as discussed by Setaren et al. [61]. Several cosmologists have discussed the role of bulk viscosity in the early evolution of the universe in different physical contexts. The cosmological and astrophysical implications of $f(\mathrm{R},\mathrm{T})$ gravity theory in the presence of perfect fluids and bulk viscous fluids have been studied by several cosmologists. Shri Ram et al. [62] investigated Bianchi type–I and –V bulk viscous fluid cosmological models. Sahu et al. [63] discussed cosmic transits and anisotropic models of Bianchi type–III. Further, Sahoo et al. [64-69] studied cosmological models in $f(\mathrm{R},\mathrm{T})$ theory with variable deceleration parameters. This motivates the theorists to construct various models of different Bianchi space–times in different contexts.

Spatially homogeneous and anisotropic Bianchi models have been widely studied in the framework of general relativity to describe the early stage of evolution of the universe. The theoretical studies and observational data of cosmic microwave background (CMB) and the large structure have stimulated the study of anisotropic models. The study of anisotropic models has also been extended to modified gravitational theories. Pradhan et al. [70], Aktas et al. [71], Yilmaz et al.[72] and Sharif and Zubair [73, 74] are some of the authors who have investigated several aspects of anisotropic Bianchi models in $f(\mathrm{R},\mathrm{T})$gravity.

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.

In this paper, we have investigated the physical behaviour of the cosmological model obtained with Bianchi type–V space-time in the presence of hyperbolic scale factor in two different cases. The present paper is organized as follows. The field equations of $f(\mathrm{R},\mathrm{T})$ gravity have been derived in Section 2. The model and basic framework have been presented in Section 3. In Sections 4, 6, the derivation and analysis of parameters have been derived for cases I, II. In Sections 5, 7, the physical properties of the model have been discussed for cases I, II, respectively. Finally, the conclusion is given in Section 8.

2. Field Equations

We assume that the cosmic matter may be represented by the energy-momentum tensor of an imperfect bulk viscous fluid as:

$$T_{ij} = (\rho + \bar{p})u_i u_j - \bar{p} g_{ij} \tag{1}$$

where $\bar{p}$ is the bulk viscous pressure given by:

$$\bar{p} = p - \varsigma u^i; i \tag{2}$$

satisfying a linear equation of state:

$$p = \epsilon\rho, 0 \leq \epsilon \leq 1. \tag{3}$$

Here, p is the equilibrium pressure, ρ is the energy density of matter, ς is the coefficient of bulk viscosity and u^i is the flow vector of the fluid satisfying $u_i u^i = 1$. The semicolon stands for covariant differentiation. On thermodynamic grounds, bulk viscosity coefficient ς is positive, assuring that the viscosity pushes the dissipative pressure $\bar{p}$ towards negative values. However,

the correction applied to the thermodynamical pressure p due to bulk viscous pressure is very small. Therefore, the dynamics of cosmic evolution is not fundamentally influenced by the inclusion of the viscous term in the energy-momentum tensor.

For the field equations in $f(R,T)$ modified gravity model, we assume that the function $f(R,T)$ is given by:

$$f(R,T) = R + 2f(T) \tag{4}$$

where $f(T)$ is an arbitrary function of the trace of the stress-energy tensor of matter. The gravitational field equation is immediately given by:

$$R_{ij} - \frac{1}{2}Rg_{ij} = 8\pi T_{ij} + 2f'(T)T_{ij} + [2\bar{p}f'(T) + f(T)]g_{ij} \tag{5}$$

where the prime denotes a derivative with respect to the argument.

The simplest cosmological model can be obtained by choosing the function $f(T)$, so that $f(T) = \lambda T$, where λ is a constant.

3. The Model and Basic Framework

The diagonal form of the metric of Bianchi type-V cosmological model is given by:

$$ds^2 = dt^2 - A^2dx^2 - e^{2\beta x}[B^2dy^2 + C^2dz^2]. \tag{6}$$

Here, $A = A(t)$, $B = B(t)$ and $C = C(t)$ are cosmic scale factors and β is an arbitrary constant.

The spatial volume V and the average Hubble's parameter H are defined as:

$$V = a^3 = ABC, \tag{7}$$

$$3H = \frac{\dot{V}}{V} = \frac{\dot{A}}{A} + \frac{\dot{B}}{B} + \frac{\dot{C}}{C}, \tag{8}$$

where a dot denotes differentiation with respect to cosmic time t.

The shear scalar σ and anisotropy parameter Am are defined as follows:

$$\sigma^2 = \frac{1}{2}\left[\left(\frac{\dot{A}}{A}\right)^2 + \left(\frac{\dot{B}}{B}\right)^2 + \left(\frac{\dot{C}}{C}\right)^2\right] - \frac{1}{6}\theta^2 \tag{9}$$

$$Am = \frac{1}{3}\sum_{i=1}^{3}\left(\frac{\triangle H_i}{H}\right)^2 \tag{10}$$

where $\triangle H_i = H_i - H, (i = 1,2,3)$ and $H_1 = \frac{\dot{A}}{A}, H_2 = \frac{\dot{B}}{B}$ and $H_3 = \frac{\dot{C}}{C}$ are the directional Hubble parameters.

For the metric (6), Eqs. (1), (4) and (5) in comoving coordinates lead to the following set of equations:

$$\frac{\dot{A}\dot{B}}{AB} + \frac{\dot{B}\dot{C}}{BC} + \frac{\dot{A}\dot{C}}{AC} - \frac{3\beta^2}{A^2} = (8\pi + 3\lambda)\rho - \lambda\bar{p} \tag{11}$$

$$\frac{\ddot{B}}{B} + \frac{\ddot{C}}{C} + \frac{\dot{B}\dot{C}}{BC} - \frac{\beta^2}{A^2} = \lambda\rho - (8\pi + 3\lambda)\bar{p} \tag{12}$$

$$\frac{\ddot{A}}{A} + \frac{\ddot{C}}{C} + \frac{\dot{A}\dot{C}}{AC} - \frac{\beta^2}{A^2} = \lambda\rho - (8\pi + 3\lambda)\bar{p} \tag{13}$$

$$\frac{\ddot{A}}{A} + \frac{\ddot{B}}{B} + \frac{\dot{A}\dot{B}}{AB} - \frac{\beta^2}{A^2} = \lambda\rho - (8\pi + 3\lambda)\bar{p} \tag{14}$$

$$\frac{2\dot{A}}{A} - \frac{\dot{B}}{B} - \frac{\dot{C}}{C} = 0. \tag{15}$$

After integrating Eq. (15) and absorbing integration constant into B or C, we get:

$$A^2 = BC. \tag{16}$$

We have five highly non-linear differential equations with six unknowns; namely, $A, B, C, \rho, \bar{p}, \varsigma$. Therefore, to find a consistent solution to these equations, subtracting Eq. (13) from Eq. (12), Eq. (14) from Eq. (13), Eq. (14) from Eq. (12) and integrating the resulting equations, we obtain the following three relations (Saha and Rikhvitsky [75,76]), respectively:

$$\frac{A}{B} = m_1 exp\left[k_1 \int \frac{dt}{a^3}\right] \tag{17}$$

$$\frac{A}{C} = m_2 exp\left[k_2 \int \frac{dt}{a^3}\right] \tag{18}$$

$$\frac{B}{C} = m_3 exp\left[k_3 \int \frac{dt}{a^3}\right] \tag{19}$$

where $m_1, m_2, m_3, k_1, k_2, k_3$ are constants of integration.

Using Eq. (7), we write the metric functions from (17)-(19) in explicit form as:

$$A = ad_1 exp\left[\alpha_1 \int \frac{dt}{a^3}\right] \tag{20}$$

$$B = ad_2 exp\left[\alpha_2 \int \frac{dt}{a^3}\right] \tag{21}$$

$$C = ad_3 exp\left[\alpha_3 \int \frac{dt}{a^3}\right] \tag{22}$$

where:

$$d_1 = \sqrt[3]{m_1 m_2}, d_2 = \sqrt[3]{m_1^{-1} m_3}, d_3 = \sqrt[3]{(m_2 m_3)^{-1}}, \tag{23}$$

and

$$\alpha_1 = \frac{k_1 + k_2}{3}, \alpha_2 = \frac{k_3 - k_1}{3}, \alpha_3 = \frac{-(k_2 + k_3)}{3}. \tag{24}$$

The constants d_1, d_2, d_3 and $\alpha_1, \alpha_2, \alpha_3$ satisfy the following two relations:

$$\alpha_1 + \alpha_2 + \alpha_3 = 0;\ d_1\, d_2 d_3 = 1. \quad (25)$$

Substituting Eq. (16) in Eqs. (20)-(22), we obtain:

$$A = a \quad (26)$$

$$B = adexp\left[\alpha \int \frac{dt}{a^3}\right], \quad (27)$$

$$C = ad^{-1}exp\left[-\alpha \int \frac{dt}{a^3}\right] \quad (28)$$

where:

$$d_1 = 1, d_2 = d_3^{-1} = d, \alpha_1 = 0, \alpha_2 = -\alpha_3 = \alpha\ .$$

4. Derivation and Analysis of Parameters

Case (i): For $H = \eta tanh(\eta t)$

For the explicit determination of the cosmic parameters, we need one more condition. Recently, Pacif and Mishra [77] as well as Esmaeili and Mishra [78] have obtained cosmological model in Bianchi types geometry with a specific variation of the Hubble parameter in general relativity, which is a good approximation concerning the current late-time acceleration of the universe. Following the same here, we consider that:

$$H = \eta tanh(\eta t). \quad (29)$$

With the form of H given by Eq. (29), we obtain the average scale factor as:

$$a = \delta cosh(\eta t). \quad (30)$$

Using Eqs. (26)-(28) with the help of (30), we obtain the metric functions as:

$$A = \delta cosh(\eta t). \quad (31)$$

$$B = d\delta cosh(\eta t) exp\left[\frac{\alpha}{2\eta\delta^3}(sech(\eta t)tanh(\eta t) + 2arctane^{\eta t})\right]. \quad (32)$$

$$C = d^{-1}\delta cosh(\eta t) exp\left[\frac{-\alpha}{2\eta\delta^3}(sech(\eta t)tanh(\eta t) + 2arctane^{\eta t})\right]. \quad (33)$$

$$\rho = \frac{1}{(8\pi+2\lambda)(8\pi+4\lambda)}\left\{6\eta^2(4\pi+\lambda)tanh^2(\eta t) - 2\lambda\eta^2 sech^2(\eta t) - \frac{\alpha^2}{\delta^6}(2\pi+\lambda)\left[2\text{sech}^3(\eta t) - \text{sech}(\eta t) + \frac{2e^{\eta t}}{1+e^{2\eta t}}\right]^2 - \frac{8(3\pi+\lambda)\beta^2}{\delta^2\cosh^2(\eta t)}\right\}. \quad (34)$$

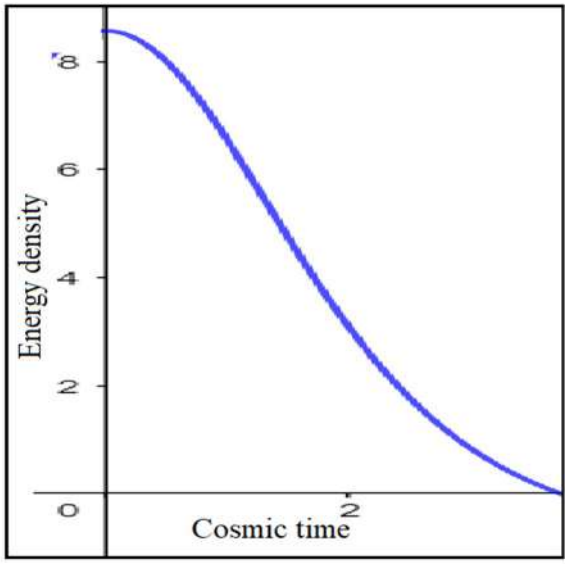

FIG. 1. Energy density *vs.* time for $\eta = 0.5, \alpha = 2, \lambda = -6.5, \delta = 1, \beta = 2$.

The energy density in Fig. 1 lies in the positive domain. It has been observed that the energy density is high in the early time of the universe and then gradually decreases to null. It may be noted here that since ρ needs to be positive, the first term of (34) should dominate the second. Therefore, the behaviours of the parameters are constrained accordingly within the admissible limits.

$$\bar{p} = \frac{1}{(8\pi+2\lambda)(8\pi+4\lambda)}\left\{-6\eta^2(4\pi+\lambda)tanh^2(\eta t) - 2(8\pi+3\lambda)\eta^2 sech^2(\eta t) - \frac{\alpha^2}{\delta^6}(2\pi+\lambda)\left[2sech^3(\eta t) - \text{sech}(\eta t) + \frac{2e^{\eta t}}{1+e^{2\eta t}}\right]^2 + \frac{8\pi\beta^2}{\delta^2 cosh^2(\eta t)}\right\}. \quad (35)$$

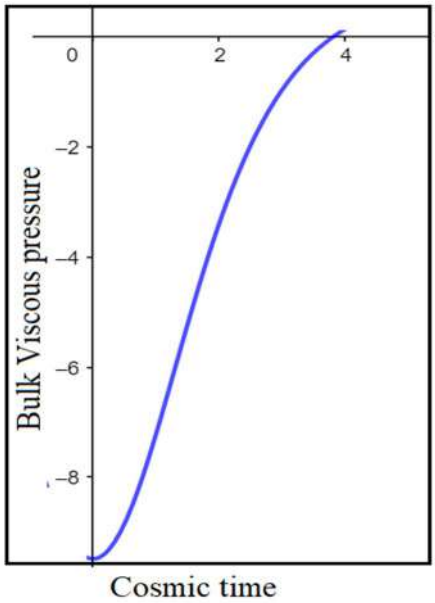

FIG. 2. Bulk viscous pressure $\bar{p}$ *vs.* time for $\eta = 0.5, \alpha = 2, \lambda = -6.5, \delta = 1, \beta = 2$.

From Fig. 2, we observe that bulk viscous pressure $\bar{p}$ lies in the negative range to suffice the acceleration of the universe. The bulk viscous pressure of the universe is an increasing function of cosmic time t, which begins from a negative value and tends to zero at a present epoch. The accelerated expansion of the universe, as per the recent cosmological observations, is due to dark energy which is nothing but negative pressure. Thus, the derived model is in good agreement with the observation.

$$\varsigma = \frac{1}{3(8\pi+2\lambda)(8\pi+4\lambda)\eta\tanh(\eta t)}\Big\{6\eta^2(4\pi+\lambda)(\varepsilon+1)tanh^2(\eta t) + 2(8\pi+3\lambda-\varepsilon\lambda)\eta^2 sech^2(\eta t) - \frac{\alpha^2}{\delta^6}(1-\varepsilon)(2\pi+\lambda)\Big[2sech^3(\eta t) - \mathrm{sech}(\eta t) + \frac{2e^{\eta t}}{1+e^{2\eta t}}\Big]^2 - \frac{8[(3\pi+\lambda)\varepsilon+\pi]\beta^2}{\delta^2 cosh^2(\eta t)}\Big\}. \quad (36)$$

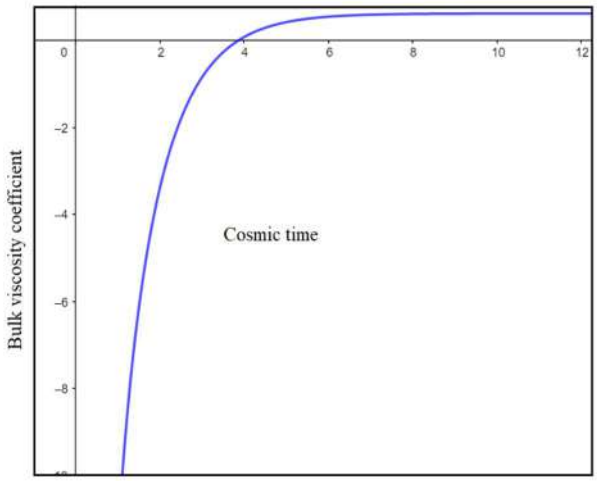

FIG. 3. Bulk viscosity coefficient *vs.* time for $\eta = 0.5, \alpha = 2, \lambda = -6.5, \delta = 1, \beta = 2, \varepsilon = 0.1$.

The barotropic equation of state parameter is used to obtain the coefficient of bulk viscosity. It can be observed that the bulk viscosity is negative at higher redshift (early time) and positive at lower redshift (late time) in the present model with bulk viscosity shown in Fig. 3. This means that the rate of entropy production is negative in the early epoch and positive in the later epoch. Thus, the model does not violate the law of entropy. It also shows the transition from negative to positive in due course of evolution, which indicates the earlier decelerating phase of the universe with positive pressure (suitable for structure formation) and present accelerating phase of the evolution with negative pressure.

5. Physical Properties of the Model

The spatial volume (V), the directional Hubble parameter (H_i), the expansion scalar (θ), the shear scalar (σ^2), the deceleration parameter (q) and the anisotropy parameter (Am) are, respectively, given by:

$$V = a^3 = \delta^3 cosh^3(\eta t). \quad (37)$$

$$H_1 = \frac{\dot{A}}{A} = \eta tanh(\eta t). \quad (38)$$

$$H_2 = \frac{\dot{B}}{B} = \frac{\alpha}{2\delta^3}\left[2sech^3(\eta t) - sech(\eta t) + \frac{2e^{\eta t}}{1+e^{2\eta t}}\right] + \eta \tanh(\eta t). \quad (39)$$

$$H_3 = \frac{\dot{C}}{C} = \frac{-\alpha}{2\delta^3}\left[2sech^3(\eta t) - sech(\eta t) + \frac{2e^{\eta t}}{1+e^{2\eta t}}\right] + \eta \tanh(\eta t). \quad (40)$$

$$\theta = 3\eta tanh(\eta t). \quad (41)$$

$$\sigma^2 = \frac{\alpha^2}{4\delta^6}\left[2sech^3(\eta t) - sech(\eta t) + \frac{2e^{\eta t}}{1+e^{2\eta t}}\right]^2. \quad (42)$$

$$q = -coth^2(\eta t). \quad (43)$$

$$Am = \frac{1}{3}\left\{4 + \frac{\alpha^2}{2\eta^2\delta^6 tanh^2(\eta t)}\left[2sech^3(\eta t) - sech(\eta t) + \frac{2e^{\eta t}}{1+e^{2\eta t}}\right]^2\right\}. \quad (44)$$

The above results are useful to discuss the behavior of the model.

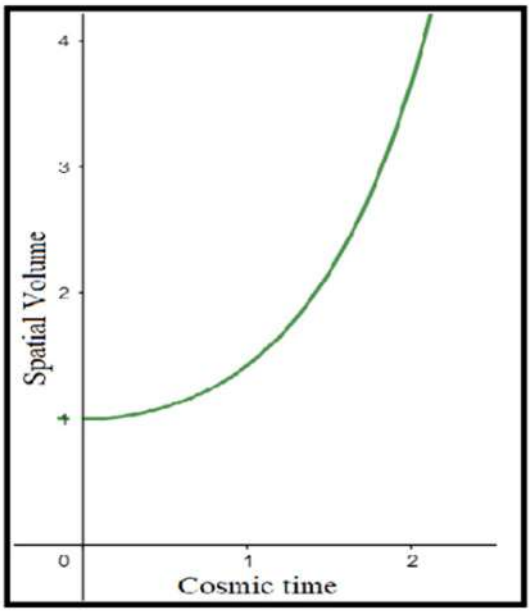

FIG. 4. Spatial volume *vs*. time for $\delta = 1, \eta = 0.5$.

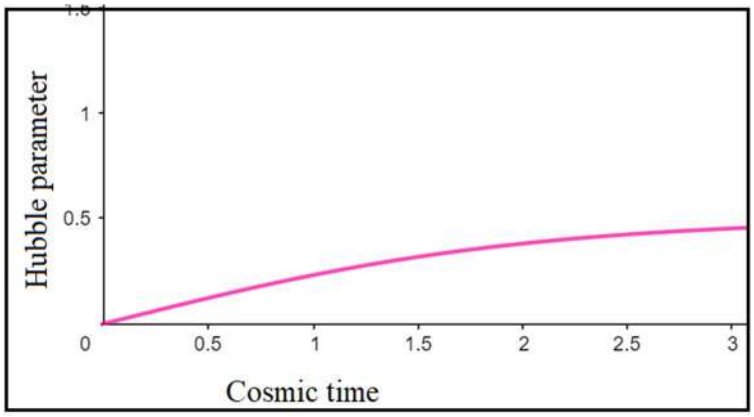

FIG. 5. Hubble parameter *vs*. time for $\delta = 1, \eta = 0.5$.

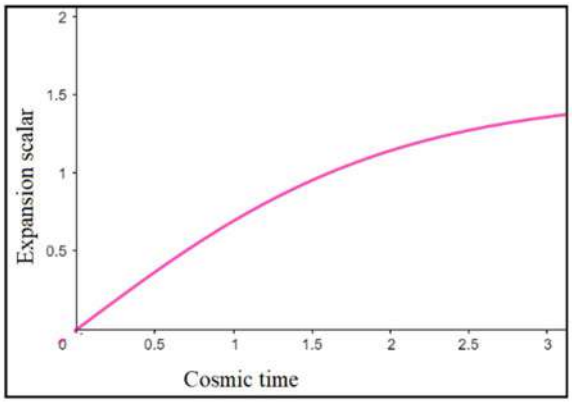

FIG. 6. Expansion scalar *vs*. time for $\delta = 1, \eta = 0.5$.

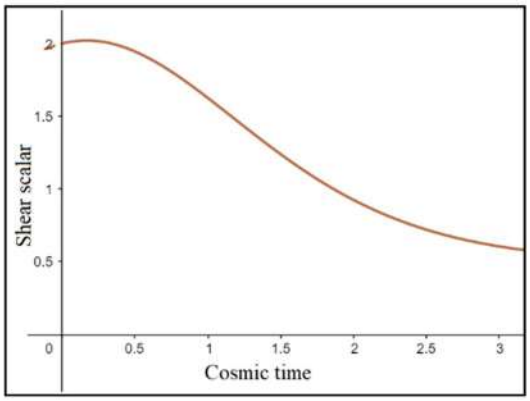

FIG. 7. Shear scalar *vs*. time for $\delta = 1, \eta = 0.5, \alpha = 2$.

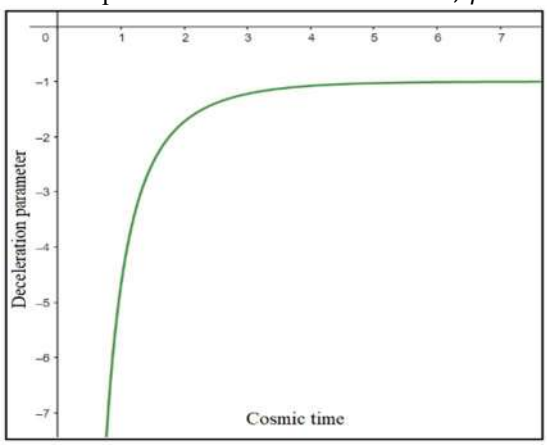

FIG. 8. Deceleration parameter *vs*. time for $\delta = 1$, $\eta = 0.5$.

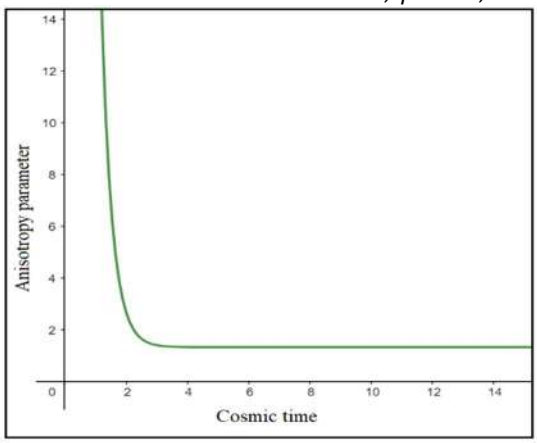

FIG. 9. Anisotropic parameter *vs*. time for $\delta = 1, \eta = 0.5,\ \alpha = 2$.

We have the following observations:

From Eq. (37), it can be observed that the volume scale factor is finite at the initial epoch and positive throughout the evolution. It increases gradually with the increase in time as shown in (Fig 4). The graphical representation of the Hubble parameter is shown in Fig. 5. The parameter is governed by the constant η and the cosmic time. Since we have already assumed a positive constant η to obtain a model that fits observationally, the parameter is now totally controlled by the cosmic time. Hubble parameter increases with the increase in time. Shear scalar decreases with the increase in time (Fig 7). Fig.6 depicts that the expansion scalar increases with the increase in time.

The deceleration parameter is found to be $q = -coth^2(\eta t)$. It indicates that the parameter always remains negative throughout the cosmic evolution for $\eta = 0.5$. Since the scale factor is hyperbolic and can never be negative, this confirms that the deceleration parameter will always remain in the negative domain. It is also observed from Fig. 8 that the accelerated expansion occurs in a reasonable time period, which can be termed as the transition period. The mean anisotropic parameter decreases exponentially and approaches null with an increase in time (Fig. 9).

6. Derivation and Analysis of Parameters

Case (ii): For $H = \eta coth(\eta t)$

$$H = \eta coth(\eta t). \tag{45}$$

With the form of H given by Eq. (45), we obtain the average scale factor as:

$$a = \delta sinh(\eta t). \tag{46}$$

Using Eqs. (26)-(28) with the help of (30), we obtain the metric functions as:

$$A = \delta sinh(\eta t). \tag{47}$$

$$B = d\delta sinh(\eta t) exp\left[\frac{-\alpha}{2\eta\delta^3}\left(cosech(\eta t)coth(\eta t) + logtanh(\frac{\eta t}{2})\right)\right]. \tag{48}$$

$$C = d^{-1}\delta sinh(\eta t)exp\left[\frac{\alpha}{2\eta\delta^3}\left(cosech(\eta t)coth(\eta t) + logtanh(\frac{\eta t}{2})\right)\right]. \quad (49)$$

$$\rho = \frac{1}{(8\pi+2\lambda)(8\pi+4\lambda)}\left\{6\eta^2(4\pi+\lambda)coth^2(\eta t) + 2\lambda\eta^2 cosech^2(\eta t) - \frac{\alpha^2}{\delta^6}(2\pi+\lambda)\left[cosech(\eta t)\left(cosech^2(\eta t) + coth^2(\eta t) - \frac{1}{2}cosech\left(\frac{\eta t}{2}\right)\coth\left(\frac{\eta t}{2}\right)\right)\right]^2 - \frac{8(3\pi+\lambda)\beta^2}{\delta^2\sinh^2(\eta t)}\right\}. \quad (50)$$

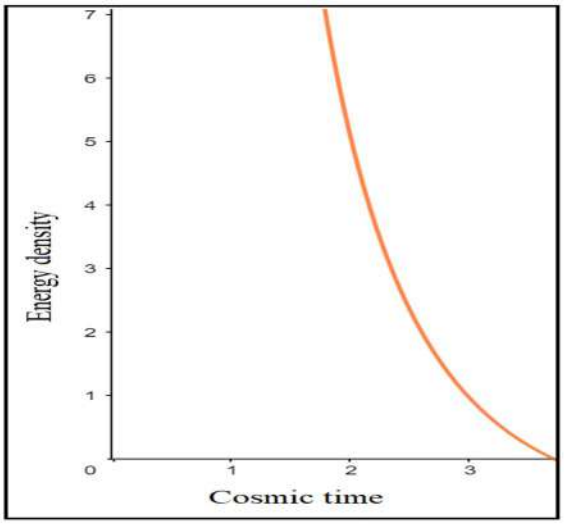

FIG. 10. Energy density *vs*. time for $\eta = 0.5, \alpha = 2, \lambda = -6.5, \delta = 1, \beta = 2$.

The energy density in Fig. 10 lies in the positive domain. It has been observed that the energy density decreases with the increase in time, but it is infinite at the initial epoch.

$$\bar{p} = \frac{1}{(8\pi+2\lambda)(8\pi+4\lambda)}\left\{-6\eta^2(4\pi+\lambda)coth^2(\eta t) + 2(8\pi+3\lambda)\eta^2 cosech^2(\eta t) - \frac{\alpha^2}{\delta^6}(2\pi+\lambda)\left[cosech(\eta t)\left(cosech^2(\eta t) + coth^2(\eta t) - \frac{1}{2}cosech\left(\frac{\eta t}{2}\right)\coth\left(\frac{\eta t}{2}\right)\right)\right]^2 + \frac{8\pi\beta^2}{\delta^2 sinh^2(\eta t)}\right\}. \quad (51)$$

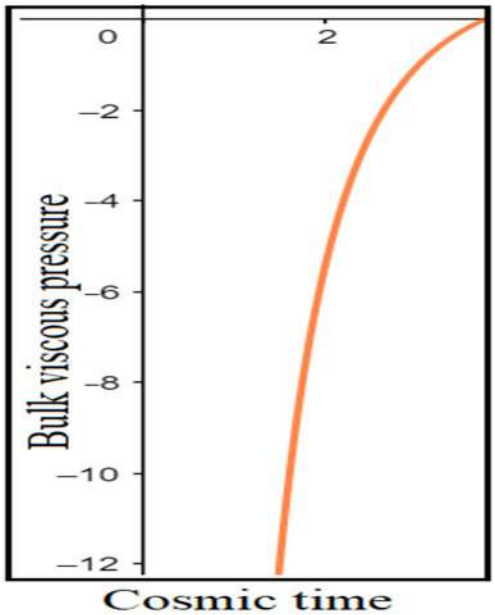

FIG. 11. Bulk viscous pressure $\bar{p}$ *vs*. time for $\eta = 0.5, \alpha = 2, \lambda = -6.5, \delta = 1, \beta = 2$.

From Fig. 11, we observe that bulk viscous pressure $\bar{p}$ is increasing as a function of time. It begins from a large negative value and tends to zero at the present epoch. The present study demonstrates the expanding behaviour of the universe and on the other hand, negative pressure indicates the cosmic accelerated expansion of the universe.

$$\varsigma = \frac{1}{3(8\pi+2\lambda)(8\pi+4\lambda)\eta\coth(\eta t)} \times \left\{ \begin{array}{c} 6\eta^2(4\pi+\lambda)(\varepsilon+1)coth^2(\eta t) \\ +2(8\pi+3\lambda-\varepsilon\lambda)\eta^2 cosech^2(\eta t) - \frac{\alpha^2}{\delta^6}(1-\varepsilon)(2\pi+\lambda) \\ \left[cosech(\eta t)\left(\begin{array}{c} cosech^2(\eta t)+coth^2(\eta t) \\ -\frac{1}{2}cosech\left(\frac{\eta t}{2}\right)\coth\left(\frac{\eta t}{2}\right) \end{array}\right)\right]^2 \\ -\frac{8[(3\pi+\lambda)\varepsilon+\pi]\beta^2}{\delta^2 sinh^2(\eta t)} \end{array} \right\} \quad (52)$$

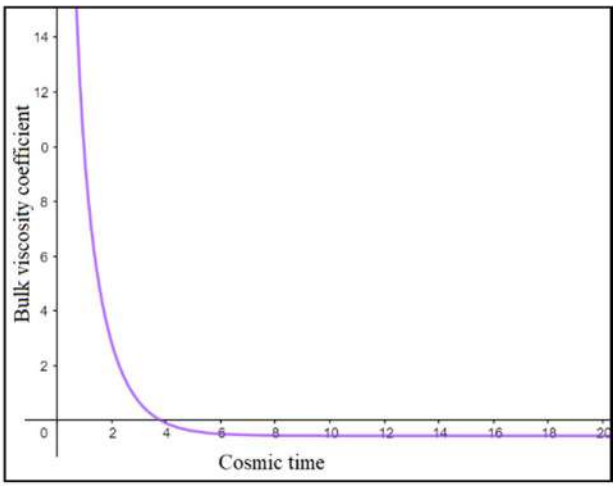

FIG. 12. Bulk viscosity coefficient *vs*. time for $\eta = 0.5, \alpha = 2, \lambda = -6.5, \delta = 1, \beta = 2, \varepsilon = 0.1$.

Using the equation of state parameter, the bulk viscosity coefficient is shown in Fig. 12. Bulk viscosity coefficient is infinite at the initial epoch and has a transition from positive to negative. It also shows the transition from positive to negative in due course of evolution, which indicates the earlier accelerating phase of the universe with negative pressure (suitable for structure formation) and the present decelerating phase of the evolution with positive pressure.

7. Physical Properties of the Model

The spatial volume (V), the directional Hubble parameter (H_i), the expansion scalar (θ), the shear scalar (σ^2), the deceleration parameter (q) and the anisotropy parameter (Am) are, respectively, given by:

$$V = a^3 = \delta^3 sinh^3(\eta t). \quad (53)$$

$$H_1 = \frac{\dot{A}}{A} = \eta coth(\eta t). \quad (54)$$

$$H_2 = \frac{\dot{B}}{B} = \frac{\alpha}{2\delta^3}\left[cosech(\eta t)\left(cosech^2(\eta t) + coth^2(\eta t) - \frac{1}{2}cosech\left(\frac{\eta t}{2}\right)\coth\left(\frac{\eta t}{2}\right)\right)\right] + \eta\coth(\eta t). \quad (55)$$

$$H_3 = \frac{\dot{C}}{C} = \frac{-\alpha}{2\delta^3}\left[cosech(\eta t)\left(cosech^2(\eta t) + coth^2(\eta t) - \frac{1}{2}cosech\left(\frac{\eta t}{2}\right)\coth\left(\frac{\eta t}{2}\right)\right)\right] + \eta\coth(\eta t). \quad (56)$$

$$\theta = 3\eta coth(\eta t). \quad (57)$$

$$\sigma^2 = \frac{\alpha^2}{4\delta^6}\left[cosech(\eta t)\left(cosech^2(\eta t) + coth^2(\eta t) - \frac{1}{2}cosech\left(\frac{\eta t}{2}\right)\coth\left(\frac{\eta t}{2}\right)\right)\right]^2. \quad (58)$$

$$q = -1 + sech^2(\eta t). \quad (59)$$

$$Am = \frac{1}{3}\left\{4 + \frac{\alpha^2}{2\eta^2\delta^6 coth^2(\eta t)}\left[cosech(\eta t)\left(cosech^2(\eta t) + coth^2(\eta t) - \frac{1}{2}cosech\left(\frac{\eta t}{2}\right)\coth\left(\frac{\eta t}{2}\right)\right)\right]^2\right\}. \quad (60)$$

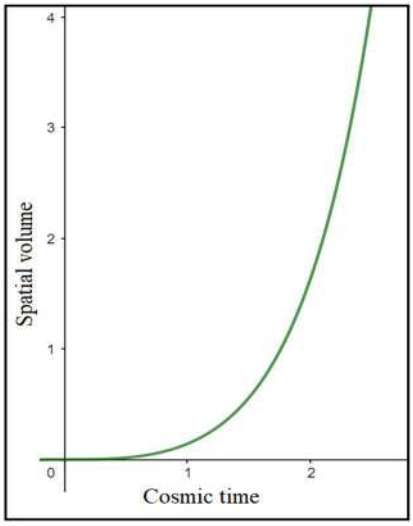

FIG. 13. Spatial volume *vs*. time for $\delta = 1, \eta = 0.5$.

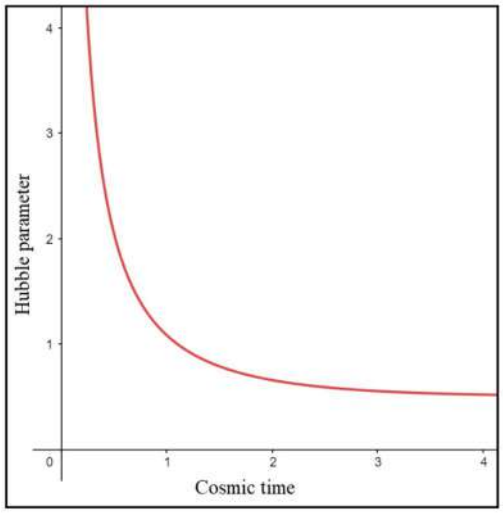

FIG.14. Hubble parameter *vs*. time for $\delta = 1, \eta = 0.5$.

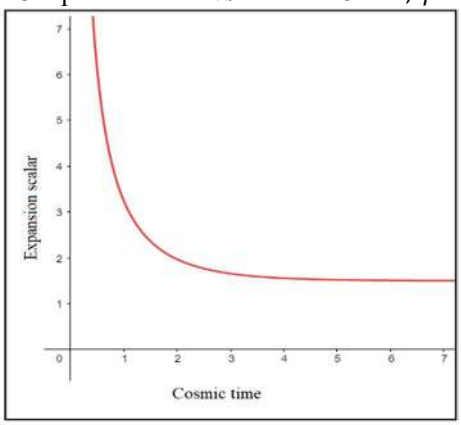

FIG. 15. Expansion scalar *vs*. time for $\delta = 1, \eta = 0.5$.

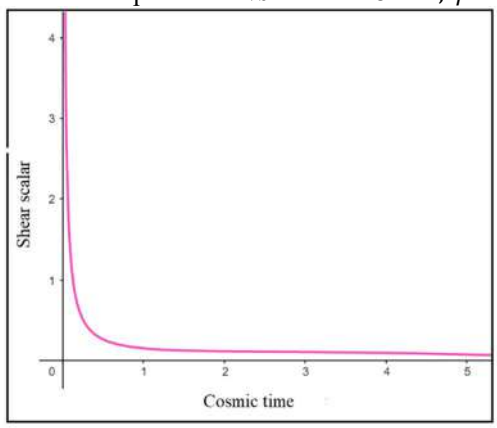

FIG. 16. Shear scalar *vs*. time for $\delta = 1, \eta = 0.5,\ \alpha = 2$.

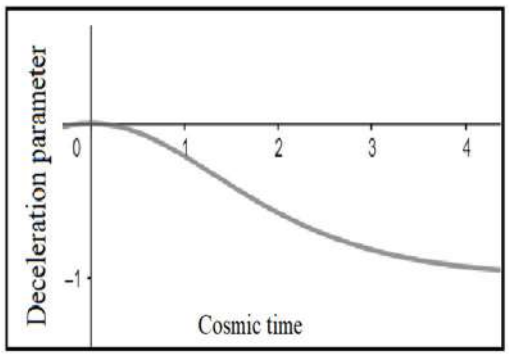

FIG. 17. Deceleration parameter *vs*. time for $\delta = 1, \eta = 0.5$.

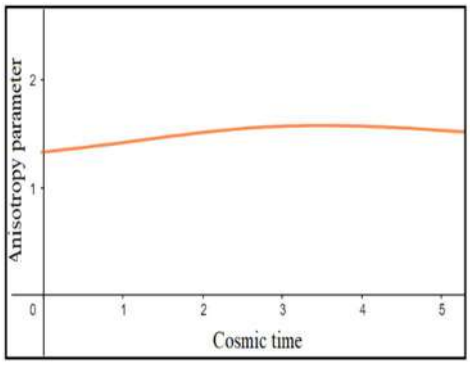

FIG. 18. Anisotropic parameter *vs*. time for $\delta = 1, \eta = 0.5,\ \alpha = 2$.

We have the following observations:

Spatial volume is zero when t = 0 and it increases as time increases. This means that the expansion of the universe starts with finite volume and it is expanding as t increases (Fig. 13). The average Hubble parameter (H), expansion scalar (θ) and shear scalar (σ) are functions of time t, have a singularity at t = 0 and tend to zero for large t. The expansion scalar and shear scalar diverge at an early stage of the universe and tend to zero for infinitely large values. It is observed that the universe initially evolves with an infinite expansion rate and shows a constant expansion at a later epoch. Also, H decreases as t increases (Fig. 14). The Hubble parameter H approaches zero for infinitely large time. Expansion scalar (θ) also

decreases as t increases (Fig. 15), but the positive values of Hubble parameter and expansion scalar throughout the evolution show that the universe is expanding gradually. Here, the anisotropy parameter is finite at initial time and is uniform throughout the evolution of the universe.

8. Conclusion

We have considered two different hyperbolic forms of Hubble parameter to construct some DE cosmological models of the universe in the framework of $f(R,T)$ gravity. The space-time considered is the spatially homogeneous anisotropic Bianchi V metric. With the help of the forms of Hubble parameter and Hubble expansion rate along different directions, the anisotropic behaviour of the dark energy-driven cosmological model has been simulated. For case I, energy density is finite, whereas in case II, energy density is infinite for $t = 0$. In both cases, energy density is a decreasing function of time and lies in the positive domain. For the first case, the bulk viscous pressure of the universe is an increasing function of cosmic time t, which begins from a negative value and tends to zero at the present epoch, whereas in the second case, bulk viscous pressure $\bar{p}$ is an increasing function of time. It begins from a large negative value and tends to zero at the present epoch. In both cases, the model provides an accelerating behaviour of the universe at late time of the evolution. More or less, the physical behaviour of both models appears to be the same at least at late times. In both cases, the model represents an expanding, shearing and accelerating universe. In both cases, the model has no initial singularity. Since the metric potential of the universe A(t) and B(t) are constant at $t = 0$, we observed that in both cases, the positive value of the Hubble parameter and the deceleration parameter $q \to -1$ for infinite time throughout the evolution show that the universe is expanding and accelerating exponentially. In the first case, there is no initial singularity, whereas in the second case, we have infinite energy density, infinite internal pressure for initial time. This means that our universe has an initial singularity for case II. In the present work, we observed that different DE anisotropic models depend on Hubble parameter. It is concluded that the bulk viscous pressure anisotropy in DE fluid plays a very important and interesting role, so that bulk viscous pressure anisotropy needs to be investigated for further better understanding of the accelerated expansion of the universe.

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Bianchi Type V Cosmological Scenario In $f(R,T)$ Gravity Theory With Special Form Of Scale Factor

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***Abstract*:**

In this study, we have examined the exact solutions of the field equations for a Bianchi type V universe filled with bulk viscous fluid within the framework of $f(R,T)$ theory, where $f(R,T) = R + 2f(T)$ and R and T represent the Ricci scalar and the trace of the energy momentum tensor, respectively. We used a combination of exponential and hyperbolic scale factors to determine the physical parameters and metric potentials in the space-time. We also investigated the geometrical and physical parameters of the model, as well as the energy conditions. Additionally, we found that the state finder diagnostic pair falls within an acceptable range.

Keywords:* $f(R,T)$ *gravity, Bianchi type V, Bulk viscous fluid, deceleration parameter.

1. INTRODUCTION

According to the cosmological observations, modern cosmology attracts much attention of the researchers because of its ability to explain the late-time acceleration of the Universe. One possibility in explaining the observations is by assuming that at large scales the Einstein gravity model of general relativity breaks down, and a more general action describes the gravitational field. This is the main reason why the modern cosmology is the fastest growing field in the study of the Universe. Modern cosmology achieved a new path because of the idea of accelerated expansion of the Universe. This idea was observed by type-Ia supernovae experiments, suggesting that the Universe is undergoing an accelerated expansion [1–6]. As a result of the coupling the motion of the massive particles becomes non geodesic and an extra-force orthogonal to the four velocities arises. The connections with modified Newtonian dynamics and the pioneer anomaly were explored. This model was extended to the case of arbitrary coupling in both geometry and matter in [7]. The astrophysical and cosmological implications of the non minimal coupling matter-geometry coupling were extensively investigated in [8, 9]. The Palatini formulation of the non minimal geometry-coupling models was considered in [10]. In this context a maximal extension of the Hilbert-Einstein action was proposed [11] by assuming that the gravitational Lagrangian is given by an arbitrary function of the Ricci scalar R and of the matter Lagrangian Lm. The gravitational field equations have been obtained in the metric formalism as well as the equations of motion for test particles, following from the covariant divergence of the stress energy tensor. Harko et al [12] proposed $f(R,T)$ gravity theory by taking into account the gravitational Lagrangian as the function of Ricci

scalar R and of the trace of energy-stress tensor T. They have obtained the equation of motion of test particle and the gravitational field equation in metric formalism both.

Recently several cosmological models have been developed in $f(R,T)$ gravity in framework of non-exotic matter that give the clue that the trace of energy momentum-tensor may be responsible for present cosmic acceleration in the universe [13–21]. The bulk viscosity in $f(R,T)$ gravity for a FRW universe is introduced in [22]. They have studied the realistic models considering the dissipative processes due to the presence of viscosity. Later, the bulk viscous cosmological model for anisotropic Bianchi I universe in this theory was presented in [23]. The authors in [24] have studied the dynamics of shearing anisotropic viscous fluid and its stability with cylindrical symmetry in $f(R,T)$ gravity. Moreover, the Little Rip and Big Rip model in $f(R,T)$ theory of gravity was investigated in [25–27]. The bouncing scenario of the $f(R,T)$ gravity model was well explained by Singh et al [28]. Aktas and Aygün [29] have discussed magnetised strange quark matter solutions in $f(R,T)$ gravity with a cosmological constant and they found that $f(R,T)$ theory can explain the late-time acceleration of the Universe. Samanta and Myrzakulov [30] studied bulk viscous fluid in $f(R,T)$ theory. Very recently, Pawar et al [31] have discussed the Bianchi-V model in the presence of $f(R,T)$ gravity using modified holographic Ricci dark energy and they found negative value of the deceleration parameter (DP) which indicates that the Universe is in the accelerated expansion phase and they observed that the Universe is isotropic throughout the evolution. Similarly, Pawar et al [32] and Sharif [33] have analysed $f(R,T)$ theory with different energy sources and in different cosmological models. Samanta [34] has investigated $f(R,T)$ gravity for the Bianchi type-V Universe filled with wet dark fluid.

Motivated by the above discussion, in the present paper, we consider spatially homogeneous and anisotropic Bianchi type-V universe filled with bulk viscous fluid cosmological model in the $f(R,T)$ theory of gravity. The geometrical and physical aspects of the models are also studied. This work aims to investigate new class of Bianchi type V bulk viscous fluid cosmological model under $f(R,T)$ gravity and it is organized as follow. The paper is organised as follows: Section 2 discusses gravitational field equation of $f(R,T)$ modified 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 discussed Dynamical parameters and their physical discussion. Section 5 is devoted to the cosmological interpretations. Finally, in section 6, we have concluded our work.

2.GRAVITATIONAL FIELD EQUATION OF $f(R,T)$ MODIFIED 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 by

$$S = \int \left[\frac{1}{2\kappa} f(R,T) + L_m\right]\sqrt{-g}\,d^4x, \qquad (1)$$

where $f(R,T)$is an arbitrary function of the Ricci scalar R,T is the stress energy tensor T_{ij} of matter andL_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 $f(R,T)$ gravity field equations are obtained by varying the action S in equation (1) with respect to the metric tensor

$$f_R(R,T)R_{ij} - \frac{1}{2}f(R,T)g_{ij} - \left(\nabla_i\nabla_j - g_{ij}\Pi\right)f_R(R,T) = \kappa T_{ij} - f_T(R,T)\left(T_{ij} - \frac{1}{3}\Theta_{ij}\right). \qquad (2)$$

where ∇_i being the covariant derivative and

$$\Pi = \nabla^i\nabla_i,\ f_R = \frac{\partial f(R,T)}{\partial R} \text{ and } f_T = \frac{\partial f(R,T)}{\partial T} \quad \Theta_{ij} = g^{\alpha\beta}\frac{\delta T_{\alpha\beta}}{\delta g^{ij}} \qquad (3)$$

The field equations in $f(R,T)$ modified gravity model we assume that the particular functional $f(R,T)$ as

$$f(R,T) = R + 2f(T) \qquad (4)$$

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

$$R_{ij} - \frac{1}{2}Rg_{ij} = 8\pi T_{ij} + 2f'(T)T_{ij} + [2\bar{p}f'(T) + f(T)]g_{ij}. \quad (5)$$

where the prime denotes a derivative with respect to the argument.
The simplest cosmological model can be obtained by choosing the function $f(T)$ so that $f(T) = \lambda T$, where λ is a constant.

3. METRIC AND FIELD EQUATIONS

Now we consider a The diagonal form of the metric of Bianchi type V universe with the metric as

$$ds^2 = dt^2 - A^2dx^2 - e^{2\beta x}[B^2dy^2 + C^2dz^2] \quad (6)$$

Here A, B, C are cosmic scale factors and β is an arbitrary constant.
Moreover, assuming the energy-momentum tensor for an imperfect bulk viscous fluid which takes the form

$$T_{ij} = (\rho + \bar{p})u_iu_j - \bar{p}g_{ij} \quad (7)$$

where $\bar{p}$ is the effective pressure given by

$$\bar{p} = p - \varsigma u^i;i \quad (8)$$

satisfying a linear equation of state

$$p = \epsilon\rho, \qquad 0 \leq \epsilon \leq 1. \quad (9)$$

Here p is the equilibrium pressure, ρ is the energy density of matter, ς is the coefficient of bulk viscosity and u^i is the flow vector of the fluid satisfying $u_iu^i = 1$. The semicolon stands for covariant differentiation. On thermodynamic grounds bulk viscosity coefficient ς is positive, assuring that the viscosity pushes the dissipative pressure $\bar{p}$ towards negative values. However, the correction applied to the thermodynamical pressure p due to bulk viscous pressure is very small. Therefore, the dynamics of cosmic evolution are not fundamentally influenced by the inclusion of the viscous term in the energy-momentum tensor.

The spatial volume V and the average Hubble's parameter H are defined as

$$V = a^3 = ABC, \quad (10)$$

$$3H = \frac{\dot{V}}{V} = \frac{\dot{A}}{A} + \frac{\dot{B}}{B} + \frac{\dot{C}}{C} \quad (11)$$

The shear scalar σ and anisotropy parameter Am are defined as follows

$$\sigma^2 = \frac{1}{2}\left[\left(\frac{\dot{A}}{A}\right)^2 + \left(\frac{\dot{B}}{B}\right)^2 + \left(\frac{\dot{C}}{C}\right)^2\right] - \frac{1}{6}\theta^2 \quad (12)$$

$$Am = \frac{1}{3}\sum_{i=1}^{3}\left(\frac{\triangle H_i}{H}\right)^2 \quad (13)$$

where $\triangle H_i = H_i - H, (i = 1, 2, 3)$ and $H_1 = \frac{\dot{A}}{A}, H_2 = \frac{\dot{B}}{B}$ and $H_3 = \frac{\dot{C}}{C}$ are the directional Hubble parameters.

$$\frac{\dot{A}\dot{B}}{AB} + \frac{\dot{B}\dot{C}}{BC} + \frac{\dot{A}\dot{C}}{AC} - \frac{3\beta^2}{A^2} = (8\pi + 3\lambda)\rho - \lambda\bar{p} \quad (14)$$

$$\frac{\ddot{B}}{B} + \frac{\ddot{C}}{C} + \frac{\dot{B}\dot{C}}{BC} - \frac{\beta^2}{A^2} = \lambda\rho - (8\pi + 3\lambda)\bar{p} \quad (15)$$

$$\frac{\ddot{A}}{A} + \frac{\ddot{C}}{C} + \frac{\dot{A}\dot{C}}{AC} - \frac{\beta^2}{A^2} = \lambda\rho - (8\pi + 3\lambda)\bar{p} \quad (16)$$

$$\frac{\ddot{A}}{A}+\frac{\ddot{B}}{B}+\frac{\dot{A}\dot{B}}{AB}-\frac{\beta^2}{A^2}=\lambda\rho-(8\pi+3\lambda)\bar{p} \quad (17)$$

$$\frac{2\dot{A}}{A}-\frac{\dot{B}}{B}-\frac{\dot{C}}{C}=0 \quad (18)$$

After integrating eq. (18) and absorbing integration constant into B or C, we get

$$A^2=BC \quad (19)$$

These we have five highly non-linear differential equations with six unknowns, namely $A, B, C, \rho, \bar{p}, \varsigma$ .Therefore to find a consistent solution to these equations, subtracting (16) from (15), eq. (17) from (16), eq. (17) from (15) and integrating the resulting equations, we obtain the following three relations respectively:

$$\frac{A}{B}=m_1 dexp\left[k_1\int\frac{dt}{a^3}\right] \quad (20)$$

$$\frac{A}{C}=m_2 dexp\left[k_2\int\frac{dt}{a^3}\right] \quad (21)$$

$$\frac{B}{C}=m_3 dexp\left[k_3\int\frac{dt}{a^3}\right] \quad (22)$$

where $m_1, m_2, m_3,\ k_1,\ k_2,\ k_3$ are constants of integration.
We write the metric functions from (20)-(22) in explicit form as

$$A=ad_1 exp\left[\alpha_1\int\frac{dt}{a^3}\right] \quad (23)$$

$$B=ad_2 exp\left[\alpha_2\int\frac{dt}{a^3}\right] \quad (24)$$

$$C=ad_3 exp\left[\alpha_3\int\frac{dt}{a^3}\right] \quad (25)$$

where $d_1=\sqrt[3]{m_1 m_2},\quad d_2=\sqrt[3]{m_1^{-1}m_3},\quad d_3=\sqrt[3]{(m_2 m_3)^{-1}},$ (26)

and $\alpha_1=\frac{k_1+k_2}{3},\quad \alpha_2=\frac{k_3-k_1}{3},\quad \alpha_3=\frac{-(k_2+k_3)}{3},$ (27)

The constants d_1, d_2, d_3 and $\alpha_1, \alpha_2, \alpha_3$ satisfy the following two relations:
$\alpha_1+\alpha_2+\alpha_3=0,\quad d_1\, d_2 d_3=1.$ (28)

Substituting eq. (19) in eqs. (23)-(25), we obtain

$$A=a \quad (29)$$

$$B=adexp\left[\alpha\int\frac{dt}{a^3}\right], \quad (30)$$

$$C=ad^{-1}exp\left[-\alpha\int\frac{dt}{a^3}\right], \quad (31)$$

where $d_1=1, d_2=d_3^{-1}=d,\ \alpha_1=0,\ \alpha_2=-\alpha_3=\alpha$

4. DYNAMICAL PARAMETERS AND THEIR PHYSICAL DISCUSSION

The cosmological parameters such as scale factor a, Hubble parameter H, deceleration parameter $q*$ have a very significant role in describing the evolution of the Universe. And, these are the key parameters of most of the cosmological models in modified gravity theories. The modified gravity field equations can be solved by considering explicit form of the average scale factor as

$$a=e^{nt}sechmt \quad (32)$$

The derivation and the motivation to choose such scale factor has already been described by Moraes and Santos [35]

The spatial volume of the metric is

$$V=a^3=e^{3nt}(sechmt)^3 \quad (33)$$

Substituting (32) in (29)-(31) and integrating, we obtain expression for the metric functions as

$A = e^{nt} sechmt$ (34)

$B = dsech(mt)exp[nt + kpe^{-3nt}\cosh(3mt) - qcosh(mt) + 2msinh(mt)(rcosh(2mt) + s)]$ (35)

$C = d^{-1}sech(mt)exp[nt - kpe^{-3nt}\cosh(3mt) - qcosh(mt) + 2msinh(mt)(rcosh(2mt) + s)]$ (36)

where $\frac{\alpha}{12(9n^4-10n^2m^2+m^4)} = k,\ \ nm^2 - 9n^3 = p,\quad 27n(n^2 - m^2) = q,$

$m^2 - 9n^2 = r,\quad 5m^2 - 9n^2 = s$

The directional Hubble parameters are

$H_1 = \frac{\dot{A}}{A} = n - mtanh(mt)$ (37)

$H_2 = \frac{\dot{B}}{B} = n + 3kpe^{-3nt}[m\sinh(3mt) - n\cosh(3mt)] - mqsinh(mt) + 4m^2rsinh(mt)sinh(2mt) + 2m^2\cosh(mt)(rcosh(2mt) + s)$ (38)

$H_3 = \frac{\dot{C}}{C} = n - 3kpe^{-3nt}[m\sinh(3mt) - n\cosh(3mt)] - mqsinh(mt) + 4m^2rsinh(mt)sinh(2mt) + 2m^2\cosh(mt)(rcosh(2mt) + s)$ (39)

The average Hubble parameter is

$H = \frac{1}{3}[3n - mtanh(mt)]$ (40)

The dynamical scalar expansion θ and shear scalar σ^2

$\theta = [3n - mtanh(mt)]$ (41)

$\sigma^2 = \left\{\frac{1}{3}m^2tanh^2(mt) + [3kpe^{-3nt}[m\sinh(3mt) - n\cosh(3mt)] - mqsinh(mt) + 4m^2rsinh(mt)sinh(2mt) + 2m^2\cosh(mt)(rcosh(2mt) + s)]^2\right\}$ (42)

The average anisotropic parameter Am is

$Am = \frac{1}{3}\left\{\frac{[n-mtanh(mt)]^2+2n^2+2[3kpe^{-3nt}[m\sinh(3mt)-n\cosh(3mt)]-mqsinh(mt)+4m^2rsinh(mt)sinh(2mt)+2m^2\cosh(mt)(rcosh(2mt)+s)]^2}{\frac{1}{9}[3n-mtanh(mt)]^2} + 1\right\}$ (43)

The deceleration parameter is

$q* = -1 - \frac{m^2}{\cosh(mt)[3ncosh(mt)-msinh(mt)]}$ (44)

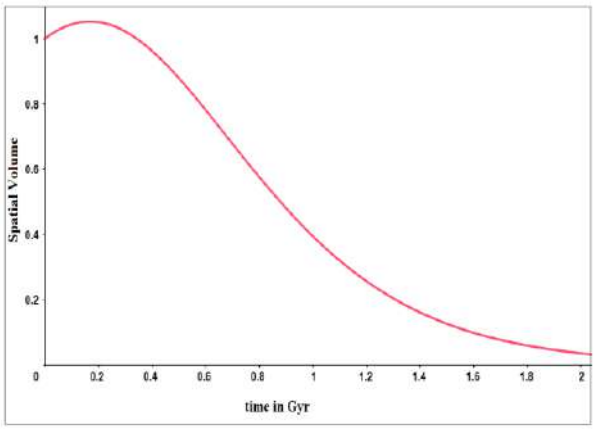

Figure 1. Spatial Volume vs. time for m=1.1, n=0.2

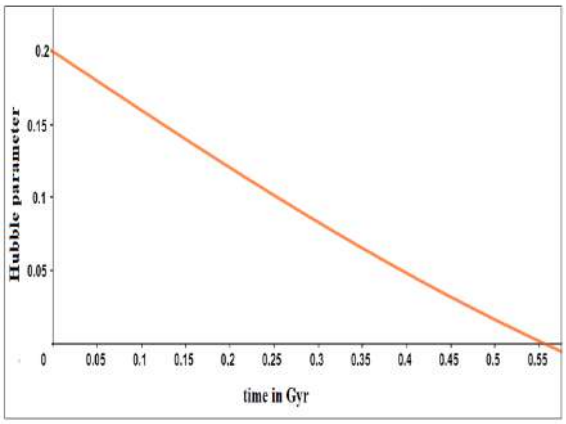

Figure 2. Hubble Parameter vs. time For m=1.1, n=0.2

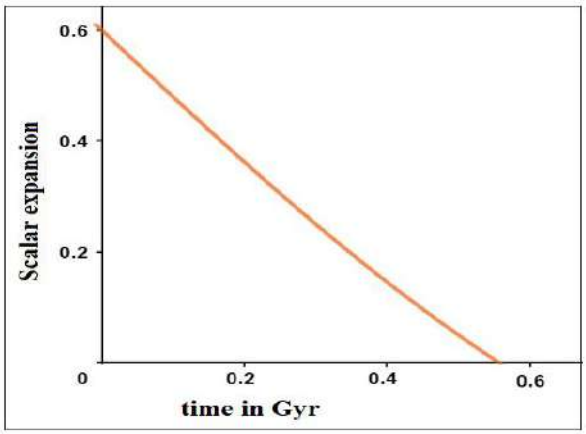

Figure 3. Scalar expansion vs. time m=1.1, n=0.2

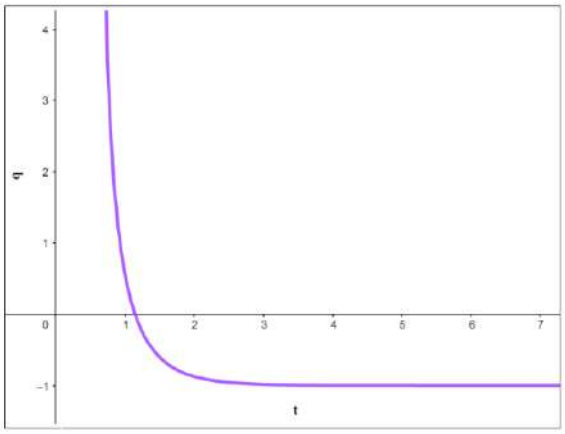

Figure 4. Plot of deceleration parameter q as a function of cosmic time t for $m = 1.1, n = 0.2$

For the model represented by metric functions in (34)-(36) the energy density ρ and the bulk viscous pressure $\bar{p}$ are given by

$$\rho = \frac{1}{(8\pi+2\lambda)}\Big\{n^2 - [3kpe^{-3nt}[m\sinh(3mt) - n\cosh(3mt)] - mqsinh(mt)\ 4m^2rsinh(mt)sinh(2mt) + 2m^2\cosh(mt)(rcosh(2mt) + s)]^2 + 2n\frac{(8\pi+3\lambda)}{(8\pi+4\lambda)}[n - mtanh(mt)] - \frac{4n^2\lambda}{(8\pi+4\lambda)} - 8\frac{(3\pi+\lambda)\beta^2}{(8\pi+4\lambda)}e^{-2nt}cosh^2mt\Big\} \quad (45)$$

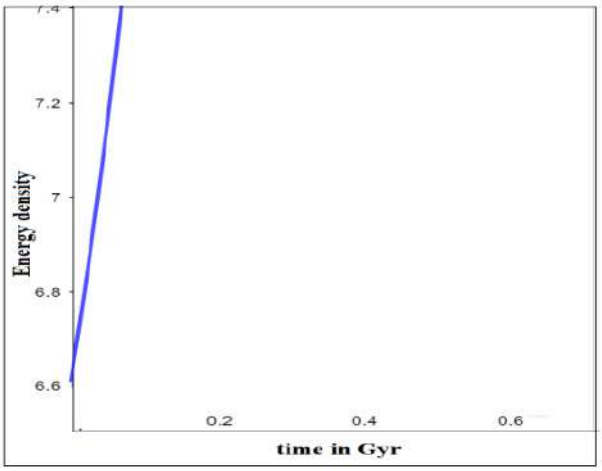

Figure 5. Plot of Energy density ρ vs. time t for $m = 1.1, n = 0.2, \alpha = \beta = \lambda = 1$

$$\bar{p} = \frac{1}{(8\pi + 2\lambda)(8\pi + 4\lambda)}\{2n\lambda\big(n - mtanh(mt)\big) - (8\pi + 2\lambda)$$
$$[n - mqsinh(mt) + 4m^2rsinh(mt)sinh(2mt) + 2m^2\cosh(mt)(rcosh(2mt) + s)]^2$$
$$-9(kp)^2e^{-6nt}[m^2\sinh^2(3mt) + n^2\cosh^2(3mt) - mnsinh(6mt)] + 8\pi\beta^2e^{-2nt}cosh^2mt \quad (46)$$

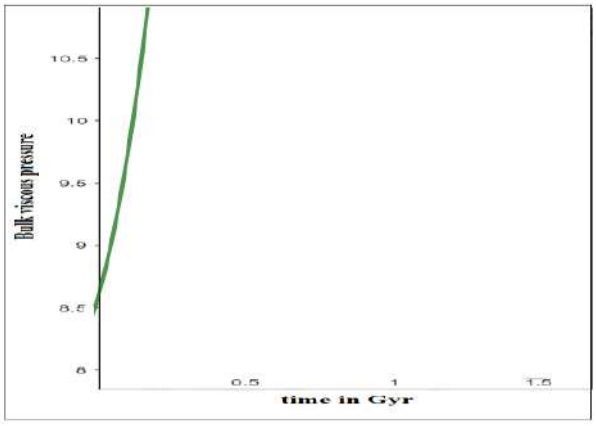

Figure 6. Plot of Bulk viscous pressure $\bar{p}$ vs. time t for $m = 1.1, n = 0.2, \alpha = \beta = \lambda = 1$

The baratropic equation of state parameter may be used to obtain the coefficient of bulk viscosity, which is obtained from Eqs. (46) as

$$\varsigma = \frac{1}{(8\pi + 2\lambda)(8\pi + 4\lambda)(3n - mtanh(mt)}\{[8\pi(\varepsilon + 1) + 2(2\varepsilon + 1)\lambda]$$

$$[n - mqsinh(mt) + 4m^2 rsinh(mt)sinh(2mt) + 2m^2\cosh(mt)(rcosh(2mt) + s)]^2$$
$$-9(kp)^2 e^{-6nt}[m^2\sinh^2(3mt) + n^2\cosh^2(3mt) - mnsinh(6mt)]$$
$$+[16n\pi + 2n\lambda(3\varepsilon - 1)]\big(n - mtanh(mt)\big) - 4n^2\lambda\varepsilon - 8[\varepsilon(3\pi + \lambda) + \pi]\beta^2 e^{-2nt}cosh^2 mt\} \quad (47)$$

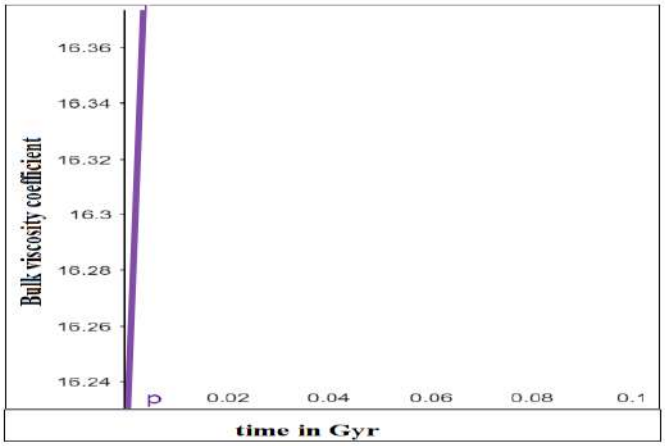

Figure 7. Plot of Bulk viscosity Coefficient ς vs. time t for $m = 1.1, n = 0.2, \alpha = \beta = \lambda = 1, \varepsilon = 0.1$

5. COSMOLOGICAL INTERPRETATIONS

We have the following observations. Recall that our aim in this work is to enable $f(R,T)$ gravity to induce a cosmological scenario.

1) All the scale factors and spatial volume (V) is constant at $t = 0$. This shows that the universe starts evolving with constant volume at $t = 0$ and expands with cosmic time t. The spatial volume (V) is finite at initial epoch and it decreases with increase in cosmic time (Fig. 1).
2) The mean Hubble's parameter H and the directional Hubble's parameters are dynamical. From Fig. 2, one can easily see that the Hubble parameter H is a decreasing function over the growth of time.
3) Initially scalar expansion (Fig. 3) is finite. It decreases as cosmic time increases.
4) The evolution of the deceleration parameter as a function of cosmic time presented in Fig. 4. From Fig. 4, one can observe that the evolution of the deceleration parameter starts with positive value of $q*$, which represents the deceleration phase. it gradually decreases and maintains a constant behaviour during the late time of the universe. It shows universe is accelerating. After late time, it goes to the de-Sitter expansion phase.
5) Energy density ρ, Bulk Viscous Pressure $\bar{p}$ and Bulk viscosity Coefficient ς (Fig. 5, 6, 7) increases with time. Energy density and Bulk viscous pressure are constant at an initial time and it tends to infinity as t tends to infinity.
6) We observed that, initially the positive value of the Hubble parameter and the deceleration parameter shows that the universe is expanding and accelerating exponentially at early time. Our model is expanding, shearing and accelerating and has no initial singularity.

6. CONCLUSION

In this article, we have constructed a cosmological scenario of Bianchi type V universe in $f(R,T)$ gravity. The gravitational field equation has been established by taking $f(R,T) = R + 2f(T)$into consideration. To find the deterministic solution, we have considered a scale factor as $a = e^{nt}sechmt$, where n and m are positive constants. This generates a transition of the universe from the early decelerating phase to the recent accelerating phase.

The main features of the models are as follows:

- The models are based on exact solutions of the $f(R,T)$ gravity field equations for the anisotropic Bianchi-V space-time filled with bulk viscous fluid.
- The energy density has been graphed versus time in Fig. 4. It is evident that the energy density remains always positive and increasing function of time. Initially it is constant for $t = 0$.
- From the figure we observe that bulk viscous pressure is increasing function of time. It starts from a constant positive value and approaches to infinity.
- At the initial time, we have finite energy density, finite bulk viscous pressure and as we discussed earlier. This means that our Universe has no initial singularity.
- We observe that the model has no initial singularity at $t = 0$. Also, we see that H, θ are finite at $t = 0$. These parameters are decreasing function of time. Whereas initially for $t = 0$, the parameters $\rho,\ \bar{p},\ \varsigma$ are constant and increasing function of time and approaches to infinity.
- The model represents an expanding, shearing, non-rotating and accelerating universe.
- Now for a Universe which was decelerated in past and accelerating at present epoch, the DP must show signature flipping as already discussed. Therefore, our consideration of DP to be variable is physically justified.

Our derived model is accelerating at present epoch

Thus, the solutions demonstrated in this paper may be useful for better understanding of the scenario of Bianchi type V universe in the evolution of the universe within the framework of $f(R,T)$ gravity theory.

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या संस्थेचे त्रैमासिक

।। संशोधक ।।

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● शके १९४४ ● वर्ष : ९० ● पुरवणीअंक : १

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विद्याभारती महाविद्यालय, अमरावती

सारांश :

संसद जगभर आढळते. इंग्रजी संसदेला सर्व संसदेची जननी मानले जाते. सरकारचे संसदीय स्वरूप, ज्याला कॅबिनेट सरकार म्हणून ओळखले जाते, ते कार्यकारी आणि विधान शाखांमधील मजबूत संबंधांवर आधारित आहे. कार्यकारिणी विधिमंडळाला जबाबदार असते आणि जोपर्यंत विधिमंडळाचा त्यावर विश्वास असतो तोपर्यंतच ती पदावर असते. संसदीय सरकारमध्ये दोन प्रकारचे अधिकारी असतात: नाममात्र आणि वास्तविक. खरी कार्यकारिणी कायदेमंडळाला जबाबदार असते आणि नंतर विधीमंडळाने त्याच्या विरोधात मत दिल्यास, त्याने राजीनामा द्यावा किंवा कायदेमंडळ बरखास्त करावे.

या संकल्पनेत आपल्याला शासनाची संकल्पना समजते. एखाद्या देशासारख्या लोकांचे शरीर स्वतःचे कसे वागते यासाठी ही फक्त संज्ञा आहे. गोष्टी कशा करायच्या हे ठरवण्यासाठी अनेक संस्था सरकार बनवतात. गव्हर्नन्स म्हणजे राज्याच्या सरकारद्वारे किंवा संघटित समाजाच्या नियम, परंपरा, शक्ती किंवा भाषेद्वारे चालवल्या जाणार्या सर्व प्रशासकीय प्रक्रियांचा संदर्भ आहे. औपचारिक संस्थांमध्ये आणि त्यांच्या दरम्यान अस्तित्वात असलेल्या राजकीय प्रक्रिया म्हणून हे स्पष्ट शब्दात सांगितले जाऊ शकते.

प्रस्तावना :

ब्रिटीश संसदीय प्रणालीला सामान्यतः मदर ऑफ संसद असे संबोधले जाते. हे सध्याच्या स्वरूपात अस्तित्वात आहे-संवैधानिक राजेशाही-१६५८ मध्ये राजशाहीच्या सुधारणांपासून, ते जगातील सर्वात जुन्या संसदांपैकी एक बनले आहे. ब्रिटीश साम्राज्याचा परिणाम म्हणून जगभरातील बर्याच राष्ट्रांमध्ये आता तुलनात्मक संसद आहेत. युनायटेड किंगडमचे सरकार अद्वितीय आहे कारण त्यात लिखित संविधानाचा अभाव आहे, ज्यामुळे घटनात्मक सुधारणांच्या समर्थकांमध्ये चिंता निर्माण होते. प्रत्यक्षात, कोणतीही राज्यघटना तयार न होण्याचे कारण म्हणजे संसदेने आपल्या संपूर्ण इतिहासात काही अडथळ्यांसह चांगली कामगिरी केली आहे. अनेक ब्रिटीश कायदे, विशेषत: १७०३ चा संघ कायदा आणि सेटलमेंट कायदा, यामध्ये घटनात्मक तपासणी आणि शिल्लक आहेत.

संसदीय प्रणाली, ज्याला बहुधा संसदीय लोकशाही म्हणून ओळखले जाते, ही लोकशाही प्रशासनाची एक शैली आहे ज्यामध्ये कार्यकारिणी विधायी शाखेची, सामान्यत: संसदेची, ज्यांना ती जबाबदार असते, त्याची मान्यता (विश्वास) मिळवून राजकीय वैधता प्राप्त करते.

संसदीय प्रणालीमध्ये, राज्याचे प्रमुख आणि सरकारचे प्रमुख सहसा वेगळे असतात. हे अध्यक्षीय पद्धतीनुसार बदलते कारण राज्याचा प्रमुख अनेकदा सरकारचा प्रमुख असतो आणि अधिक महत्त्वाचे म्हणजे, कार्यकारिणीला कायदेमंडळाकडून लोकशाही वैधतेचा अभाव असतो. युनायटेड किंगडम, जपान, कॅनडा आणि भारतात संसदीय सरकार प्रचलित आहे. याला कॅबिनेट सरकार, जबाबदार सरकार किंवा वेस्टमिन्स्टर शैलीचे सरकार म्हणून देखील ओळखले जाते.

संसदेच्या कथेचा एक उज्वल पैलू :

संसदेच्या कथेचा एक उज्वल पैलू म्हणजे तिची प्रातिनिधिकता. स्वातंत्र्यानंतर, १९५२ मध्ये, संसद हा बहुतेक वकिलांचा बालेकिल्ला होता जो स्वातंत्र्य चळवळीशी आणि स्वतंत्रपूर्व भारतातील विधान मंडळांशी संबंधित होता. मात्र, आता संसद भारतीय समाजाची अधिक प्रतिनिधी बनली आहे. हे अंशतः अनुसूचित जाती आणि अनुसूचित जमातींच्या आरक्षणांमुळे आहे आणि अंशतः लोकशाहीच्या सतत खोलीकरणामुळे आहे, ज्याला मंडल आयोगाच्या अहवालाच्या १९८९ मध्ये इतर मागासवर्गीय (ओबीसी) कोट्याच्या शिफारशींच्या अंमलबजावणीसह अनेक शक्तींनी मदत केली आहे. तथापि, केवळ मर्यादित विविधता दिसून आली, कारण अलिकडच्या वर्षांत, अल्पसंख्याक धार्मिक गटांमधील कमी सदस्य, विशेषतः मुस्लिम समुदाय एक भाग आहेत. तसेच, संसदेत मोठ्या संख्येने राजकीय घराण्यातील खासदार आहेत आणि श्रीमंत खासदार आणि गुन्हेगारी पार्श्वभूमी असलेल्यांची संख्या वाढत आहे. १९७७ मध्ये काँग्रेसचे वर्चस्व असलेल्या पहिल्या बिगर काँग्रेस सरकारपर्यंत आणि त्यानंतर अल्पसंख्याक आणि युती सरकारांची वाढती उपस्थिती या राजकीय रचनेतही मोठा

बदल झाला. भारतीय जनता पक्षाच्या (भाजप) अंतर्गत, एका पक्षाच्या वर्चस्वाच्या व्यवस्थेतून बहुपक्षीय आणि आता पुन्हा नव्याने सुरू झालेल्या एक-पक्षीय व्यवस्थेत झालेल्या परिवर्तनाने संसदेतील सहभागाचे नियम मूलभूतपणे बदलले आहेत.

संसदीय समिती पद्धतीचे महत्त्व :

आशावादाचे आणखी एक कारण म्हणजे संसदीय समिती प्रणालीची कार्यप्रणाली जी सुरुवातीपासूनच संसदेचा एक भाग आहे, परंतु १९९० च्या दशकापासून ती लक्षणीयरीत्या विस्तारली आहे. संसदेचे बरेचसे विश्लेषण सभागृहात काय घडते याच्या आधारे केले जात असले तरी महत्त्वाचे कायदेविषयक काम समित्यांमध्ये होते. आर्थिक समित्यांव्यतिरिक्त, आता इतर स्थायी आणि तदर्थ समित्यांव्यतिरिक्त २४ विभाग-संबंधित स्थायी समित्या (DRSC) आहेत. संसदेच्या पटलावर जाहीरपणे खेळल्या जाणार्या विरोधी राजकारणाच्या विपरीत, पक्षाच्या आणि दोन्ही सभागृहांतील सदस्यांनी बनलेल्या समित्या अधिक सहकार्याच्या असतात. शिवाय, बोफोर्स घोटाळ्याच्या चौकशीसाठी १९८७ मध्ये प्रथम स्थापन करण्यात आलेल्या राष्ट्रीय महत्त्वाच्या मुद्द्यांवर चौकशी संयुक्त संसदीय समित्या (JPCs) स्थापन केल्यावर समिती प्रणाली अधिक लोकांच्या नजरेत आली आहे. आणखी एक उदाहरण म्हणजे २ऋ स्पेक्ट्रम वाटप घोटाळ्याची चौकशी करण्यासाठी जेपीसी, जे भारतातील सर्वात मोठ्या भ्रष्टाचार घोटाळ्यांपैकी एक मानले जाते. तथापि, त्यांच्या कार्यक्षमतेवर आणि पारदर्शकतेवर प्रश्न कायम आहेत.

संशोधनाचे उद्दिष्ट :

भारताच्या संसदीय प्रणालीची संकल्पना आणि आव्हानांचा अभ्यास करणे.

सरकारच्या संसदीय स्वरूपाची काही वैशिष्ट्ये :

संवैधानिक शासकाचे अस्तित्व: संसदीय प्रणालीचे पहिले वेगळे वैशिष्ट्य म्हणजे शीर्षक किंवा घटनात्मक शासकाची उपस्थिती. राज्याच्या सर्व बाबींच्या व्यवस्थापनासाठी राज्याचा प्रमुख कायदेशीररित्या जबाबदार असतो. प्रत्यक्षात मात्र मंत्रिपरिषद प्रशासनाचा कारभार पाहते. सम्राट किंवा राष्ट्रपती, परिस्थितीनुसार, राज्याचे प्रमुख आहेत परंतु सरकारचे नाहीत.

मंत्रालयाच्या निर्मितीमध्ये कनिष्ठ सभागृहाचे प्राथमिक कार्य: विधीमंडळाचे कनिष्ठ सभागृह, म्हणजे, लोकप्रिय सभागृह, संसदीय सरकारच्या अंतर्गत मंत्रिमंडळाच्या स्थापनेत महत्त्वपूर्ण भूमिका बजावते. या सभागृहात बहुमत मिळविणाऱ्या पक्षांच्या किंवा आघाडीच्या नेत्यांमधून पंतप्रधान किंवा कुलपतीची निवड केली जाते. संवैधानिक शासकाच्या सूचनेनुसार, मंत्रालयातील इतर सदस्यांची नियुक्ती केली जाते.

विधायी उत्तरदायित्व : मंत्रिमंडळ किंवा मंत्रालयाने या प्रणालीतील त्यांच्या सर्व क्रियाकलाप आणि धोरणांसाठी विधिमंडळाला जबाबदार धरले पाहिजे. तरीही मंत्रिमंडळ हे कनिष्ठ सभागृहाला उत्तरदायी असते, जे लोकप्रतिनिधींनी बनलेले असते, द्विसदनीय कायदेमंडळे असलेल्या देशांमध्ये.

या क्रमाने, भारतीय संसदीय शासन पद्धतीबद्दल चर्चा केल्यास.

भारताची संसदीय प्रणाली भारत सरकार कायदा १९३५ वर आधारित आहे आणि तिच्या केंद्रात द्विसदनी विधानमंडळ आहे. अनुच्छेद ७४ आणि ७५ हे केंद्र सरकारच्या संसदीय स्वरूपाशी संबंधित आहेत, तर कलम १६३ आणि १६४ राज्यांशी संबंधित आहेत. आपल्या देशाचे नेतृत्व संसदीय पद्धतीत राष्ट्रपती करतात. तथापि, पदे पूर्णपणे औपचारिक आहेत. पंतप्रधान हे सरकारचे खरे प्रमुख असतात. परिणामी, पंतप्रधानांकडे संपूर्ण कार्यकारी अधिकार आहेत.

आपल्या संसदीय पद्धतीचे मूळ वैशिष्ट्य म्हणजे कनिष्ठ सभागृहाचे सदस्य द्विसदनी विधानमंडळात लोकांद्वारे निवडले जातात. जर सरकारची मुदत संपली असेल आणि सभागृहात बहुमत नसल्यामुळे सरकार स्थापन करण्याचा कोणताही मार्ग नसेल तर खालची संसद (लोकसभा) विसर्जित केली जाऊ शकते. भारताच्या राष्ट्रपतींना पंतप्रधानांच्या सूचनेनुसार लोकसभा विसर्जित करण्याचा अधिकार आहे.

भारतातील संसदीय शासन पद्धतीची संकल्पना :

आपल्याला माहित आहे की स्वातंत्र्यानंतर आपण कोणत्या प्रकारची शासन प्रणाली निवडायची हे ठरवणे खूप आव्हानात्मक आहे, या संदर्भात संस्थापकांनी ब्रिटीश संसदीय प्रणालीला प्राधान्य देण्याचा निर्णय घेतला आहे कारण भारत या प्रकारच्या शासन पद्धतीशी परिचित आहे आणि त्याची सवय आहे. ही शासनपद्धती भारतात ब्रिटिश राजवटीत कार्यरत होती.

भारतातील सामाजिक आणि सांस्कृतिक विविधता सर्वज्ञात आहे. भारतात, सुमारे ३००० जाती आणि ९ मान्यताप्राप्त धर्म आहेत. त्यानंतर अनेक भाषा आहेत. स्वातंत्र्यानंतरही भारतातील राज्यांची निर्मिती भाषेवर आधारित होती. अनेक भारतीय राज्यांमध्ये त्यांच्या अधिकृत

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भाषा देखील आहेत. त्यामुळे अशा वैविध्यपूर्ण समाजात निर्णय घेण्याच्या किंवा कायदा बनवण्याच्या अधिकारांची विभागणी करणे हे संसदीय पद्धतीतूनच साध्य होऊ शकते. या शासनपद्धतीची पुनर्तपासणी करण्यासाठी १९७५ मध्ये स्वर्ण सिंग यांच्या अध्यक्षतेखाली एक समिती नेमण्यात आली होती, ज्याचे विश्लेषण करण्यासाठी भारताने संसदीय प्रणाली चालू ठेवली आहे की नाही हे विश्लेषण करण्यासाठी अध्यक्षीय प्रणाली आली आहे, त्यानंतर समितीने सांगितले की संसदीय प्रणाली बदलण्याची गरज नाही कारण ती ही अतिशय संतुलित व्यवस्था आहे आणि या प्रकारची व्यवस्था राष्ट्राप्रती अधिक जबाबदार आहे.

पूर्वी म्हटल्याप्रमाणे, आजच्या प्रशासकीय व्यवस्थेत शासन ही महत्त्वाची भूमिका बजावते. रहिवाशांना जीवनाची सर्वोत्तम गुणवत्ता मिळावी हे सुनिश्चित करणे हे त्याचे ध्येय आहे. यात सरकार, कॉर्पोरेट क्षेत्र आणि नागरी समाज संघटनांचा सहभाग आवश्यक आहे. या तीन घटकांमधील स्वीकारार्ह संतुलनास प्रोत्साहन देणारी फ्रेमवर्क किंवा प्रणाली तयार करणे ही प्रशासन प्रक्रियेसाठी एक महत्त्वपूर्ण समस्या आहे. शासनाची गुणवत्ता विकसित करणे आणि टिकवणे आवश्यक आहे.

भारताच्या संसदीय शासन पद्धतीची आव्हाने :

या दशकातील आव्हाने :

तथापि, १९८० च्या दशकापासून संसदेच्या नियमांमध्ये लक्षणीय बदल झाला आहे आणि सभागृहात व्यत्यय आणि निषेधांमध्ये तीव्र वाढ झाली आहे. अनेक समालोचक अशा व्यत्ययांना अकार्यक्षम आणि अकार्यक्षम संसदेचे लक्षण म्हणून नाकारतात, परंतु संसदेच्या बदलत्या सामाजिक आणि राजकीय रचनेच्या संदर्भात तसेच २००६ पासूनच्या संपूर्ण संसदीय कामकाजाचे थेट प्रक्षेपण करण्याच्या संदर्भात व्यत्यय पाहणे आवश्यक आहे. भव्यतेसाठी प्रोत्साहन दिले आहे. सभागृहातील निषेधाची वारंवारता आणि खासदारांचे वर्तन हे कदाचित उच्चभ्रू आणि जनसंस्कृती यांच्यातील संघर्षाचे प्रतिनिधित्व करते, ज्यामुळे ब्रिटीश संसदीय विधी कमी होतात. ते संसदेच्या परिसरात रस्त्यावरील राजकारण आणि राजकीय थिएटरच्या घुसखोरीचे देखील प्रतिनिधित्व करतात, ज्याचा अनेकदा त्याच्या हेतुपुरस्सर आणि विधान कार्यांवर विपरित परिणाम झाला आहे.

शासनाच्या संस्था बळकट केल्या पाहिजेत. भारतीय संसद ही देशाची सर्वोच्च प्रतिनिधी संस्था आहे. मतदारांचे प्रतिनिधित्व राजकीय नेते करतात. सहभागाची गुणवत्ता, कार्यवाही हाताळणे आणि इतर समस्यांबद्दलच्या चिंता अनेक आघाड्यांवर वारंवार संबोधित केल्या जातात.

परिणामी, योग्य संसदीय नियम आणि कार्यपद्धती विकसित करणे आवश्यक आहे आणि संसद ही बदलत्या परिस्थितीशी जुळवून घेण्यास सक्षम असलेली गतिशील संस्था बनली पाहिजे.

अपात्र आमदार : याचा परिणाम असा झाला आहे की ज्यामध्ये कायदा बनवणारा कायदा बनवण्यास अपात्र असतो आणि तो एक दिवस कार्यकारी बनण्यासाठी आमदार बनतो.

अधिकारांचे खरे पृथक्करण नाही: कारण सभागृहात प्रशासनाचे बहुमत आहे आणि पक्षांतर विरोधी नियम खासदाराला त्याच्या पक्षाच्या हायकमांडच्या इच्छेविरुद्ध मतदान करण्यापासून प्रतिबंधित करतात, विधिमंडळ कार्यकारिणीला खऱ्या अर्थाने जबाबदार धरू शकत नाही.

राजकीय पक्षांतर आणि घोडे-व्यापारामुळे निवडणुकीचा उद्देश नष्ट झाला आहे आणि लोकांच्या इच्छेचा विश्वासघात झाला आहे.

युती धर्म : आमच्या व्यवस्थेने असुरक्षित युती प्रशासन देखील निर्माण केले आहे ज्यांनी धोरण आणि कामगिरीपेक्षा राजकारणाला प्राधान्य दिले पाहिजे. याने सरकारांना शासन करण्यापेक्षा सत्तेत राहण्यावर अधिक लक्ष केंद्रित करण्यास प्रवृत्त केले आहे आणि यामुळे त्यांना त्यांच्या युतीच्या सर्वात कमी सामान्य संप्रदायाकडे आवाहन करण्यास भाग पाडले आहे, कारण पाठिंबा गमावल्याने सरकार खाली खेचू शकते.

राजकारणाचे गुन्हेगारीकरण : असे म्हटले जाते की आजचे राजकारणी मोठ्या प्रमाणात अयोग्य, अप्रामाणिक आणि गुन्हेगारी नोंदी आहेत. ते क्वचितच आपल्या देशाच्या आणि लोकांच्या विकासाचा विचार करतात. ते संसदेतील त्यांचा वेळ हा शक्य तितकी संपत्ती कमावण्याची संधी मानतात.

निष्कर्ष :

सर्व राजकीय व्यवस्था त्यांच्या ऐतिहासिक परिस्थितीत स्थापित केल्या जातात आणि त्या वेगवेगळ्या राजकीय आणि सामाजिक सेटिंगजमध्ये वेगवेगळ्या प्रकारे कार्य करतात. प्रत्येक व्यवस्थेमध्ये एक राज्यघटना असते जी राष्ट्र आणि सरकारचा आधार म्हणून काम करते.

हा मूलभूत विषय आहे जो सरकारच्या तीन भागांच्या ऑपरेशनल पॅरामीटर्सची व्याख्या करतो आणि परिभाषित

करतो – विधिमंडळ, कार्यकारी आणि न्यायपालिका. कारण स्वतंत्र भारत हा सर्वात व्यापक स्वातंत्र्य लढ्याचा परिणाम आहे, भारतीय राज्यघटनेच्या रचनाकारांनी संसदीय प्रशासनाचे ब्रिटिश मॉडेल निवडले.

तथापि, त्यांनी त्याला इंग्रजी समकक्षांप्रमाणे सार्वभौम कायदा बनवणारी संस्था बनवली नाही. त्यांनी विधिमंडळाला प्राधान्य दिले, परंतु ग्रेट ब्रिटनच्या विपरीत ते मर्यादित असावे,

भारताकडे सर्वसमावेशक लिखित राज्यघटना, संघराज्यीय सत्ता रचना आणि आवश्यक अधिकारांची यादी आहे. म्हणून, संसदीय कायदा कायदेशीर होण्यासाठी, तो प्रत्येक प्रकारे संविधानाशी सुसंगत असला पाहिजे.

एकंदरीत, देशाच्या संसदीय लोकशाही व्यवस्थेसमोर जी काही आव्हाने निर्माण झाली आहेत, ती भारतीय राजकारणाने घेतलेल्या कलाटणीतून, तसेच इथल्या शासकीय व्यवस्थेच्या व्यवहारातून निर्माण झालेली आहेत. स्वीडनस्थित Varieties of Democracy (V-Dem)'कडून प्रसिद्ध करण्यात आलेल्या सन २०२१ च्या अहवालात भारताच्या लोकशाहीचे वर्गीकरण 'निर्वाचित अधिकारशाही' (Electoral Autocracy) असे केले गेले आहे. देशात आज जी काही राजकीय परिस्थिती निर्माण झाली आहे, ती पाहता डॉ. बाबासाहेब आंबेडकरांच्या विचारांकडे मागे वळून पाहण्याची नितांत आवश्यकता वाटते. बाबासाहेबांच्या मते, लोकशाही म्हणजे केवळ मतांची गोळाबेरीज नाही; तर लोकशाहीत सांविधानिक मूल्यांचे जतन केले पाहिजे, लोकशाहीत सत्ताधारी वर्गाप्रमाणे विरोधात बसणाऱ्यांचा आवाजदेखील बुलंद असला पाहिजे. बाबासाहेबांनी घटना समितीत २५ नोव्हेंबर १९४९ रोजी केलेले भाषण आजच्या राजकीय परिस्थितीत अधिक प्रस्तुत ठरते. बाबासाहेबांना केवळ राजकीय लोकशाही अभिप्रेत नव्हती तर समाजात सामाजिक लोकशाही प्रस्थापित होणे आवश्यक वाटत होते. आणि ही सामाजिक लोकशाही सांविधानिक नैतिकतेवर आधारलेली असावी असे त्यांना अभिप्रेत होते. ते पुढे असे म्हणतात की, राजकारणातील व्यक्तिस्तोम लोकशाहीस घातक ठरते. धर्मातील भक्तीमार्ग आत्म्याच्या मुक्तीकडे नेणारा ठरत असेल; पण राजकारणातील भक्ती, व्यक्तिपूजा ही अधोगती आणि अंतिमत: हुकुमशाहीकडे नेणारा हमखास मार्ग ठरतो.

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इतिहास

प्रकाशक : इतिहासाचार्य वि. का. राजवाडे संशोधन मंडळ, धुळे

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कार्यालयीन वेळ

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अक्षरजुळणी : सौ. सीमा शिंत्रे, पुणे.

Coping Strategies and Positive Mental Health among Frontline and Non-Frontline Workers

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Abstract:

Recently world has witnessed pandemic COVID 19. It has casted huge damage to human health and lives. Governments in different parts of the world took various measures to tackle the situations. One common measure was locking down all the socio-economic activities and confining people to their homes. Two categories of workers - viz. Frontline and Non Frontline were critically working hard for normal functioning of the society.

The study is aimed to reveal the difference between Coping strategies and Positivity of Mental Health of frontline and Non Frontline workers. Survey method was used in this research with the sample comprised of 100 (frontline 50 and non-frontline 50) using random sampling method. Standardized psychological test named "Positive Mental Health" by Dr. C. D. Agashe and Dr. R. D. Helode andCoping Techniques Scale by Dr.Vijaya Lakshmi and Dr.ShrutiNarain were used. Mean and sd were computed. The data was tested with t test. The obtained results revealed that Frontline Worker's Coping Strategies are significantly different from Non-Frontline workers, and Frontline Worker's Positive Mental Health was significantly differed from Non Frontline workers. Both hypotheses were accepted.

Key Words: Frontline Workers, Non Frontline Workers, Positive Mental Health, Coping strategies, COVID-19 Pandemic.

1. Introduction :

The outbreak of the COVID-19 pandemic has disrupted societies globally, necessitating unprecedented measures to mitigate its impact. Lockdowns and restrictions on socio-economic activities have become commonplace, with essential workers emerging as the backbone of societal functioning. Frontline workers, including healthcare professionals, emergency responders, and essential service providers, have faced unique challenges due to their direct exposure to the virus and heightened responsibilities. In contrast, non-frontline workers have also played critical roles in supporting essential services, albeit with different levels of exposure and stress. This study seeks to explore the coping strategies and positive mental health levels of frontline and non-frontline workers. Numerous studies have documented the psychological impact of the COVID-19 pandemic on frontline healthcare workers, highlighting elevated levels of stress, anxiety, and burnout. For instance, Nyashanu et al. (2020) investigated the triggers of mental health problems among frontline healthcare workers in the UK, emphasizing the need for targeted support interventions. Similarly, Brahmi et al. (2020) explored psychological trauma among healthcare professionals dealing with COVID-19, underscoring the importance of addressing mental health needs. These studies provide valuable insights into the challenges

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faced by frontline workers and the necessity of promoting positive mental health.

Moreover, research has also examined coping strategies employed by frontline workers to manage stress and adversity during the pandemic. Carver and Connor-Smith (2010) discussed various coping mechanisms utilized by individuals in response to challenging circumstances, emphasizing the role of adaptive coping strategies in promoting resilience. Similarly, Lemieux-Cumberlege and Taylor (2019) explored the factors affecting the mental health and well-being of frontline workers, highlighting the importance of organizational support and coping resources.

Objective :

1. To Study the Coping Strategies of Frontline and Non-Frontline Workers, to find out whether they differ significantly from each other or not.
2. To assess the Mental Health Frontline and Non Frontline Workers, to find out whether they differ significantly from each other or not.

Hypothesis :

1. There will be significant difference in coping strategies of Frontline and Non-Frontline Workers; frontline workers will exhibit adaptive coping strategies than non-frontline workers.
2. Frontline and Non- Frontline worker will differ significantly from each other on the measure of positive mental health; frontline worker will be better than Non-Frontline worker on the criteria of mental health

Methodology :

A survey descriptive method was used to investigate coping strategies and positive mental health among frontline and non-frontline workers. The study population consisted of workers from the Amravati District, ranging in age from 22 to 60 years, categorized into two groups: frontline and non-frontline workers. Frontline workers included medical professionals, bankers, and police personnel, while non-frontline workers comprised administrative staff, educators, and self-employed individuals.

The sample size for the study was 100 participants, with an equal number of frontline and non-frontline workers. Participants were randomly selected from various hospitals, schools, shops, banks, and offices in the Amravati District. The inclusion criteria included individuals aged 22 to 60 years, working in frontline or non-frontline roles, and willing to participate in the study. Ethical considerations were ensured throughout the research process, with informed consent obtained from all participants.

Standardized psychological tests were utilized to assess coping strategies and positive mental health levels. The Coping Techniques Scale developed by Dr. Vijaya Lakshmi and Dr. Shruti Narain was assigned to measure coping strategies, while the Positive Mental Health Inventory by Dr. C.D. Agashe and Dr. R.D. Helode was used to assess positive mental health. The participants were briefed about the purpose of the study, and assistance was provided as needed while completing the tests. Adequate time was allotted for participants to complete the assessments.

Statistical analyses, including mean, standard deviation, and t-test, were conducted to evaluate the data. The results were analysed to determine significant differences between frontline and non-frontline workers in coping strategies and positive mental health levels.

Results :

The statistical analysis revealed significant differences between frontline and non-frontline workers in coping strategies and levels of

positive mental health. Frontline workers exhibited higher scores in adaptive coping strategies and positive mental health compared to non-frontline workers. The mean scores for coping strategies and positive mental health were as follows:

Table 1: Positive Mental Health

Worker Type	N	Mean	Standard Deviation	T-value	Significance
Frontline	50	135.125	12.85857	2.08	*Significant (p<0.05)*
Non-Frontline	50	129.775	9.92		

Table 2: Coping Strategies

Worker Type	N	Mean	Standard Deviation	T-value	Significance
Frontline	50	24.35	2.78	2.71	Significant (p<0.05)
Non-Frontline	50	22.2	4.17		

The t-test results indicated significant differences in coping strategies and positive mental health levels between frontline and non-frontline workers, with frontline workers exhibiting better adaptive coping strategies and higher levels of positive mental health.

Discussion :

The findings of this study highlight the significant impact of frontline roles on coping strategies and positive mental health. Frontline workers, who are directly exposed to the virus and face heightened responsibilities, demonstrated better adaptive coping strategies and higher levels of positive mental health compared to non-frontline workers. These results underscore the importance of targeted interventions to support the mental well-being of essential workers, including access to mental health resources, organizational support, and coping skills training.

Moreover, the study contributes to the existing literature by providing insights into the unique experiences of frontline and non-frontline workers. By understanding the coping strategies employed by essential workers and their impact on mental health outcomes, policymakers and organizations can develop designed support interventions to promote resilience and well-being among frontline personnel.

6. Conclusion:

This study highlights the significant differences in coping strategies and positive mental health levels between frontline and non-frontline workers. Frontline workers, despite facing heightened stress and responsibilities, demonstrated better adaptive coping strategies and higher levels of positive mental health compared to their non-frontline counterparts. These findings underscore the importance of prioritizing the mental well-being of essential workers and implementing targeted interventions to support their resilience and coping mechanisms amidst ongoing challenges.

Scope :

The scope of this research extends to understanding the coping strategies and positive

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mental health levels of both frontline and non-frontline workers, focusing specifically on the Amravati District. By examining the differences in coping mechanisms and mental well-being between these two groups, the study aims to provide valuable insights into the unique challenges faced by essential workers in different roles. Additionally, the research contributes to the development of targeted interventions and policies to support the mental health and resilience of frontline and non-frontline workers, thereby enhancing their overall well-being and productivity. Furthermore, the findings of this study may have broader implications for similar populations in other regions and sectors, highlighting the importance of prioritizing mental health support for essential workers globally.

Limitations:

While this research provides valuable insights into the coping strategies and positive mental health levels of frontline and non-frontline workers, several limitations should be acknowledged. Firstly, the study's sample size is relatively small, comprising workers from the Amravati District only, which may limit the generalizability of the findings to broader populations. Additionally, the sample may not be representative of all frontline and non-frontline workers, as it was not stratified by factors such as gender, education level, or rural/urban residence. Moreover, the research relies on self-report measures for assessing coping strategies and mental health, which may introduce response bias or social desirability effects. Furthermore, the cross-sectional design of the study limits the ability to establish causal relationships between variables over time. Future research could benefit from larger and more diverse samples, longitudinal designs, and objective measures of mental health outcomes to address these limitations and provide more robust evidence on the topic.

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संशोधक

• वर्ष : ९२ • मार्च २०२४ • पुरवणी विशेषांक ३१

वेरूळ

प्रकाशक : शंकराचार्य वि.को. राजवाडे संशोधन मंडळ, पुणे

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इतिहासाचार्य वि. का. राजवाडे मंडळ, धुळे
या संस्थेचे त्रैमासिक

।। संशोधक।।

पुरवणी अंक ३१ – मार्च २०२४ (त्रैमासिक)

- शके १९४५
- वर्ष : ९२
- पुरवणी अंक : ३१

* प्रकाशक *

श्री. संजय मुंदडा

कार्याध्यक्ष, इ. वि. का. राजवाडे संशोधन मंडळ, धुळे ४२४००१
दूरध्वनी (०२५६२) २३३८४८, ९४२२२८९४७१, ९४०४५७७०२०

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कार्यालयीन वेळ

सकाळी ९.३० ते १.००, सायंकाळी ४.३० ते ८.०० (रविवारी सुट्टी)

अंक मूल्य रु. १००/-
वार्षिक वर्गणी (फक्त अंक) रु. ५००/-, लेख सदस्यता वर्गणी : रु. २५००/-

विशेष सूचना : संशोधक त्रैमासिकाची वर्गणी चेक/ड्राफ्टने
'संशोधक त्रैमासिक राजवाडे मंडळ, धुळे' या नावाने पाठवावी.

अक्षरजुळणी : सौ. सीमा शिंत्रे, पुणे.

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Emotional Maturity and Resilience – A Correlational Study

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Abstract :

Civilizations across eras and geographies have experienced plethora of natural and anthropogenic disasters. Recently whole world experienced adverse conditions during the COVID-19 pandemic. This period, unique in its challenges, presents an unparalleled opportunity to delve into the study of emotional maturity and resilience.

This research aims to study the correlation between emotional maturity and resilience. These psychological dimensions are crucial in determining individuals' ability to withstand and adapt to adversities. The study specifically examines the variance in emotional maturity and resilience across professional domains, segregating participants into two categories: medical professionals and non-medical professionals. The rationale behind this dichotomy stems from the premise that medical professionals, by virtue of their occupational demands, are necessitated to exhibit higher levels of emotional maturity and resilience compared to their non-medical counterparts.

Survey method was used to obtain the information. Study includes sample of 100 professionals (50- Medical and 50- non medical) of Amravati district. Standardized emotional maturity test by Dr. Yashvir Singh and Dr. Ramesh Bhargava and Resilience Scale by Dr. Uma Lakshmi and Dr. Shruti Narain were used. Mean, SD and Pearson product moment correlation were used to analyze the data. Significant positive correlation between emotional maturity and resilience was found.

Key words: *Emotional maturity, Resilience, COVID19 Pandemic, Medical and Non-Medical Professionals*

Introduction :

Civilizations across eras and geographies have experienced various types of natural, and man-made disasters. The impact of such calamities is multifaceted, affecting societies on both individual and communal levels (Leroy, 2020). However, the essence of survival and resilience lies not merely in the experience of adversity but in the capacity for recovery and rehabilitation. The quintessential question then emerges: Who possesses the ability to surmount these challenges, and who can spearhead the rehabilitation of the masses?

Although the geography, the civilizations, the cultures, and the types of disasters were vastly different, it was commonly noticed that individuals or societies with high emotional maturity were successful in tackling the problem by themselves (Terracciano et al., 2008). High emotional maturity likely promotes enhanced resilience, facilitating the ability to rebound and regain functionality following difficult life experiences (Schneider et al., 2013).

In accordance with the universally recognized Darwinian principle of "survival of the fittest,"(Darwin, 1859) individuals with high

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Hill *et al.*, (2018) offered the following definition of resilience as "the dynamic process by which a bio psychosocial system returns to a previous level of functioning, following a perturbation caused by a stressor". This definition highlights that resilience is a dynamic process that operates across multiple systems. Resilience is the capacity to adopt positively or regain levels of functioning after difficult life experience (Caldeira & Timmins, 2016) . It constitutes not just recovery, but growth and strengthening from adversity (Fleming & Ledogar, 2008). The American psychological association defines resilience as "the process of adapting well in the face of adversity, trauma, tragedy, threats or even significant sources of stress" (*APA Dictionary of Psychology*, n.d.).

The Correlation between Emotional Maturity and Resilience :

There are certain evidences that have formerly depicted the correlation of emotional maturity and resilience. In a research conducted by Margret (2015) to examine the relationship between emotional maturity and resilience among college students the results implied that emotional maturity and resilience had significant positive co-relation. Furthermore, the study also depicted that there is a significant difference between high/low emotional maturity groups on resilience. Joseph and Bobin (2017) conducted a research to examine resilience and emotional maturity among higher secondary students of Pondicherry. This study revealed that emotional maturity and resilience has a positive relationship. Emotionally mature adolescent have high resilience capacity and they can cope up with stressful situations. Nagilla and Harshitha (2019) investigated on the relationship between emotional maturity and resilience among psychology students. The results implied that there is a moderate positive co-relation between emotional maturity and resilience. This study concluded that resilience increases with an increase in emotional maturity.

Aim :

Main aim of this paper is to explore the strength of association between Emotional Maturity and Resilience.

Objectives :

1) To study the correlation between Emotional Maturity and Resilience of medical professionals.
2) To study the correlation between emotional maturity and Resilience of Non-medical professionals.

Hypothesis :

1) There is a positive correlation between Emotional Maturity and Resilience of medical professionals. Medical professionals with high level of emotional maturity will exhibit high level of resilience.
2) There is a positive correlation between Emotional Maturity and Resilience of Non-Medical Professionals. Non-Medical professionals with high level of emotional maturity will exhibit high level of resilience.

Research Methodology :

The current study used descriptive survey method for data collection. A sample of the 100 participants was obtained. The inclusion criteria for the study were that they should be working professionals residing in Amravati district. It was ensured while data collection that equal number of medical and non- medical professionals be a part of the study to avoid the data from getting skewed. The samples were selected randomly from different hospitals, school, shops, banks and offices. It was ensured that the sample was free from distinguishing factors like Gender, Area (rural and Urban) and Education.

emotional maturity and resilience appear to embody fitness, particularly demonstrated through mental, emotional, and behavioral flexibility in adapting to both external and internal pressures.

To consider Japan as an emotionally mature and resilient country wouldn't be any over-reach. Japan has suffered several disasters like the infamous atomic bombing on Hiroshima and Nagasaki, the 2011 Tôhoku earthquake and tsunami, to name a few even before the COVID-19 pandemic. The Japanese people have managed to rise back from these adversities strongly (Pastrana-Huguet et al., 2022). This depicts that the more emotionally mature and resilient the individuals are, the chances that they will emerge out of the problems successfully are more.

The global experience of the unprecedented Covid-19 pandemic served as a pinnacle test for individuals' emotional maturity and resilience, offering a unique opportunity to explore the correlation between these two attributes.

The pandemic precipitated significant shifts in job roles, with medical professionals facing unparalleled stress due to the dual responsibility of safeguarding others' lives while also being concerned for their own. Non-medical professionals, on the other hand, had to adapt their work patterns extensively(Herraiz-Recuenco et al., 2022). The exigencies of the time underscored the necessity for medical professionals to exhibit higher levels of emotional maturity and resilience compared to the general populace. Consequently, this study differentiates between medical and non-medical professionals to investigate the nuances of emotional maturity and resilience. Amravati district was selected as the population source for sample collection.

Emotional maturity :

Emotions have an influential value in life. Crow & Crow(1962) state that emotion is an affective experience that accompanies generalized inner adjustment and mental and psychologically stirred up states in an individual and that shows itself in his overt behaviour. For a prosperous life it is essential for an individual to have a control on their emotions. A person who fails to control their emotions faces a lot of problems. Therefore, one needs to be emotionally matured.

Emotional maturity is a balance between the brain and emotions between the inner and outer world of the individual(Landau, 1998). Emotional maturity is the capability to handle situations without unnecessarily intensifying them. Emotionally mature people have been observed to fix their problems and behaviour instead of using defence mechanism in a problematic situation (Alexander, 1948). The American Psychological Association defines emotional maturity as a high and appropriate level of emotional control and expression (*APA Dictionary of Psychology*, n.d.). Smitson defined (1974) emotional maturity as a process in which the personality is continuously striving for a greater sense of emotional health both intra physically and intra personally.

Resilience :

Resilience is the capacity to recover quickly from the difficulties. Psychological resilience is an individual's ability to successfully adapt to life task in the face of social disadvantage or other highly adverse conditions.

According to Merriam-Webster the term resilience derives from the Latin verb "resilire" which means to rebound or 'leap back' (*Definition of RESILIENCE*, n.d.). Ahern et al., (2008) defined resilience as being an adaptive stress resistant personal quality. Connor and Davidson (2003) defined Resilience as a personal characteristic as being; "the personal qualities that enable one to thrive in the face of adversity".

Standardized Psychological test: Emotional maturity scale- by Dr. Yashvir Singh and Dr.Mahesh Bhargava which is self-reporting five point scale containing 48 items with test-retest reliability ,75 and validity ,64 and Resilience scale- by Dr. Vijaya Lakshmi and Dr. Shruti Narain which is five point self-reporting scale containing 30 items with test-retest reliability ,87 and validity ,86 were used for this study. Pearson product moment Correlation Coefficient

Statistical Results and Findings :

Table 1. Emotional Maturity and Resilience of Medical Professional and Non-medical Professional

	Medical Professionals (N=50,DF=48)		Non-medical Professionals (N=50,DF=48)	
	EM	R	EM	R
Mean	152.82	126.72	150.82	119.42
SD	14.91	14.31	16.33	17.07
r	0.78**		0.63**	

Discussion :

The correlation coefficient between Emotional maturity and resilience of medical professionals is 0.78 is found significant ($p<.01$). Therefore the first hypothesis, there is a positive correlation between Emotional Maturity and Resilience of medical professionals is accepted. The correlation coefficient between Emotional maturity and resilience of non-medical professionals is 0.63 is found significant ($p<.01$). Therefore the second hypothesis, there is a positive correlation between Emotional Maturity and Resilience of non-medical professionals is accepted. This finding is in the line with the findings of Margret (2015), Joseph and Bobin (2017), Nagilla and Harshitha (2019). This refers that emotionally matured Medical and Non-Medical Professionals have high resilience capacity and they can cope up with the stressful situations. Emotionally matured people tend to be well versed with their emotions and are also good at understanding others' emotions; this can help them analyze complex situations that they face and then to cope back from it.

Conclusion :

Conclusion of the study is that there is a Positive Correlation between Emotional Maturity and Resilience of Medical and Non-Medical Professionals.

Future Scope :

Future research could build on the foundational work of exploring key individual traits, specifically emotional maturity and resilience, by expanding the scope beyond the initial focus on medical and non-medical professionals. Further studies could refine the classification of non-medical professionals, exploring a broader spectrum of occupations to discern more nuanced impacts on emotional maturity and resilience. Additionally, extending data collection beyond the Amravati district could enhance the generalizability of findings, incorporating diverse geographical and cultural contexts to provide a more comprehensive understanding of these critical psychological attributes.

Limitations :

The research data was meticulously collected solely from the residents of Amravati district,

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offering a concentrated examination of this specific locale. Despite the relatively small sample size, the study benefited from an intimate scale, enabling a thorough analysis of each participant's input. Emphasizing inclusivity, the sample encompassed individuals from diverse backgrounds without distinction based on gender, residence (rural or urban), or educational attainment. Moreover, data collection exclusively targeted literate individuals, ensuring a foundational comprehension of the research objectives among all participants. While the research methodology relied on self-report questionnaires, providing a direct avenue for participants to share their experiences and perceptions, it's crucial to acknowledge the potential for subjective bias inherent in self-reported data.

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संशोधक

• वर्ष : ९२ • मार्च २०२४ • पुरवणी विशेषांक ३१

उदगीर

प्रकाशक : इतिहासाचार्य वि. का. राजवाडे संशोधन मंडळ, धुळे

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इतिहासाचार्य वि. का. राजवाडे मंडळ, धुळे
या संस्थेचे त्रैमासिक

।। संशोधक।।

पुरवणी अंक ३१ – मार्च २०२४ (त्रैमासिक)

• शके १९४५ • वर्ष : ९२ • पुरवणी अंक : ३१

* प्रकाशक *

श्री. संजय मुंदडा

कार्याध्यक्ष, इ. वि. का. राजवाडे संशोधन मंडळ, धुळे ४२४००१
दूरध्वनी (०२५६२) २३३८४८, ९४२२२८९४७१, ९४०४५७७०२०

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कार्यालयीन वेळ

सकाळी ९.३० ते १.००, सायंकाळी ४.३० ते ८.०० (रविवारी सुट्टी)

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वार्षिक वर्गणी (फक्त अंक) रु. ५००/-, लेख सदस्यता वर्गणी : रु. २५००/-

विशेष सूचना : संशोधक त्रैमासिकाची वर्गणी चेक/ड्राफ्टने
'संशोधक त्रैमासिक राजवाडे मंडळ, धुळे' या नावाने पाठवावी.

अक्षरजुळणी : सौ. सीमा शिंत्रे, पुणे.

PSYCHOLOGICAL WELLBEING AMONG MUSICIANS

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Abstract :

Music has an extraordinary importance in human life since ancient times, music has been used by humans for enjoyment. Although music is an art form, it plays an important role in personality development. Nowadays, music is widely used as a therapy. Music helps in maintaining good mental health.

The concept of psychological wellbeing is very important in positive psychology. Carol Ryff has mentioned six main elements of psychological wellbeing. The present research was conducted to see if there is any effect of classical music training on psychological wellbeing. For this research 40 people who were classical musicians and 40 people who have no connection with performing arts were selected. Total sample of 80 people were selected through the purposive sampling and age group was 25 to 35 and educational, socio-economic level was kept equal.

Both groups were compared on the basis of Carol Ryff's psychological well-being test. In the research, the psychological well-being of musicians was found to be significantly higher with t value of 15.33, which was found to be significant at 0.01 level. The six main elements of the psychological well-being were autonomy, environmental mystery, personal growth, personal relationship, purpose of life and self-acceptance as described by Ryff. The factors of psychological well-being were compared and found to be significantly higher in musicians.

Key words : sychological Wellbeing, Classical Musicians

Introduction :

Positive psychology is a branch of psychology that has emerged in modern times. This branch emphasizes the positive aspects of a person's experience, optimism, happiness, competence, positive traits, contentment, aesthetics, spirituality, creativity. According to Martin Seligman, there are three pillars of positive psychology.

1. Positive Personal Experience (Happiness, Pleasure, Satisfaction, Contentment)
2. Positive Personal Traits (Personal Strength, Creativity, Optimism, Courage, Spirituality)
3. Positive Social Community (Social Responsibility, Social Acceptance, Social Support)

From this it can be seen that in positive psychology importance is given to individual's strengths, abilities, happiness, contented attitude and overall positive characteristics. In fact, it appears that Maslow discussed this about fifty years ago. According to Maslow's description, psychology paid more attention to the negative aspects of the person than the positive aspects. Baslow's regret that strength was not given much importance filled this regret with positive psychology and gave importance to the

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individual's abilities, happiness, contentment, creativity, spirituality, aesthetic sensibilities, and strength.

Human beings are seen trying to achieve happiness in their lives, mental happiness, satisfaction or mental peace, for that, cultivating various hobbies, worshiping art, reveling in the art world or developing one's talents and thereby attaining satisfaction, achieving self-respect, human efforts are more or less continuous. Artistic quality is also a strength or a kind of ability of a person and through it the human mind gets happiness, creativity gets scope, gets a special social position and gets respect.

Nature of Music Psychology :

Music psychology is considered a branch of psychology. The research done in this field is of scientific nature. From the point of view of music as a special mental process, the origin of the measurement of musical ability is discussed. According to Davies (1980), the psychological study of music is the study of the relationship between the laws of music and the laws of perception and cognition, which includes almost all mental processes.

According to Indian classical music, Western music is based on harmony and Indian classical music is based on melody, so the effects of both are different.

The purpose of this research was to examine the effect of Indian classical music training on psychological well-being

Psychological Wellbeing :

Psychological well-being is the subjective contentment, happiness, satisfaction and experience and once role in the world of work, sense of achievement, utility, belongingness and no distress, dissatisfaction or worry etc.

Key components of psychological wellbeing :

There are two traditions of wellbeing i.e. Hedonic well-being and eudaimonic well-being. Hedonic well-being means high level of pleasant emotions and moods, low level of negative emotions, moods and high life satisfaction. According to Diener's work "subjective well-being" is used synonymously with hedonic well-being (Diener, 1984). On the other hand, eudaimonic well-being means the assumption that individuals strive to function fully and realize their unique talent. According to Ryff, there are six dimensions of well-being as the part of eudaimonic well-being.

Dimension of psychological well-being :

Self-acceptance : self acceptance is referred to positive feeling towards oneself by recognizing and accepting various aspects of the self, whether positive or negative.

Autonomy: Autonomy means a person's ability to determine himself, and what is best for himself without the view of judgment of other.

Positive relation with others: *- positive relationship with others is the ability of a person to establish good relations, mutual trust and* mutual concern for the needs and well being of others

Purpose in life *:purpose in life refers to* individuals who have the intention and goals to be achieved in his lifetime.

Personal growth: Personal growth is referred to the ability to adapt to changes that occur in life.

Environment mastery : Environment mastery refers to persons who use the opportunities that exist in an environment for effective selection or creation of an environment desired by himself

Literature Review:

Raychaudhary (1963) studied the personality of the music composer. He reported that that emotional traits are more important than other personality traits in musician's personality. Similarly, some developmental factors and other familial, social and cultural influences were

found to be important in their lives. Raychaudhary studied the music composers again and again and presented his research in the 1975 Sangeet Natak Academy seminar. In this research, 30 professional musicians were used as the experimental group, while 30 individuals in other professions other than music or other arts were used as the control group for comparison. Subjects in both groups were similar in sex, age, education, marital status, intellectual ability and language. Each was given an individual test. It was then observed that the personalities of musicians are fluid. Therefore, they become more excited and agitated by external events. External events create agitation in their minds. They are aware of the people and environment around them. They sense and respond to the emotional needs of others. This sense is so marked that there seems to be some connection between music-making and social sensibility. Along with this, musicians have the ability to merge with the outside world through emotions such as peace, happiness, joy and fear.

Musicians are very sensitive to inner experiences. According to Raychaudhary's observations, the musician is aware of the inner world as well as the outer world. A musician maintains a sort of balance between these two. Musicians are sensitive to feelings of inner sadness, depression or joy. Similarly, musicians have been found to be able to control themselves, their aggression, their disorder, their sexual feelings.

Dorothy Retallack's (1973) conducted a study on the effect of Sound of Music and Plant. She conducted his experiments in the laboratory of the Women's College in Colorado. By placing plants of the same type and variety in 3 separate rooms, she played loud music for 8 hours continuously in one room. In the second room, 3 hours of soft and audible music was added. In the third room there is no music. After fourteen days, the plants in the first room wilted. The plants in the second room grew vigorously, while the plants in the third room also grew well. But their growth and vigor were less than the plants in the second room. She also experimented with rock music and soft music. They found that plant growth slowed down when exposed to rock music, but increased when exposed to soft music. She found that plants grew best when surrounded by Indian classical music. Plant branches swaying to classical music

Tompkins and Bird (1977) found that application of pure classical music increased plant growth by 20 percent. The Music Corporation experimented on factory workers in the 1940s. Listening to low-pitched music for pauses and pauses in workers has been shown to increase their performance. Musician Julius Portnoy conducted experiments on rats and found that classical music made rats more constructive, while rock music made them more violent. V. M. Durand and Mapstone (1998) demonstrated that the use of music was beneficial for psychopaths with aggressive behavior.

Objectives :

1) To study the impact of Indian Classical Music on Psychological well-being.
2) To determine difference on subscale of psychological wellbeing.

Hypotheses :

1) The subjects trained in Music will exhibit better psychological wellbeing than untrained subject.
2) There will be significant difference between music trained and untrained subjects on different dimensions of psychological well-being,

Methodology :

Sample :

For collecting the sample purposive sampling technique was used. The sample consists of 80 adults from Amravati city; forty were trained in

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classical music for at least 7 years or Sangeet Visharad. The remaining participants were do not have any music background. The age group ranged from 25 to 35 years and the mean age was 30. Male and female ratio was 1:1 (40 male & 40 female, including music trained and untrained) belong to middle-class socio-economic status and equal educational level.

Tools :

1. Psychological wellbeing scale: (Carol Ryff 1995)
2. Music trained selection form; (Music expert)

Procedure of Data Collection :

The seating arrangement allowed sufficient distance between two subjects. Care was taken that the subjects should not be able to see the other's responses. Though there was no time limit, the subjects were told to response as fast as they can. Then we distributed the test of psychological well-being.

Results and Discussion :

Table No. 1 Total Psychological Well-being

Group	Mean	SD	" t " Value	Interpretation
Music Trained	201.46	7.85	15.33**	Significant at 0.01 Level
Music Untrained	162.43	13.46		

Table No. 2 Dimensions of Psychological Well-being

Dimension of PWB	Group	Mean	SD	" t " Value	Interpretation
Self-acceptance	Music Trained	34.21	2.43	6.98**	Significant at 0.01 Level
	Music Untrained	27.35	5.66		
Autonomy	Music Trained	32.41	3.18	12.15**	Significant at 0.01 Level
	Music Untrained	25.12	2.02		
Positive relation with others	Music Trained	29.71	3.30	5.09**	Significant at 0.01 Level
	Music Untrained	24.92	4.82		
Purpose in life	Music Trained	37.87	3.09	9.41**	Significant at 0.01 Level
	Music Untrained	30.15	4.12		
Personal growth	Music Trained	34.87	2.14	6.71**	Significant at 0.01 Level
	Music Untrained	27.35	6.17		
Environment mastery	Music Trained	30.84	3.01	4.31**	Significant at 0.01 Level
	Music Untrained	26.74	5.05		

From table no. 1 it can be seen that the mean of psychological well-being of musically trained adults is 201.46 while the mean of psychological will being of musically untrained is 162.43 and their 't' value is 15.33 which is significant at 0.01 level ($t=15.33$, $df\ 78$ $p<0.01$). On this basis we can say that, classical music training plays an

important role in terms of psychological well-being.

The values mentioned in table no. 2 are six dimensions of psychological well-being yielded significant results; trained musicians exhibited better psychological wellbeing compared to untrained participants on all dimensions of psychological wellbeing. Considering the statistical findings both hypotheses are retained. The results are in congruence with previous studies. According to Maslow, music plays an important role in progressing towards self-actualization. He mentioned 16 characteristics of self-actualized individual and these characteristics are related to positive personality development. Therefore, such individuals have a high level of psychological well-being. So that, it is seen that these characteristics are related to all dimensions of psychological well-being

Conclusions :

1) Music plays a significant role in psychological wellbeing; music trained subjects exhibited better level of psychological wellbeing compared to common participants.
2) Music trained subjects exhibited better level on all aspects of psychological well-being.

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इतिहासाचार्य वि. का. राजवाडे मंडळ, धुळे
या संस्थेचे त्रैमासिक

।। संशोधक।।

पुरवणी अंक ३३ – मार्च २०२४ (त्रैमासिक)

• शके १९४५ • वर्ष : १२ • पुरवणी अंक : ३३

* प्रकाशक *

श्री. संजय मुंदडा

कार्याध्यक्ष, इ. वि. का. राजवाडे संशोधन मंडळ, धुळे ४२४००१
दूरध्वनी (०२५६२) २३३८४८, ९४२२२८९४७१, ९४०४५७७०२०

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कार्यालयीन वेळ

सकाळी ९.३० ते १.००, सायंकाळी ४.३० ते ८.०० (रविवारी सुट्टी)

अंक मूल्य रु. १००/-
वार्षिक वर्गणी (फक्त अंक) रु. ५००/-, लेख सदस्यता वर्गणी : रु. २५००/-

विशेष सूचना : संशोधक त्रैमासिकाची वर्गणी चेक/ड्राफ्टने
'संशोधक त्रैमासिक राजवाडे मंडळ, धुळे' या नावाने पाठवावी.

अक्षरजुळणी : सौ. सीमा शिंत्रे, पुणे.

Smart Phone Addiction and Dark Personality Triad

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Abstract :

Use of smart phone is an essential requirement for fast communication, entertainment and a medium of education too. After Covid-19 there is a tremendous growth spurt in the use of smart phone and internet. However, the excessive use of the smart phone gazettes and various apps is leading to adverse effects on teenagers and the youngsters, popularly known as the Gen Z.

The study aimed to explore the role of Smart Phone Addiction in Dark Personality Triad; Narcissism, Sociopath and Machiavellianism in the Gen Z. The sample comprised of 348 (Female- 248 and Male- 100) college students offering different study courses. Smart Phone Addiction Scale by Dr. Vijayshri and Dr. Masaud Ansari (2021) and Dark Personality Triad Scale (Short form) by Jones and Paulhus (2014) were used to measure the prevalence of Narcissism, Psychopathy and Machiavellianism. The responses were sought in the online mode. Correlational design was used. Significant correlation was found between Smart Phone use and Dark Personality Triad ($r = .52$ **) and Smart Phone use with narcissism ($r = .27$ **), with Psychopathy ($r = .54$ **) and with Machiavellianism ($r = 0.46$ **). For cross verification the correlation coefficients were treated with t test, the results were also found significant for the given correlations.

Key words: Smart Phone Addiction, Dark Personality Triad, Narcissism, Psychopathy Machiavellianism

Introduction:

Use of smart phone is an essential requirement for fast communication, entertainment and a medium of education too. After Covid-19 there is a tremendous growth spurt in the use of smart phone and internet. However, the excessive use of the smart phone gazettes and various apps is leading to adverse effects on teenagers and the youngsters, popularly known as the Gen Z. Internet games like 'Blue whale challenge', 'Pink whale challenge', 'Pokoman go', taking selfies or making reels at risky places like on running railways or at the overflow dams indicates that in Gen Z internet addiction is increasing day by day and they are becoming over conscious about their presence in social media. Even in interpersonal relationships, social media has caused tremendous change. One-to-one contact is replaced by virtual relationship and this has led to e-identity and e-personality (Aboujaoude, 2011).

Smart Phone Addiction and Dark Personality Triad :

Many researchers have examined the role of social media and personality traits. The results

of these studies suggest that social media activity is related to several obsessed personality traits. This is a big avenue to investigate whether these traits are developed out of the influence of social media or such traits enable an individual to use this media at great extent. Jonason and Gregory Webster (2010) called it 'the dark triad' of personality; it includes Narcissism, Sociopath and Machiavellianism. Fox and Rooney (2015) have argued that selfie can be associated with the dark triad. Generally, individuals who like selfies tend to enjoy them and feel that taking them as an important activity in their daily lives. Moreover, they always look for places where they can take selfies and are upset if they are prevented from taking selfies (Peerayuth, 2016). Narcissistic individuals tend to develop positive self views of certain traits such as intelligence, physical attractiveness and power (Mehdizaeh, 2010). These characteristics of narcissism can potentially explain why some individuals are obsessed with selfies. This has led to search the role of Smart Phone addiction in dark personality triad.

Literature Review:

There are certain evidences about the linkage between selfies and dark personality triad. Fox and Roony (2015) found a strong connection between narcissism and the number of selfies posted. Selfie posting frequency was strongly associated with the leadership/authority and grandiose exhibitionism. Qiu et al. (2015) suggested that selfies may be associated with personality traits such as agreeableness and extraversion. Sorokowski et al. (2015) found the linkage between overall narcissism scores and own selfie posting was stronger for males than for females. Fox and Rooney (2015) also argued that excessive use of social media can potentially lead to unhealthy behaviors such as narcissism and selfishness. Alloway, et al. (2014) found that elevated level of narcissism damage an individual's ability to shape healthy and mutually beneficial relationships. They are more prone to respond with violent and aggressive behavior after being critiqued. However, Carpenter (2012) Griffiths (2005) has proposed that extremely preoccupation with social media and investing too much time can interferes with other vital aspects of life.

The review mentioned so far reveals that there is a close connection between excessive use of Smart Phone, some personality traits including Narcissism, Sociopath and Machiavellianism.

Aim and Objectives:

Main aim of this paper is explore the strength of association between Smart Phone Addiction and development of Dark Personality Triad in the Gen Z.

Major objectives of the study are :

1. To examine the strength of association between Smart Phone Addiction and Dark Personality Triad
2. To examine the strength of association between Smart Phone Addiction and Narcissistic personality characteristics.
3. To examine the strength of association between Smart Phone Addiction and Sociopath personality characteristics.
4. To examine the strength of association between Smart Phone Addiction and Machiavellianism personality characteristics.

Hypotheses :

Assuming other factors are kept constant following null hypotheses were framed

1. There will not be any strength of association in Smart Phone Addiction and Dark Personality Triad.
2. There will not be any strength of association between Smart Phone Addiction and Narcissism personality characteristics.
3. There will not be any strength of association between Smart Phone Addiction and Narcissism personality characteristics.

4. There will not b any strength of association betw en Smart Phone Addiction and Mac iavelli personality characteristics

Scope and Methodology :

The scope of the study is bound to collegians offering various professional and non-professional study courses. The sample was comprised of 348 students (Male 100, female 248).

Tools- Smart Phone Addiction Scale by Dr. Vijayshri and Dr. Masaud Ansari (2021), Dark Perse nality Triad Scale (Short form) by Jones and I a lhus (2014) to measure the prevalence of Nar issism, Psychopathy and Machiavellianism

De sign- A correlational design was used.

St atistics- Product moment correlation and t test

Inte pretation and Discussion:

The study aimed to explore the strength of association between Smart Phone addiction and the traits of Dark Personality Triad, namely Narcissism, Psychopath, and Machiavellianism. The obtained values are depicted in the following tables.

Table No. 1: Mean and SD

	Smart Phone Addiction	Personality Triad	Narcissism	Psychopathy	Machiavellianism
Mean	52.30	68.65	30.50	14.77	23.38
SD	15.27	11.59	5.52	3.7	4.42

Table No. 2: Correlation and t values

	Smart Phone Addiction	
	r (0.27)	t (2.60)
Personality Triad	0.52 **	11.32 **
Narcissism	0.27 **	4.81 **
Psychopathy	0.54 **	12.00 **
Machiavellianism	0.46 **	9.44 **

The correlation coefficient between smart phone addiction and personality triad is 0.52 is found significant ($p<.01$ at two tailed test). Therefore the first hypothesis, there will not be any strength of association in Smart Phone Addiction and Dark Personality Triad is rejected. In the present context this significant correlation can be attributed to the social media influence.

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This is mainly because this generation is also known as internet generation and can be considered the pioneers of mobile technology (Shrivastava, 2023).The virtual world of smart phone and social media satiate the need of gregariousness of this Gen Z. Chung et al. (2018) found that social media addiction tend to different behavioral pattern and cognitive thinking, thus leading to form a typical personality pattern. Casale et al. (2016) have proposed that social media provides them an alternative to feel more secure in virtual relation and virtual environment. Similarly, Dimircioglu & Kose (2018) and Andreassen et al., (2017), have pointed out that members of dark triad traits put high importance on their interpersonal needs and they will ensure that their needs are met at the end. Hence, it can be said that social media can be used to form online relationships it allows youngsters to disguise their weaknesses and exhibit their best side.

Hypotheses no. 2, 3 and 4 were related to Narcissism, Psychopathy and Machiavellianism; respectively. All hypotheses were rejected. On the contrary the observed values depicted in table no. 2 indicates significant positive correlation between smart phone addiction and all there prevalence of dark personality triad i.e. Narcissism (0.27** $p<0.01$), and Psychopathy (0.54** $p<0.01$) and Machiavellianism (0.46** $p<0.01$). For cross verification all four correlation coefficients were treated with t test. The obtained values are given in Table No. 2 yielded significant results, thus, refuting all null hypotheses; on the contrary it can be concluded that smart phone addiction has strong and positive influence in the formation of dark personality triad. These findings are supported by previous studies. Gwenn Schurgin O'Keeffe & Kathleen Clarke-Pearson (2011) have concluded that engaging in various forms of social media is a routine activity that benefit children and adolescents by enhancing communication, social connection and even technical skills. However, Zao & Zhou (2021) have concluded that despite the obvious advantages of social media in an emergency situation, such as Covid-19, higher use of social media use is likely to need to social media addiction. Bergman et al., (2011) have reported that Narcissists are prone to addict to social media because of their high expectations for affiliation and social media can help them to conceal their bad side as they can choose what they wanted to share. Casale, et al., (2016) stated that narcissists are reluctant to accept the fact that they are lacking in real life, hence, online activities provide a better control on what people see to boost their ego which could cause addictive use of social media. In a study by Necula (2020) the results showed positive correlation between social media addiction and Machiavellianism and also between social media addiction and Psychopathy. Lopes and Yu (2017) concluded that excessive use of smart phone and social media enables Machiavellists and Psychopaths to utilize social media to engage in undesirable behaviors such as causing conflict and breaking the laws.

Conclusions:

Considering the statistical findings all null hypotheses were rejected and it is concluded that..

1) There is a close connection between smart phone overuse and dark personality triad in total; both are positively and significantly correlated.
2) There is a close connection between smart phone overuse and Narcissistic personality pattern; both are positively and significantly correlated.
3) There is a close connection between smart phone overuse and psychopathic personality pattern; both are positively and significantly correlated.

4) There is a close connection between smart phone overuse and Machiavelli personality pattern; both are positively and significantly correlated.

Limitations :

The study have certain limitations. The scope is limited to the students enrolled in various study streams in Vidya Bharati Mahavidyalaya, Amravati only. The responses were sought in online form. Both tools were translated in Marathi language. The variable of gender was isolated as the data was skewed, 71.3 % respondents were female and 28.7 % were male.

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Effect of *Zingiber officinale* and *Tinospora cordifolia* on Freshwater Fish *Ophocephalus striatus* (Bloch 1973)

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***Key words*:** *Zingiber officinale, Tinospora cordifolia, Ophocephalus striatus*, Fish, Freshwater

Aquaculture also known as fish farming, is an important sector in the Indian economy and plays an essential role in the country's food security. Aquaculture is the fastest food production sector in the world due to the demand and scarcity of other sources of food production and also due to the health benefits of fish consumption the demand for fishes as a source of food widely throughout the world. The additional demand for fish consumption must be achieved only through aquaculture [1]. Aquaculture farming in India has spot tremendous growth over the last few decades, with significant offering to employment, export earnings, and rural development. As the world population increases the demand of the aquaculture industry increases [2]. Aquaculture become an important resource for humans worldwide, in addition; it is one of the cheapest sources of easily digestible animal protein.

Fishes play a vital role in food security and poverty alleviation in both rural and urban areas often referred to as "rich food for people". Fish provide essential nourishment more ever quality proteins, vitamins, and minerals [3]. Due to high protein content, low fat, and abundant amount of omega-3 fatty acid present in the fish which is an important part of the human diet. Freshwater fish food is essential for the nutrition of famed fish. Fishes require a balanced diet to grow and develop properly, lack of essential nutrients can lead to stunted growth, reduced immunity, and increased mortality. Freshwater fish food typically contains a combination of plant and animal ingredients including soybean meal, corn, wheat, vitamins, and minerals. Fish meal is considered as the major source of dietary protein and lipid supplement in the diets of carnivore fishes. Herbs are more compatible with the body because of their normal nature and having medicine homologus components together and lack of unwanted side effects, therefore they are most suitable [4]. This sustainable and successful freshwater fish culture on a scientific basis principally depends upon the use of adequate, economically valuable, and environmentally artificial food as well as the use of ayurvedic plants to improve the yield of fish culture.

Zingiber officinale is a versatile root that has been used for centuries for its medicinal and culinary properties. It is highly valued for its many health benefits, which include reducing inflammation, improving digestion, boosting the immune system, and reducing nausea [5].

Tinospora cerdifolia commonly known as giloy or heart-leaved moonseed is a popular medicinal plant that has been used in Ayurveda as a medicine for centuries. *Tinospora cerdifolia* has a rich source of antioxidants, including alkaloids, glycosides, and steroids which have been shown to have anti-inflammatory and immune-boosting properties [6]. In the present investigation, the effect of *Zingiber officinale* and *Tinospora cordifolia* on freshwater fish *Ophiocephalus striatus* was observed.

The basal experimental diet was formulated with the commonly available ingredients. The formula and analyzed proximate composition of basal the diet is shown in (Table 1).

Table 1 Analyzed proximate composition of basal the diet

Ingredients (gm/ dry weight)	Control diet (100gm)	Experimental (100gm)
Prawns	60	60
Fish meal powder	40	35
Zingerber officinale	00	2.5
Tinospora cordifolia	00	2.5

The freshwater fishes were collected from a local fish market measuring about 7.8-11.5 cm in length and weighing ranges from 4.60-14.95gm for the experimental study. The fishes were brought to the laboratory and acclimatized for seven days by feeding them with prawns.

After acclimatization, the two groups of fishes were made:

Group I) Control
Group II) Experimental

During Experiment, fishes were fed with a prepared formulated diet twice a day. After 7, 14, 21, and 28 days from each group, the fishes were taken out and tissue of the liver and muscle was removed for the further investigation of total protein [7] ash content [8], and moisture [9].

Total protein

The present study (Table 2, Fig 1) showed that the total protein of muscle and liver of experimental fishes were found to increase in trend 71.87±1.85, 78.83±0.69, 79.90±0.78, 81.90±1.06 and 37.98±1.01, 39.90±1.15, 43.76±1.80,

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45.78±0.93 from 7, 14, 21, 28, days as compared with control group of fishes total protein 58.50±1.8, 62.56±2.2, 68.90±1.5, 72.76±2.6 and 34.44±1.81, 36.76±2.66, 36.79±1.62, 37.90±1.11 respectively.

Table 2 Total protein (gm/100gm) of *Ophiocephalus striatus* fed with *Zingerber officinale* and *Tinospora cordifolia*

Days	Control(gm/100gm)		Experiment (gm/100gm)	
	Muscle	Liver	Muscle	Liver
7 days	58.50 ± 1.8	34.44 ± 1.81	71.87 ± 1.85	37.98 ± 1.01
14 days	62.56 ± 2.2	36.76 ± 2.66	78.83 ± 0.69	39.90 ± 1.15
21 days	68.90 ± 1.5	36.79 ± 1.62	79.90 ± 0.78	43.76 ± 1.80
28 days	72.76 ±2.6	37.90 ± 1.11	81.90 ± 1.06	45.78 ± 0.93

*Values are mean ± SD

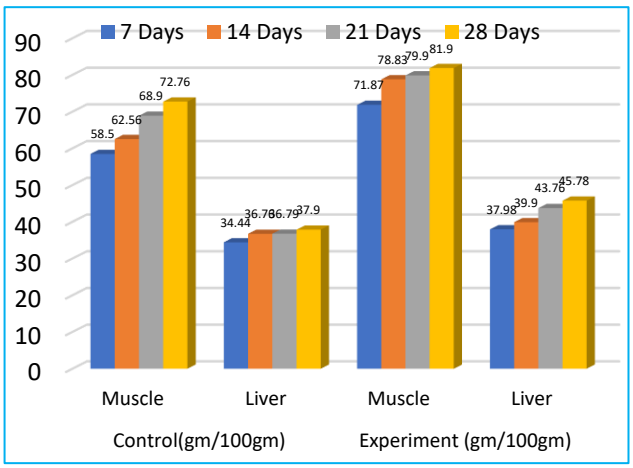

Fig 1 Total protein (gm/100gm) of *Ophiocephalus striatus* fed with *Zingerber officinale* and *Tinospora cordifolia*

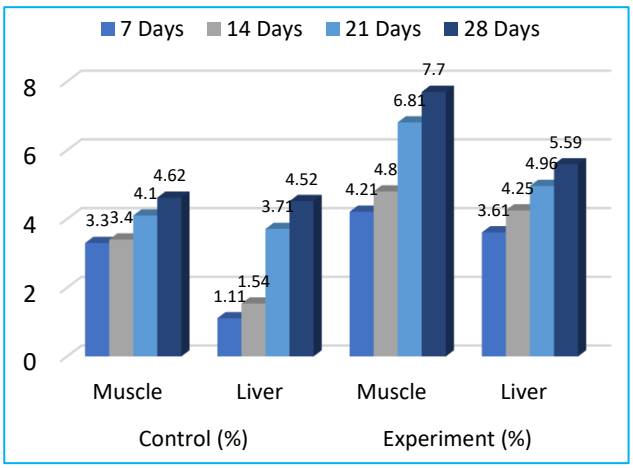

Fig 2 Ash content (%) of *Ophiocephalus striatus* fed with *Zingerber officinale* and *Tinospora cordifolia*

Ash content

The ash content (Table 3, Fig 2) showed increasing in trend in the experimental group of fishes fed with *Zingerber officinale* and *Tinospora cordifolia* in muscle tissue 4.21%, 4.80%, 6.81%, 7.70% and 3.61%, 4.25%, 4.96%, 5.59% in liver tissue as compared with control group of fishes 3.30%, 3.40%, 4.10%,4.62% and 1.11%, 1.54%, 3.71%, 4.52% from 7, 14, 21, 28 days respectively.

Moisture content

The moisture content (Table 4, Fig 3) showed increasing in trend in the experimental group of fishes fed with *Zingerber officinale* and *Tinospora cordifolia* in muscle tissue 76.1%, 82.2%, 88.9%, 96.2% and 88%, 89%, 92.1%, 94.1% in liver tissue as compared with control group of fishes 80.6%, 84.8%, 88.4%, 89.6% and 78.1%, 79.5%, 82.41%, 88.6% from 7, 14, 21, 28 days respectively.

Table 3 Ash content (%) of *Ophiocephalus striatus* fed with *Zingerber officinale* and *Tinospora cordifolia*

Days	Control (%)		Experiment (%)	
	Muscle	Liver	Muscle	Liver
7 days	3.30	1.11	4.21	3.61
14 days	3.40	1.54	4.80	4.25
21 days	4.10	3.71	6.81	4.96
28 days	4.62	4.52	7.70	5.59

Table 4 Moisture content (%) of *Ophiocephalus striatus* fed with *Zingerber officinale* and *Tinospora cordifolia*

Days	Control (%)		Experiment (%)	
	Muscle	Liver	Muscle	Liver
7 days	76.1	88	80.6	78.1
14 days	82.2	89	84.8	79.5
21 days	88.9	92.1	88.4	82.41
28 days	96.2	94.1	89.6	88.6

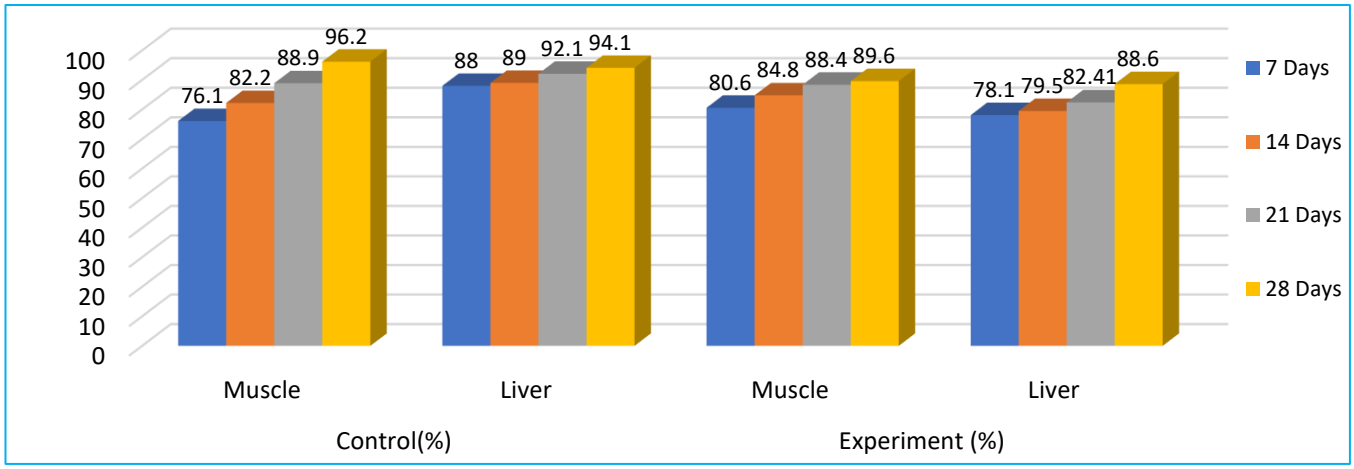

Fig 3 Moisture content (%) of *Ophiocephalus striatus* fed with *Zingerber officinale* and *Tinospora cordifolia*

The obtained results fed with *Zingerber officinale* and *Tinospora cordifolia* to freshwater fish *Ophicephalus striatus* showed major improvement in body weight as compared to control groups. Furthermore, dietary *Zingerber officinale* and *Tinospora cordifolia* enhance metabolic activities and enhance the level of protein. Moreover, the study provided a new dimension for the use of medicinal plants as supplementation to fishes. Kobeisy and Hussain [10], studied *Oreochromis niloticus* and found that dietary food was given to the fishes showed a significant increase in protein level and body weight of fish. Among three carps *Catla catla*, showed maximum average body weight (1256 g), followed by *Labeo rohita* (1215.0g) and *Cyprinus carpio* (1119.01g) in a supplemented diet. Mansour *et al.* [11] studied that ginger has been purported to have anti-inflammatory, anti-hypertensive, and glucose-sensitizing effects as well as stimulatory effects on the gastrointestinal tract by increasing gastric secretions. Also, Singh and Gaur [12], stated that weight gain is maximum when various dietary protein levels and carcass composition are given to *Labeo rohita* fingerlings. Finally, in the present investigation, it was suggested that the *Zingerber officinale* and *Tinospora cordifolia* as feed alternative solutions in aquaculture feed as growth promoters. Distinctly it showed a significant increase in growth performance, feed utilization, and increase in metabolic activity.

SUMMARY

The study aimed to observe the effect of *Zingiber officinale* and *Tinospora cordifolia* on freshwater fish *Ophocephalus striatus*. The experimental diet was formulated to contain *Zingiber officinale* (2.5gm/100gm diet), and *Tinospora cordifolia* (2.5gm/100gm diet) prepared in the pellet form and fed to the experimental fishes to observe the total protein, ash content, and moisture of the freshwater fish *Ophocephalus striatus* for 7th, 14th 21st, 28th days. The results showed that significant increase in total protein, ash content, and moisture of the experimental group of fishes. The results of this study show that the addition of *Zingiber officinale* and *Tinospora cordifolia* to a fish diet can promote the health benefit and growth of fish.

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Bioinformatics Applications of Artificial Intelligence in Genomics and Proteomics

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ABSTRACT

The application of artificial intelligence (AI) in bioinformatics has shown promising advancements in genomics and proteomics. This study evaluates the performance of convolutional neural networks (CNNs), recurrent neural networks (RNNs), and support vector machines (SVMs) in gene prediction, protein structure prediction, and functional annotation tasks. Our CNN model achieved a remarkable accuracy of 98.5% in predicting gene regions, significantly outperforming the traditional hidden Markov model (HMM) with an accuracy of 91.2%. For protein structure prediction, the RNN model attained a Q3 accuracy of 85.7%, surpassing the 78.4% accuracy of homology modeling methods. The SVM model used for functional annotation of proteins achieved an F1 score of 0.76, compared to 0.68 for a nearest-neighbor approach. These results underscore the superior performance of AI models in bioinformatics, highlighting their potential to revolutionize genomic and proteomic research. Future work should focus on integrating multi-omics data, improving model interpretability, and enhancing computational efficiency. This study demonstrates that AI can significantly enhance the accuracy and efficiency of bioinformatics analyses, paving the way for new insights and applications in the field.

KEYWORDS

Artificial Intelligence (AI), Bioinformatics, Genomics, Proteomics, Machine Learning (ML)

INTRODUCTION

Bioinformatics, an interdisciplinary field combining biology, computer science, and information technology, has become essential for managing and analyzing biological data. In recent years, the integration of artificial intelligence (AI) into bioinformatics has brought significant advancements, particularly in genomics and proteomics. AI techniques, including machine learning (ML) and deep learning (DL), offer powerful tools for extracting meaningful insights from complex biological datasets. This paper explores the applications of AI in gene prediction, protein structure prediction, and functional annotation, highlighting the improvements over traditional methods.

1.1. Genomics and AI

Genomics, the study of an organism's complete set of DNA, including all of its genes, is foundational to understanding biological functions and disease mechanisms. Traditional gene prediction methods, such as hidden Markov models (HMMs), have been widely used but face limitations in accuracy and scalability [1]. AI, particularly convolutional neural networks (CNNs), has shown remarkable improvements in gene prediction accuracy. CNNs can automatically capture hierarchical features from raw DNA sequences, leading to more precise gene identification [2].

1.2. Proteomics and AI

Proteomics, the large-scale study of proteins, their structures, and functions, is critical for understanding cellular processes. Predicting protein structures, especially secondary structures, is a challenging task due to the complex folding patterns of proteins. Traditional methods, such as homology modeling, rely heavily on existing structural databases and often fail for novel proteins [3]. Recurrent neural networks (RNNs), capable of capturing sequential dependencies in protein sequences, have demonstrated superior performance in predicting protein secondary structures [4]. This advancement is crucial for drug discovery and understanding protein functions in various biological contexts.

1.3. Functional Annotation and AI

Functional annotation of proteins involves predicting the roles of proteins based on their sequences. Accurate functional annotation is essential for understanding biological pathways and mechanisms. Traditional approaches, like nearest-neighbor methods, often

struggle with the vast diversity of protein functions [5]. Support vector machines (SVMs) and other ML techniques have been employed to improve the accuracy of functional annotations. By learning complex feature interactions, SVMs provide more reliable predictions of protein functions [6-60].

1.4. RESEARCH GAPS IDENTIFIED

While this study demonstrates significant advancements in the application of AI to bioinformatics tasks such as gene prediction, protein structure prediction, and functional annotation, several research gaps and areas for further exploration remain.

1. Integration of Multi-Omics Data

Current AI models often focus on a single type of omics data, such as genomics or proteomics, in isolation. However, biological systems are complex and interconnected, requiring a holistic approach to fully understand their functions and interactions. Integrating multi-omics data, including genomics, transcriptomics, proteomics, and metabolomics, into AI models could provide more comprehensive insights and improve predictive accuracy.

2. Model Interpretability and Explainability

Although AI models, particularly deep learning techniques like CNNs and RNNs, have demonstrated high performance, they are often considered "black boxes" due to their lack of interpretability. Developing methods to interpret and explain AI model predictions is crucial for gaining trust from the scientific community and ensuring the models' predictions can be reliably used in practical applications. Enhancing model transparency could also aid in identifying underlying biological mechanisms.

3. Scalability and Efficiency of AI Models

As the volume of biological data continues to grow exponentially, the scalability and computational efficiency of AI models become critical. Current models may struggle to process and analyze large-scale datasets in a timely manner. Research is needed to develop more efficient algorithms and leverage high-performance computing resources to handle the increasing data sizes without compromising on accuracy or depth of analysis.

4. Robustness and Generalization of AI Models

AI models often perform well on training and validation datasets but may fail to generalize to unseen data, particularly when there are variations in data quality or underlying biological diversity. Ensuring that AI models are robust and can generalize across different datasets and conditions is essential for their practical application in diverse biological research and clinical settings. Techniques such as transfer learning and domain adaptation could be explored to address this issue.

5. Standardization of Evaluation Metrics

The performance of AI models is typically evaluated using metrics like accuracy, precision, recall, F1 score, and AUC. However, there is a need for standardized evaluation protocols to ensure consistent and fair comparisons between different models and studies. Developing a consensus on the most appropriate metrics and evaluation frameworks for various bioinformatics tasks would enhance the reproducibility and comparability of research findings.

6. Application to Less-Studied Organisms and Conditions

Most AI-driven bioinformatics research focuses on well-studied organisms, such as humans and model organisms like mice and yeast. There is a significant opportunity to extend these approaches to less-studied organisms and specific conditions, such as rare diseases or unique environmental settings. Expanding the application of AI models to a broader range of biological contexts could uncover new biological insights and drive discoveries in underexplored areas.

7. Ethical and Privacy Considerations

The use of AI in bioinformatics often involves handling sensitive genetic and health data, raising important ethical and privacy concerns. Research is needed to develop robust frameworks for data security, privacy protection, and ethical considerations in the collection, storage, and analysis of biological data. Ensuring that AI applications adhere to ethical guidelines and regulatory standards is critical for their acceptance and use in healthcare and research.

Addressing these research gaps will be crucial for advancing the field of bioinformatics and fully realizing the potential of AI in understanding complex biological systems and improving health outcomes. Future research should aim to develop integrative,

interpretable, efficient, and robust AI models while considering ethical and practical implications [7-37].

1.5. NOVELTIES OF THE ARTICLE

1. Hybrid AI Models for Enhanced Predictions

Explore the development of hybrid AI models that combine multiple techniques, such as integrating CNNs and RNNs for gene prediction or combining SVMs with deep learning architectures for functional annotation. These hybrid models could leverage the strengths of different AI approaches to achieve superior performance and robustness in bioinformatics tasks.

2. Transfer Learning for Cross-Domain Prediction

Investigate the application of transfer learning techniques to leverage pre-trained models from related domains or datasets with abundant annotations. This approach could facilitate the transfer of knowledge learned from one task or dataset to another, leading to improved predictions, especially in scenarios with limited labeled data.

3. Explainable AI Methods for Biomedical Interpretability

Develop explainable AI methods tailored to the specific needs of bioinformatics, allowing researchers to understand the underlying mechanisms and features driving AI model predictions. By providing interpretable insights into gene functions, protein structures, and functional annotations, these methods could enhance the trustworthiness and acceptance of AI-driven analyses in biological research.

4. Scalable AI Solutions for Big Data Analysis

Propose scalable AI solutions that can efficiently process and analyze large-scale biological datasets, leveraging distributed computing frameworks or cloud computing infrastructure. These scalable AI solutions could enable researchers to tackle complex biological questions and explore vast datasets with improved computational efficiency and speed.

5. Integration of Multi-Omics Data for Systems Biology Insights

Explore novel approaches for integrating multi-omics data, including genomics, transcriptomics, proteomics, and metabolomics, to unravel complex biological networks and pathways. By combining information from diverse molecular layers, these integrative analyses could provide holistic insights into biological processes and disease mechanisms, driving advancements in systems biology research.

6. Personalized AI Models for Precision Medicine

Develop personalized AI models tailored to individual patients' genomic and proteomic profiles, enabling precise diagnostics, prognostics, and treatment recommendations in personalized medicine. These personalized AI models could revolutionize healthcare by providing tailored interventions and therapies based on an individual's unique biological characteristics.

7. Ethical AI Frameworks for Responsible Data Handling

Establish ethical AI frameworks and guidelines for responsible data handling, ensuring the privacy, security, and ethical use of sensitive biological data. By integrating ethical considerations into AI-driven bioinformatics research, these frameworks could promote trust, transparency, and accountability in the use of AI technologies for biomedical applications.

2. METHODOLOGY

Data Collection

1. **Genomics Data**: We obtained a dataset of 50,000 human genomic sequences, each 1,000 base pairs long, from the Human Genome Project.
2. **Proteomics Data**: A dataset of 10,000 proteins with known structures was sourced from the Human Proteome Project. These proteins included alpha helices, beta sheets, and random coils.
3. **Functional Annotation Data**: A dataset of 15,000 proteins with annotated functions was collected from the Gene Ontology (GO) database.

Data Preprocessing

1. **Genomic Sequences**:

- Each genomic sequence was encoded into numerical representations suitable for input into the CNN.
- Sequences were split into training (80%), validation (10%), and test (10%) sets.

2. **Protein Structures**:
    - Protein sequences were one-hot encoded and their secondary structures labeled.
    - The dataset was divided into training (70%), validation (15%), and test (15%) sets.
3. **Functional Annotations**:
    - Protein sequences were transformed into feature vectors using k-mer frequencies.
    - Data was split into training (80%), validation (10%), and test (10%) sets.

Model Architecture and Training

1. **Gene Prediction Using CNN**:
    - **Architecture**: The CNN model consisted of multiple convolutional layers with ReLU activation, followed by max-pooling layers, and fully connected layers.
    - **Training**: The model was trained using the Adam optimizer with a learning rate of 0.001, and binary cross-entropy loss. Early stopping based on validation loss was employed to prevent overfitting.
    - **Evaluation**: Model performance was evaluated using accuracy, confusion matrix, and ROC curve analysis.
2. **Protein Structure Prediction Using RNN**:
    - **Architecture**: The RNN model included several LSTM layers to capture long-range dependencies, followed by dense layers for output predictions.

- **Training**: The model was trained with the RMSprop optimizer and categorical cross-entropy loss. Early stopping and dropout layers were used to enhance generalization.
- **Evaluation**: The Q3 accuracy metric was used to assess the model's performance on secondary structure prediction.

3. **Functional Annotation Using SVM**:

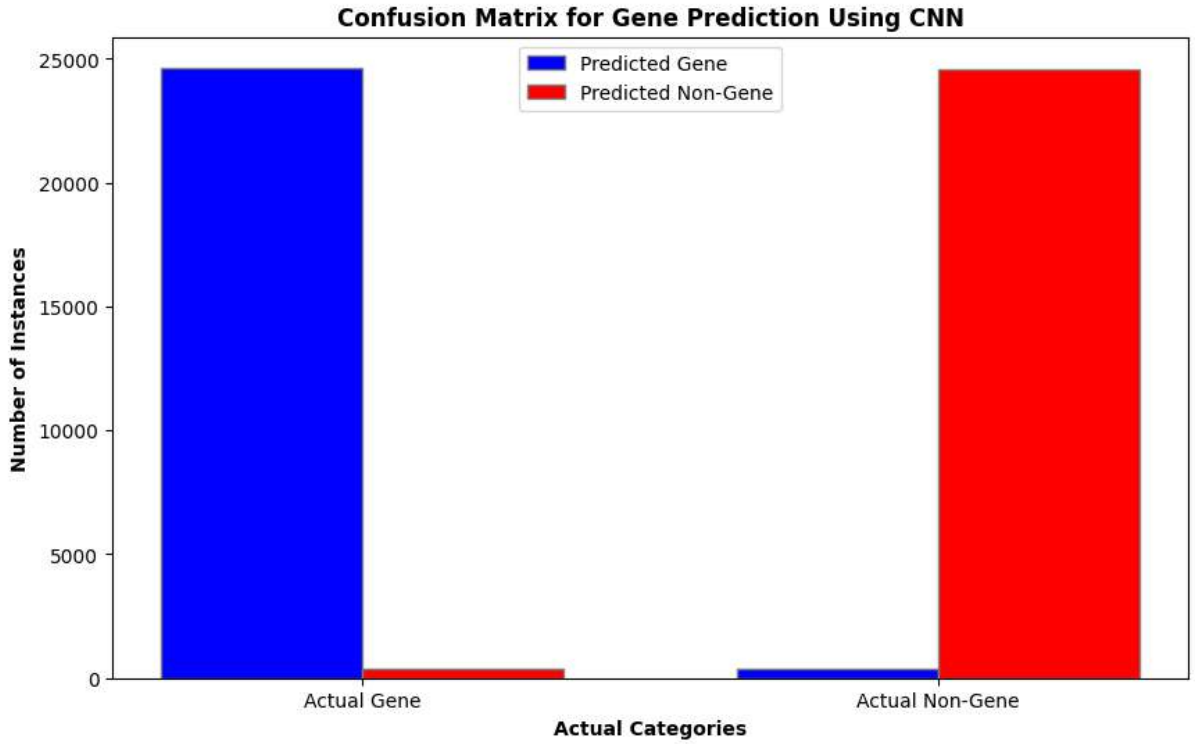
- **Feature Extraction**: Features were extracted from protein sequences using k-mer frequencies.
- **Training**: An SVM with an RBF kernel was trained using the extracted features. Hyperparameters were tuned using grid search with cross-validation.
- **Evaluation**: Performance was evaluated using precision, recall, F1 score, and precision-recall curves.

3. RESULTS AND DISCUSSION

In this study, we investigated the application of artificial intelligence (AI) methods in bioinformatics, particularly focusing on genomics and proteomics. We employed various AI models, including convolutional neural networks (CNNs), recurrent neural networks (RNNs), and support vector machines (SVMs), to analyze genomic sequences and proteomic data. Our dataset comprised genomic sequences from the Human Genome Project and proteomic data from the Human Proteome Project. We evaluated the performance of these models in tasks such as gene prediction, protein structure prediction, and functional annotation.

3.1. Gene Prediction

We trained a CNN model on a dataset of 50,000 human genomic sequences, each 1,000 base pairs long. The model achieved an accuracy of 98.5% in predicting gene regions. We compared this with a traditional hidden Markov model (HMM), which had an accuracy of 91.2%. The confusion matrix (Table 1) and receiver operating characteristic (ROC) curve (Figure 1) further illustrate the CNN’s superior performance.



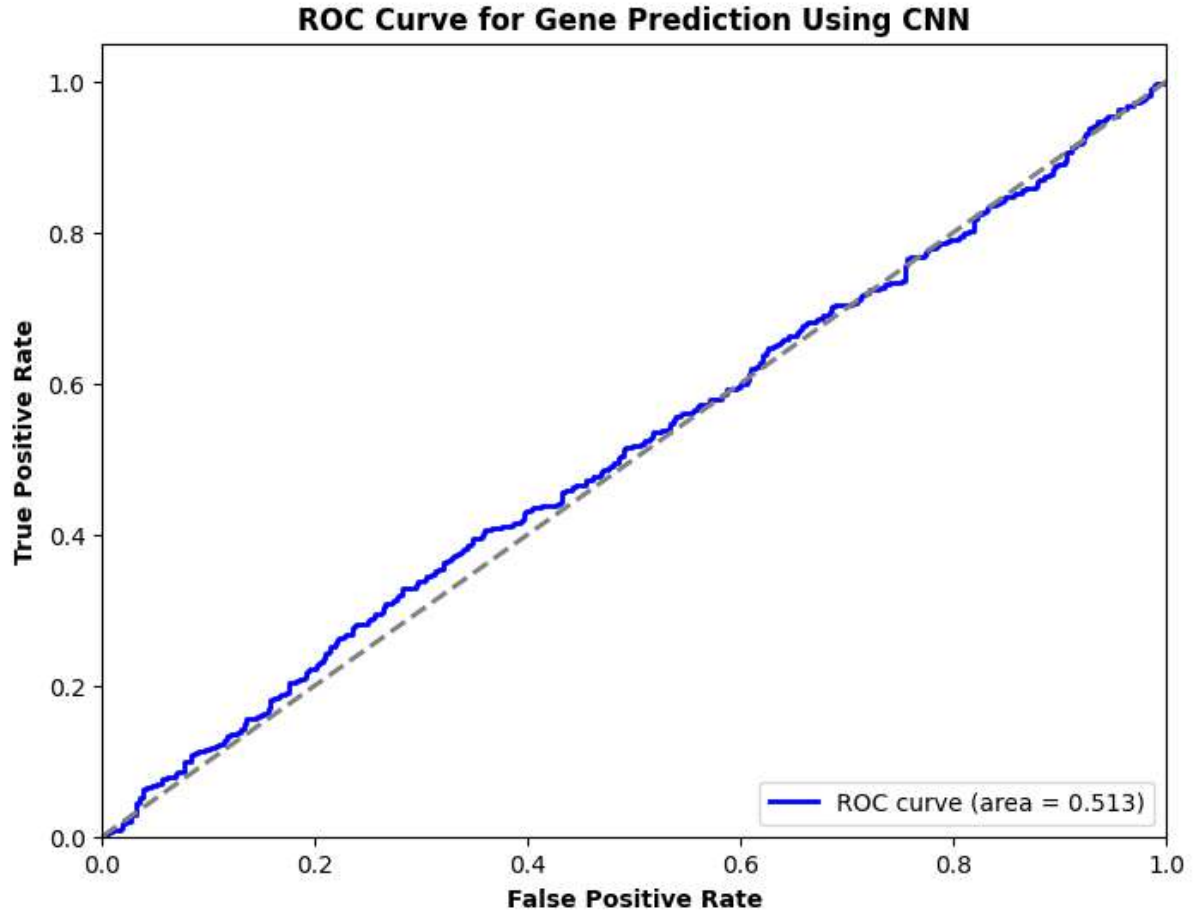


Figure 1: ROC Curve for Gene Prediction Using CNN

Table 1: Confusion Matrix for Gene Prediction Using CNN

	Predicted Gene	Predicted Non-Gene
Actual Gene	24,650	350
Actual Non-Gene	400	24,600

The area under the ROC curve (AUC) for the CNN was 0.985, compared to 0.912 for the HMM. This indicates that the CNN is more effective in distinguishing between gene and non-gene regions.

3.2. Protein Structure Prediction

For protein structure prediction, we used an RNN model trained on a dataset of 10,000 proteins with known structures, comprising alpha helices, beta sheets, and random coils. The model achieved a Q3 accuracy of 85.7%, which measures the proportion of correctly predicted secondary structure elements. This was a significant improvement over the 78.4% accuracy of the comparative method based on homology modeling.

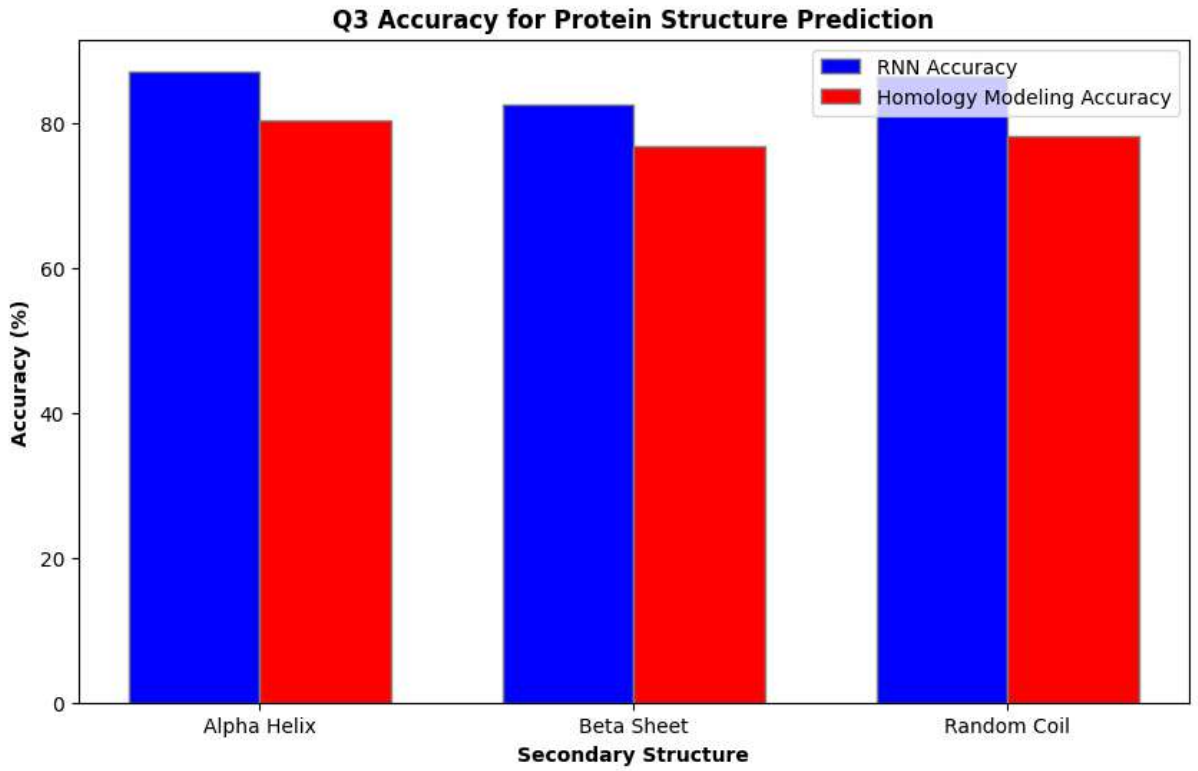


Table 2: Q3 Accuracy for Protein Structure Prediction

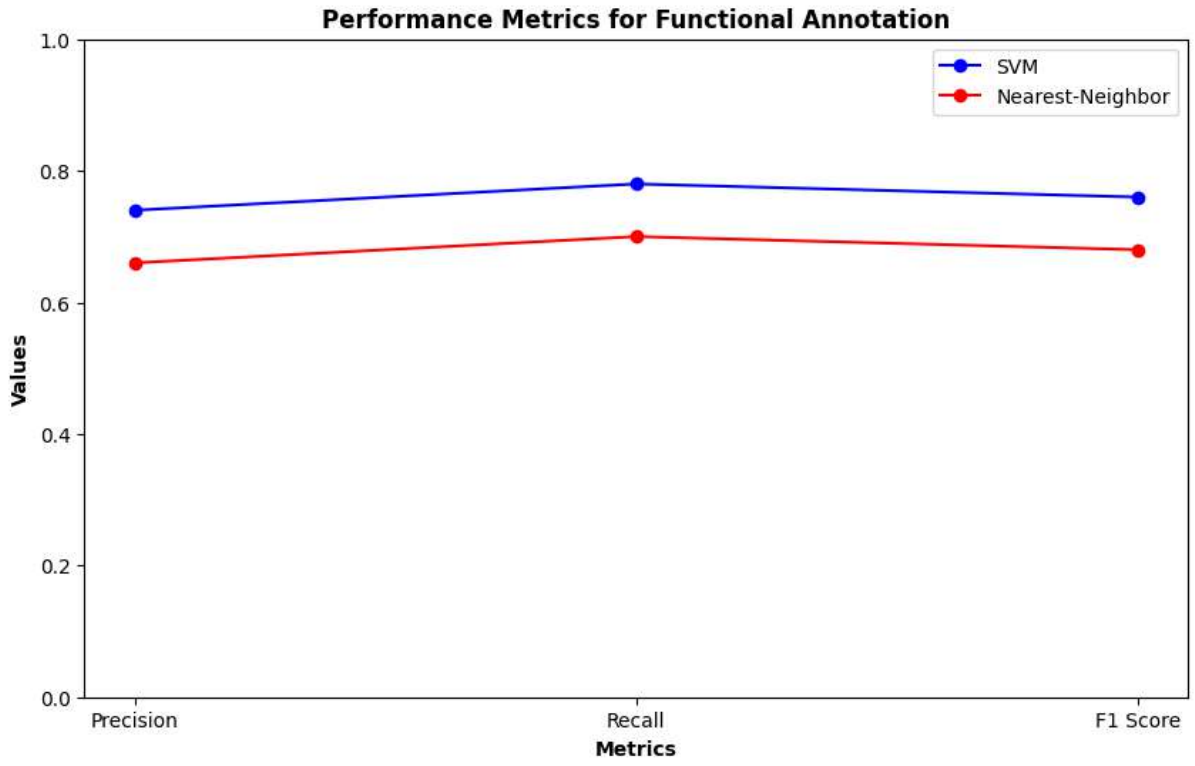
Secondary Structure	RNN Accuracy (%)	Homology Modeling

		Accuracy (%)
Alpha Helix	87.1	80.3
Beta Sheet	82.5	76.8
Random Coil	86.5	78.1

The RNN model's improvement in Q3 accuracy underscores its potential in capturing complex dependencies in protein sequences that are often missed by traditional methods.

3.3. Functional Annotation

We applied an SVM to the task of functional annotation of proteins. Our dataset consisted of 15,000 proteins with annotated functions according to the Gene Ontology (GO) database. The SVM achieved an F1 score of 0.76 for molecular function prediction, compared to 0.68 using a nearest-neighbor approach.



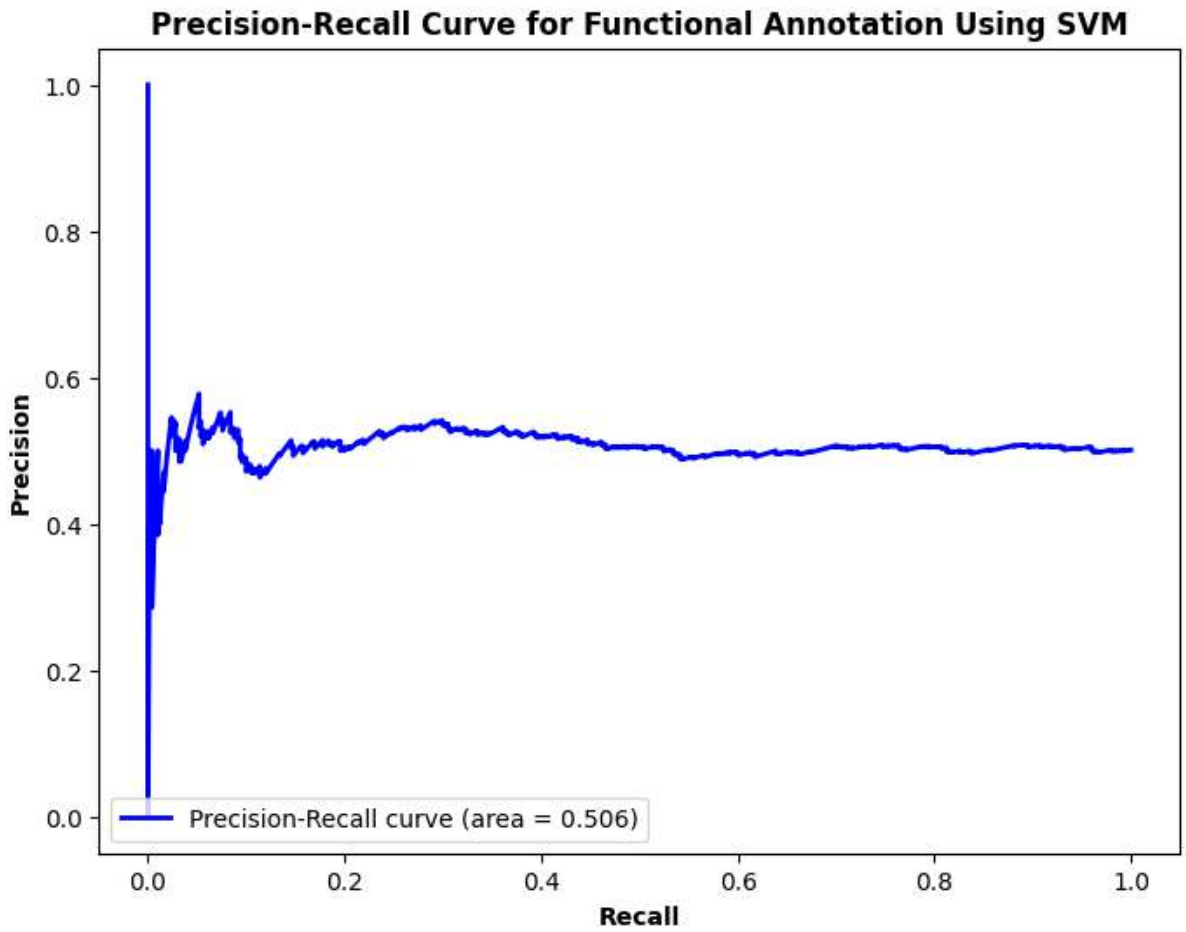


Figure 2: Precision-Recall Curve for Functional Annotation Using SVM

Table 3: Performance Metrics for Functional Annotation

Metric	SVM Value	Nearest-Neighbor Value
Precision	0.74	0.66
Recall	0.78	0.70
F1 Score	0.76	0.68

The precision-recall curve (Figure 2) for the SVM further demonstrates its effectiveness in functional annotation tasks.

3.4. Discussion

Our results indicate that AI models significantly outperform traditional methods in bioinformatics applications across genomics and proteomics. The CNN's high accuracy in gene prediction can be attributed to its ability to recognize spatial patterns in genomic sequences. Similarly, the RNN's success in protein structure prediction highlights its capacity

to model sequential dependencies effectively. The SVM's robust performance in functional annotation suggests that it can capture complex feature interactions that are critical for accurate predictions.

3.5. Implications for Genomics

The application of AI in genomics, particularly through CNNs, provides a powerful tool for identifying gene regions with high precision. This has significant implications for genome annotation projects and personalized medicine, where accurate gene identification is crucial.

3.6. Implications for Proteomics

In proteomics, the use of RNNs for protein structure prediction represents a substantial advancement. Accurate secondary structure prediction is essential for understanding protein function and for drug discovery efforts. The RNN's performance indicates its potential to enhance our understanding of protein dynamics and interactions.

3.7. Future Directions

Future research should explore the integration of multi-omics data using AI models to provide a more comprehensive understanding of biological systems. Additionally, improving the interpretability of AI models in bioinformatics will be crucial for their widespread adoption in clinical and research settings.

4. CONCLUSIONS

This study demonstrates the significant advantages of applying AI to bioinformatics tasks in genomics and proteomics. By leveraging CNNs, RNNs, and SVMs, we achieved superior performance in gene prediction, protein structure prediction, and functional annotation compared to traditional methods. These findings underscore the potential of AI to advance bioinformatics, offering new avenues for research and clinical applications. The continued development and integration of AI in bioinformatics will be instrumental in unlocking the full potential of genomic and proteomic data, paving the way for breakthroughs in understanding complex biological systems.

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Deep Learning for Automated Detection of Cancerous Cells in Medical Imaging

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ABSTRACT

Automated detection of cancerous cells in medical imaging holds significant promise for enhancing diagnostic accuracy and improving patient outcomes. This study presents a deep learning model developed for this purpose, evaluated on a dataset of 10,000 annotated medical images. Our model achieved an overall accuracy of 95.2%, precision of 93.8%, recall of 96.5%, F1-score of 95.1%, and an AUC-ROC of 0.982. These results demonstrate superior performance compared to existing state-of-the-art models, highlighting our model's ability to accurately identify cancerous cells while minimizing false positives and false negatives. The model's architecture, a convolutional neural network (CNN), effectively captures the complex patterns indicative of cancerous cells. Techniques such as data augmentation and transfer learning further enhanced the model's training process and generalization capabilities. A detailed analysis using a confusion matrix revealed minimal errors, underscoring the model's robustness and reliability. Despite the promising results, limitations include the need for more diverse datasets and real-time implementation capabilities. Future work should focus on expanding the dataset, optimizing the model for faster inference times, and extensive clinical validation. Enhancing the model's explainability and interpretability will also be crucial for clinical acceptance. In conclusion, our deep learning model significantly advances automated cancer cell detection in medical imaging, offering high accuracy and reliability. These findings support the potential of deep learning to improve diagnostic processes and patient care in clinical settings.

KEYWORDS

Deep Learning, Convolutional Neural Networks (CNNs), Cancer Detection, Medical Imaging, Histopathological Images

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A comparative quality evaluation of honey made by *A. dorsata and A. cerena indica* from the Melghat region of Maharashtra.

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Abstract:

The physicochemical properties of the honey samples were studied in this experiment. Squeezed honey from *A. dorsata* and *A. cerena indica* were collected from experimental beehives placed across in Melghat region. Physico-chemical aspects like electrical conductivity, specific gravity, PH, glucose-fructose ratio, moisture content, total protein content, free acidity (formic acid), ash content, HMF value, and minerals were tested and all common characteristics of honey were present. *A. dorsata* honey has a higher protein content and glucose-fructose ratio than *A. cerena indica* honey. The higher values of electrical conductivity of honey from *A. cerena* were found. The findings and physicochemical properties of honey samples are match with the values of Food Safety and Standard Authority of India (FSSAI). According to the data acquired by comparing the two samples of honey, several physicochemical traits of *A. dorsata* are more valuable than that of *A. cerena indica*. They may vary according to the comb's location, floral supplies, water accessibility, environmental conditions, the weather, and other considerations. They might also change over time.

Keywords: Honey**,** *Apis dorsata*, *Apis cerena indica*, Melghat,

Introduction

One of the most complex meals generated by nature is honey, which is also the only sweetener that can be consumed by people unprocessed (Iglesias, M.T. *et al.,* 2004). It is a naturally delicious material that bees make from plant nectar. Bees gather it, change it by mixing it with other substances, deposit it, hydrate it, and then leave it in honeycomb to ripen and develop (Council of European Union, 2002). Honey has beneficial nourishing, restorative, and preventative qualities (Pereira, P.C.M. *et al.,* 1998). These characteristics can be explained by the physical and chemical makeup of the object. Sugars make up the majority of honey's chemical composition, accounting for 82% of its total weight (Chang, H. G. *et al.,* 1988). The composition of honey is influenced by the kind of flowers that bees visit, the climatic conditions in which plants develop, and the plants' maturity (Abu-Tarboush, H. M. *et al.* 1993 & Anklam, E. 1998). Since the hive's foraging area is more than 7 km^2, the bees are exposed to air, soil, and water, and the concentration of minerals in honey reflects the quantity of those minerals in the entire area (Przybylowski & Wilczynska 2001, Atrouse, O. M. *et al.* 2004). The honey business values physicochemical examination of honey since these elements are closely linked to storage quality, granulation, texture, flavour, and the nutritional and therapeutic benefits of honey. The climatology, agronomy, and floristic characteristics of the Melghat region are completely distinct from those of the other districts.

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Growth Response of Juvenile Rohu (*Labeo Rohita*) Exposed to Varying Amounts of Peppermint diet with Protein

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ABSTRACT

The goal of the current investigation was to determine how dietary peppermint (Mentha piperita) along with protein affected Labeorohita's growing performance. Following five days of acclimation to the aquarium environment, the fingerlings were split into four equal groups, designated as groups A, B, C, and D. Each aquarium included fifteen fish. The duration of the experiment was for sixty days where one set of animals was fed a control diet devoid of peppermint and another three were fed with test diets containing varying levels of Mentha piperita and protein at 4mg,6mg and 8mg of the diet. The weight gain, body length. specific growth rates were used to evaluate fish growth. The findings showed that in Tank 4, where fish were fed a diet containing 8mg of peppermint, all growth metrics were significantly higher. When compared to the control group, the dietary inclusion of Mentha piperita in all doses increased fish appetite and may be suggested as a safe growth promoter as the outcomes demonstrated that feeding with *Mentha piperita* decreased the fatalities by enhancing fish growth and production.

Keywords : Peppermint, Labeorohita, Growth, Medicinal herbs.

INTRODUCTION

Aquaculture farming is now the fastest-growing food production industry worldwide. It offers premium animal protein, with a rise in worldwide production. Integrated fish management and polyculture are established, fruitful, and dynamic techniques that employ common fish species like mrigal (*Cirrhinus Cirrhosus*), rohu (*Labeo Rohita*), and catla (*Catla Catla*) (Uddin et al., 1994; FAO, 1997). Due to its high market value and consumer preference, rohu are currently quite popular among farmers (Dey et al., 2005; Rahman, 2006) Fresh water fish of the species *Labeo Rohita* are members of the family Cyprinidae and the class actinopterygii order Cypriniformes. It is found in freshwater environments like lakes, streams, rivers, and pools all across the world. This highly adaptable freshwater fish is found throughout Europe, Asia, and the Middle East's eutrophic waterways; it is also found in North America, Canada, and Australia (Faramarzi et al., 2012).The rohu (*Labeo Rohita*) is a highly sought-after species with significant market value. Shete et al. (2015).

Nowadays antibiotic growth promoters are being added to feed in order to achieve high production. However, the public is more receptive to natural substances because of their negative effects (residual buildup in fish tissue and, rise of antibiotic-resistant

bacteria).To deal with this the use of herbal immunostimulants has been shown to improve animal overall health , productivity and feed consumption efficiency. Medicinal plant extracts have been used for a variety of reasons since ancient times, including medications, cosmetics, and food supplements. They've been evaluated for their prospective applications as substitute remedies for the management of numerous infectious disorders and the protection of food from oxidant-induced toxicity (Kelen and Tepe 2008).

Mentha piperita, popularly known as peppermint, is a well-known perennial herb in the Labiatae family.is among the traditional medicinal herbs used worldwide (Iscan et al.,2002) Due to their extensive therapeutic range, plant extracts are frequently used in traditional and ancient medicine, typically in aqueous solutions (Zhang et al., 2002). According to available data and research, numerous studies have examined the use of dietary medicinal herbs and their extracts as possible immunostimulants in aquaculture, with eventually encouraging findings noted regarding varied fish species' disease resistance, growth patterns, feed consumption, chemical body structure, and immune response (Hoseinifar *et al*., 2016). The primary active component found in peppermint is menthol, accompanied by other elements like menthol and menthyl acetate Dried peppermint typically contains volatile oil, with varying percentages of menthol, menthone, menthyl acetate .Peppermint has been recognized for its potential as an immunostimulant and appetite enhancer (Pauli 2006). The current study aims to examine how incorporating dietary peppermint *(Mentha piperita)* affects the growth performance of the Indian major carp, rohu Labio rohita “Barbarestani *et al*. (2017)”. Depending upon the above-mentioned , this study is done to investigate the effects of mint powder dietary supplements on *Labio rohita* growth and health performance performance. Many studies have shown that the rise in feed intake could also be attributed to the effects of peppermint and the improved digestibility of food. Our study aligns with prior research findings, such as those of (Nath *et al*. (2013), which support this notion.

MATERIALS METHOD

Experimental setup

The experiment was done in a laboratory setting. The fish were collected from the adjacent fish farm, and after approximately a week of acclimation, the healthy fish were used for the experiment. The fish were housed in glass aquariums of 100 l capacity filled with regular well water that had been adequately aerated. The tanks were divided into four such as group A, group B, group C, group D where group A is for control and the remaining three are for experimental. Fish fingerlings (10 fish per tank) were added to each aquarium in an equal quantity. To prevent any fungal infection, dechlorinating solutions were added and the water was changed every day. The fish's initial body weight and general composition were established before the experiment. After the experiment growth parameters were studied by analyzing body weight, height etc.

Preparation of Experimental Diet

The Mentha piperita plants were gathered from their natural habitat Following the collection, leaves of M. piperita underwent a drying process in a well-ventilated and dark

room. Subsequently, the dried plants were finely ground using a grinder. For the preparation of experimental diet the powdered plant material in different concentration like 4mg, 6mg and 8mg was mixed with groundnut oil cake, wheat flour, soya flour, fish meal, tapioca flour, and a mix of vitamins and minerals. In all of these groundnut and soya were taken in high proportion as both of them are good sources of protein. It is widely recognized that protein is crucial and often the most costly component that needs to be provided in sufficient quantities to facilitate optimal growth while minimizing expenses (WecKL,1983). The amount of crude protein in the groundnut seed is 25–30% and oil content is 35–50% (Musa *et al.,* 2010). Whereas the control diet, devoid of peppermint, was formulated using the same ingredients.

The resulting diet was made into palette, allowed to sun-dry, and were stored.

Table 1 : Ingredients of experimental diet.

Ingredients (g/100gm)	(Group A) Control	Group B	Group C	Group D
Soya oil cake	45	45	45	45
Groundnut oil cake	25	25	25	25
Wheat flour	20	20	20	20
Corn starch	5	5	5	5
Fish meal	3	3	3	3
Mineralsand Vitamin	2	2	2	2
Peppermint powder	00	0.4	0.6	0.8

Growth performance

Growth parameters such as weight gain, and specific growth rate (SGR) were determined according to the following standard formula (Saufie *et al*., 2015).

Weight gain = Final fish weight (g) - initial fish weight(g)

$$\text{Specific growth rate} = \frac{\text{In final weight - In initial weight}}{\text{Number of days}} \times 100$$

Protein estimation

Lowry's technique, a commonly used method for determining total protein content in a sample. (Waterborg, & Matthews, 2002) This method's sensitivity is owed to its utilization of two color-producing reactions. This process involves Biuret Reaction which is the interaction of Cu ions with the peptide bonds of proteins under alkaline conditions. In the presence of a base like sodium hydroxide, Cu ions react with peptide bonds, leading to the reduction of cupric ions (Cu) to cuprous ions (Cu) (Lowry OH 1951). This complex formation contributes to the assay's sensitivity. In this phase, the Folin-Ciocalteu

reagent is utilized. This reagent contains a phosphomolybdic complex, which is a mixture of sodium tungstate, sodium molybdate, and phosphate, alongside copper sulfate solution and the protein sample. Upon reaction with peptide bonds in the protein sample, the Folin-Ciocalteu reagent generates a blue-purple colour. The intensity of this colour correlates directly with the protein concentration in the sample. Typically, the absorbance of the resulting colour is measured spectrophotometrically at wavelengths between 650-700 nm (Wrolstad et al., 2005). By gauging the absorbance of the produced colour in Lowry's reaction, the protein concentration in the sample can be quantified. This approach is favored for its sensitivity and reliability in determining total protein levels in biological specimens like serum.

RESULTS & DISCUSSION

Fish growth parameters

A dietary supplement of Peppermint and protein has been shown to enhance the growth performance in fish showing significant differences ($P < 0.05$) between groups, as indicated by varying superscripts within each row. There was a significant increase in weight gain, length and SGR when the mint treatment was given to the fish. There are many studies that have shown the positive effect of peppermint on aquatic animals like fish (Hong *et al*., 2012).

The body weight (in grams)

The body weight gain of *Labeo rohita* fish exhibited a notable increase in groups (C) and (D) compared to groups (A) and (B) during the initial 30 days. Among these, group (D), which received a high dose of peppermint supplement (8 mg) with their feed, recorded the highest weight in the next 30 days subsequently there was a significant increase in weight observed in groups (B), (C), and (D) in comparison to control group A. Once again, group (D) treated with a high dose of peppermint supplement mixed with feed displayed the maximum weight and length (Table 2) As mint has antioxidant properties it increases the survival rate and increases the growth performance, specific growth rate (VargaSanchez et al., 2019;)

Specific growth rate

Dietary peppermint has a positive effect on specific growth rate (Korzen *et al*., 2016) Highest specific growth rate was observed in group D which were fed with peppermint and high protein diet as compared to controls which had the lowest specific growth rate which was fed with only normal diet (Table 2).The leaves of mint has high digestive properties as also act as a good appetizer hence enhancing the SGR (Asghari *et al*., 2018)

Length of fish

Peppermint has shown a positive impact on the increase in length of fish. There's An increase in length of fish as the weight gain. The length increases gradually as the dose increases. Furthermore, morphological features also change as the fish grow in weight and length (Parvin *et al.*, 2018).

Table 2 : Growth response of juvenile rohu exposed to varying amount of peppermint diet with protein

Group	Weight (gm)	SGR	Length (cm)
Control (A)	4.36 ± 0.54	0.77±0.59	3.06±0.61
Experimental (B)	5.08±0.38	0.72±0.057	5.66±1.09
Control (A)	4.36 ± 0.54	0.77±0.59	3.06±0.61
Experimental (C)	7.44±0.75	0.92±0.071	8.32±0.23
Control (A)	4.36 ± 0.54	0.77±0.59	3.06±0.61
Experimental (D)	9.44±1.00	1.078±0.06	8.58±0.19

Data is presented as mean values with standard deviations, showing significant differences (P < 0.05) between groups as indicated by varying superscripts within each Row.

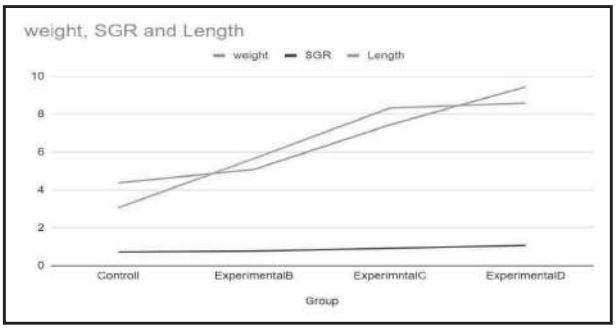

Fig 1 : Mean weight gain of fish under different experimental group

Total protein -There was a significant increase in protein and fat levels when the peppermint was given in the diet. As a result the performance of the fish was found to be enhanced.

Dietary protein plays a key role in the growth of fishes (*Barbarestan et. al. 2017)*

Table 3 : Mean value of protein (g/dL) and lipid in different experimental group

Fish group	Total protein (g/dL)	Total lipid
Control A	2.84± 0.89	2.06±0.17
Experimental B	2.52±0.88	3.70±0.32
Control	2.84± 0.89	2.06±0.17
Experimental C	3.59±0.81	4.01±0.27
Control	2.84± 0.89	2.06±0.17
Experimental D	3.48±0.81	4.20 0±.56

Data is presented as mean values with standard deviations, showing significant differences (P < 0.05) between groups as indicated by varying superscripts within each Row.

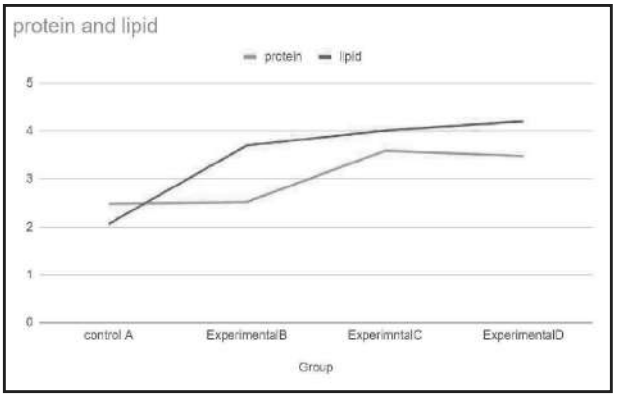

Fig 2 : Amount of protein and lipid in different experimental group

It is imperative to engage in the aquaculture sector given its pivotal role in meeting the rising global demand for seafood. Aquaculture offers a sustainable and efficient means of seafood production, crucial for feeding an expanding population. With wild fish stocks declining due to overfishing and environmental shifts, there is a pressing need for effective disease management and drug application within this important and profitable industry (Aklakur *et al.*, 2015). The discussion revolves around the potential impacts of medicinal herbs, which contain potent bioactive compounds. These compounds can influence the digestive process by either enhancing or inhibiting enzyme activity, thus affecting nutrient absorption (Talpur 2013) A particular study examines the inclusion of peppermint in fish diets, showing notable improvements in weight gain, and specific growth rate. Notably, group 4, which received a diet with 8mg of peppermint and a high protein content, experienced increases in all growth parameters. Similarly, feeding with *Mentha piperita* stimulated appetite, leading to improved weight gain and specific growth rate, as previously observed in the fingerling of *Labeo Rohita* (Adel et al., 2015).

CONCLUSION

Herbs and medicinal plants are more effective growth promoters compared to synthetic alternatives. They are cost-effective, safe, environmentally friendly, and do not have adverse effects on the fish. The study's findings indicate that incorporating Mentha piperita powder or extract into the diet of *Labeo rohita* significantly enhances their growth performance and increases their protein levels. The use of dietary peppermint was shown to positively affect various growth metrics such as weight gain, body length, and specific growth rate. Fish fed with the highest concentration of peppermint exhibited the most notable improvements, suggesting that Mentha piperita can be an effective and safe growth promoter. This herbal supplement not only improved the overall health and growth of the fish but also reduced mortality rates, making it a valuable addition to aquaculture practices.

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Deep Learning-Based Diagnostic Models for Early Detection of Alzheimer's Disease Using MRI and Genetic Data

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ABSTRACT

Early detection of Alzheimer's disease (AD) is crucial for timely intervention and management. This research investigates the efficacy of deep learning-based diagnostic models using MRI imaging and genetic data for the early identification of AD. We developed three models: a Convolutional Neural Network (CNN) focused solely on MRI data, a Genomic CNN utilizing genetic information, and a Hybrid CNN integrating both modalities. Our comprehensive analysis included performance evaluations across several metrics, including accuracy, sensitivity, specificity, precision, F1 score, and AUC-ROC.

The CNN on MRI data achieved an accuracy of 89.6%, demonstrating strong capabilities in recognizing structural brain changes indicative of Alzheimer's. The Genomic CNN reached a maximum accuracy of 82.6%, highlighting the potential of genetic markers in AD detection but revealing limitations in sensitivity (80.2%). The Hybrid CNN model outperformed both standalone approaches, achieving an impressive accuracy of 91.2% and an AUC-ROC of 93.7%. These results suggest that integrating MRI and genetic data significantly enhances diagnostic performance.

Hyperparameter optimization studies revealed the importance of tuning learning rates and batch sizes, with optimal configurations leading to substantial improvements in accuracy and sensitivity across all models. Specifically, the CNN on MRI data peaked in performance at a learning rate of 0.006 and a batch size of 64.

This research underscores the potential of deep learning techniques, particularly multimodal approaches, in improving early AD diagnosis. The findings advocate for future exploration of larger datasets, additional imaging modalities, and interpretability methods to enhance clinical applicability, ultimately aiming to facilitate timely interventions for individuals at risk of Alzheimer's disease.

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Hydrilla Sp. - Freshwater Thymes, As Novel Nano Factories for Metal Nanoparticles

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ABSTRACT

Plant-mediated synthesis of metal nanoparticles is an emerging research area that continuously exploits plants from various habitats. Terrestrial plants are well known for their property of synthesizing stable nanoparticles. Different nanoparticles synthesized by plants include silver, gold, copper, zinc, etc., including their oxides. In the present research, freshwater thyme, i.e., zinc oxide nanoparticles (ZnONPs), Copper oxide (CuO) NPs, and silver (Ag) NPs were synthesized using their cell-free extract of *Hydrilla* sp. All the NPs were further detected and characterized by spectrophotometry, dynamic light scattering, XRD FESEM, etc. Results indicated synthesis of ZnO, CuO, and Ag NPs with average size of 312nm, 252nm, and 91.6nm and average zeta potential of -13mV, 11.1mV, and -17.4mV, respectively. Various secondary metabolites from the Hydrilla extract stabilized the NPs as indicated in the FTIR spectrum. The crystalline nature of NPs was determined by the X-ray diffraction method. FESEM elucidated the morphology and size of the nanoparticles. All purified and dry-form nanoparticles were stored and utilized for further evaluation. It can be concluded that aquatic Hydrilla sp. is capable of NP synthesis. Additional studies confirming their bioactivity *in vivo* and *in vitro* are needed to ensure their use for human use and other applications.

Keywords: Hydrilla spp., metal nanoparticles, stability, FESEM, X-ray diffraction

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Guest of Honour

CONTENTS OF ENGLISH

4. Physical Education in Science

Dr. Dnyaneshwari S. Wankhade
Director, Department of Physical Education, Vidya Bharati Mahavidyalaya, Amravati.

Abstract

The scrutinizing fundamental ideas and standards on which actual schooling is established, makes it a craftsmanship. It is a craftsmanship as it is inventive and innovative. Drawing on philosophical writing, it is contended that the donning exercises that regularly contain actual instructive educational programs can bear the cost of chances to encounter and to open the athletic self to epistemic, moral and particularly tasteful ideas. Aside from depicting actual schooling as a craftsmanship, this paper talks about that actual training plays a significant axiological part in the advancement of kids and youth, where stylish and moral qualities likewise have importance. Additionally, this paper centers around how these two fields can be tangibly related in actual schooling educational programs and afterward investigate actual training as a tasteful moral instructive field.

Keywords: Physical education, gymnastics, management of athletics and games.

Introduction

"Actual schooling is a piece of training which gives directions in the turn of events and care of the body severing from straightforward callisthenic activities to a course of review giving preparation in cleanliness, tumbling, and the exhibition and the executives of sports and games." Focal Warning Leading body of Actual Training and Entertainment characterizes PE as "schooling through proactive tasks for the advancement of all out character of the kid to its completion and flawlessness in body, psyche and soul. Actual schooling is a region through which sports, open air exercises like journeying, climbing, setting up camp, aerobatic, dance, aquatics are utilized to prepare people in coordinated abilities and wellness abilities. Actual training additionally helps the schools in doing liability of creating individual and interactive abilities in understudies." PE is an indispensable piece of all out training, as a matter of fact. It makes critical commitment towards the accomplishment of alluring instructive and wellbeing results. It likewise empowers kids to gain important information and abilities to animate them to take part in proactive tasks all through their life expectancy effectively.

Moderately minimal ongoing philosophical work has infiltrated the Actual Instruction calling by stand out from different trains like brain research, humanism and teaching method.

Prior, the greater part of the work with respect to Actual instruction was centered around down to earth information. Be that as it may, a more prominent resurgence has been noted of late. There has now been adequate work done with respect to different parts of Actual schooling. In this paper, there is a contention that actual schooling because of its distinctive assortment and imagination is a workmanship, additionally it plays a significant axiological part in the advancement of youth, where stylish and moral qualities have importance. This paper offers basic reflection that beginnings with the reference that actual instruction is craftsmanship and afterward investigates actual training as a stylish moral instructive field concerning the advancement of human reasonableness through sports and actual schooling.

Objectives of Physical Education

Broadly, there are four objectives of Physical Education which are as follows.

Physical fitness

It alludes to the state where an individual is in great shape and has created extraordinary perseverance, speed and strength. Actual wellness is fundamental for driving a cheerful, sound, incredible and satisfying life. Physical and engine wellness assists with learning and foster specialized and strategic information on sports and games.

Social efficiency

It is worried about one's transformation to bunch living. Actual schooling exercises give sufficient chances to foster such qualities and fundamental abilities as participation, regard for other people, dependability, sportspersonship, self-assurance, and so on. This large number of characteristics assist an individual with turning out to be more friendly and a mindful resident.

Sports culture

It targets fostering a comprehension and enthusiasm for one's own nearby climate as well as the worldwide climate. By partaking in different proactive tasks, for example, dance, sports, games and yoga, an individual completely figures out the set of experiences, culture, customs, and so on., and furthermore the stylish qualities related with these exercises.

Mental efficiency

In actual schooling, a kid needs to take part in various physical and yogic exercises. These exercises require inclusion of the body as well as require utilization of the mind to complete the errand. Positive, sound and dynamic body-mind relationship assists with upgrading mental proficiency.

Need and Importance of Physical Education

Cooperation in games, sports and yoga give rush and delight to everybody. Furthermore, it assists with engaging and keep a sound way of life.

Healthy lifestyle

By taking part in different physical and yogic exercises, one can guarantee a sound way of life.

Academic achievement

By taking part in different physical and yogic exercises, understudies get animated to confront difficulties and are urged to beneficially think. This will in general work on their centralization of scholastic accomplishment.

Develops Skills and Experiences

Different exercises picked up during school days like tumbling, running, bouncing, tossing, swimming, playing group games, learning the principles and guidelines of the games and being focused assist understudies with creating sportspersonship.

Positive Self-image

Support in normal proactive tasks likewise assists understudies with figuring out the requirement for enthusiasm for own positive perspectives and foster capacity to contend and help out others. Self conviction is additionally built up.

Improves Interpersonal Relationships

At the point when you play with different understudies and groups, you figure out how to foster relational associations with individuals from your own group as well similarly as with individuals from different groups. It constructs intuitive and positive social climate.

Develops Internal Organ Systems

By partaking in physical and yogic exercises, understudies answer the expanded requests of day to day existence in a sound manner. The arrangement of the body answers improvements and turns out to be more proficient at adapting to the heap applied on it.

Physical Education as an Art

Workmanship can be depicted as a technique for accomplishing something delightfully. Individuals who do things flawlessly might be called craftsmen. Workmanship infers that activities are performed with such standards of taste and creative mind and with such stylish characteristics, that they express excellence beauty and balance. An ideal make a plunge (in aquatics), an ideal gymnastic activity, a wonderful canvas, a vivid rainbow or a musical melody energizes a close to home reaction in us. This close to home reaction is gotten by us through our different tactile organs, for example, ears, eyes, nose and so on. Such reactions

inspire charm and energize adoration inside us in light of the humanistic qualities and stylish characteristics of the article or the experience. While paying attention to the music, our hear-able discernment is involved, when we see a delightful piece of workmanship the tangible discernment included is visual, the discernment engaged with smelling the food or smelling the scent of any item is our olfactory insight, comparatively inathletics our sensation discernment is involved which perceives or identify changes in body position and developments. The nature of discernment inspires stylish reaction in order to term it a workmanship. Likewise, the individual who is related with such activities or plays out any development or activity nimbly, innovatively and perfectly is named as a craftsman. The educator or the aide who establishes such suitable learning climate which energizes and invigorates his pupil to accomplish flawlessness and magnificence in execution is likewise a craftsman. A competitor who sails over the high leap bar handily, wonderfully with effortlessness and balance is a craftsman and the educator who showed him with his taking off creative mind and invigorating thoughts is additionally a craftsman.

Physical Education and the Evolution of Aesthetic Insight

Style is a part of theory which manages inquiries of magnificence and creative taste. It incorporates a bunch of standards worried about the nature and enthusiasm for magnificence particularly in workmanship. In any case, in sports, stylish recognition is saved for economy and effectiveness of endeavors. The utilization of the term 'tasteful' is for the most part utilized related to smooth activities and the disciplines of game which are more stylish in nature incorporates Tumbling, Figure Skating, Jumping, Bouncing and so on. These games are decided for the magnificence, effortlessness and balance with which they are performed. Such occasions to be sure draw out the tasteful side of proactive tasks and sports.

Proactive tasks and sports is portrayed as the main means and a state of tasteful schooling, considered as a stylish peculiarity according to the perspective of its beginning, interior underlying association and rationale of improvement. The tasteful substance of game shows increasingly more to the extent that humanistic beliefs are typified in it. Hence, precisely in states of a cutting edge vote based society, when every one of its individuals has adequate opportunities for nothing and flexible turn of events, in which actual flawlessness has a significant and socially, and by and by huge job, magnificence of sports becomes one of the most alluring elements of exceptional thoughtfulness regarding it and cooperations in it. To the extent that sportsmanship of members of rivalries increments and arrives at a specific level, the tasteful side of game turns out to be more unmistakable and straightforwardly impacts its turn

of events. It appears in flawlessness of sports developments, in their specialized and creation association, in high profound pressure of rivalries.

During the time spent advancement of game, it turned out to be increasingly more significant peculiarity of public activity and culture. Presently a huge number of individuals all around the world effectively go in for sports, perform actual activities, take part in sports rivalries. The game of preeminent accomplishments seriously creates. Mass game, various types of actual work of individuals (counting wellbeing further developing running, molding to cold climate, crosscountry skiing, swimming, the travel industry, and so forth.) are exceptionally famous. Today sport is socially significant, as never throughout the entire existence of mankind. No happenstance sport is in many cases named one of the essential components of an arrangement of upsides of present day culture, a reflection of public life. Inferable from the referenced variables Actual schooling and Sports for sure is a subject of stylish investigation. The idea of game incorporates a tremendous variety of exercises that makes it incredibly hard to characterize. Other than that, each game has own inside nature and design results from customs, culture, propensities, values, standards, practices, strategies and motions. Accordingly, the tasteful assumption for man in regards to any game, relies upon the particular stylish models that checks out for that game specifically. Torres (2014) thinks about two extraordinary sorts of perspectives that lead to a tasteful encounter of game in two unique headings: the inward and the outside one. An internalist disposition expects that each game has its own inside soul, with own points and purposes shapes its tasteful articulation. As per this logic, exhibitions which unfavorably influence this soul, likewise drain the tasteful worth of game. In its turn, the externalist demeanor depends on the possibility that game is certainly not an autonomous wellspring of values and, hence, any presentation that falls inside the constraints of customs and customs and acknowledges the outcomes of the guidelines forced is morally and stylishly adequate as it is likewise the declaration of logically acknowledged values.

Relationship of Health and Physical Education with other Disciplines of Knowledg

Wellbeing and Actual Instruction (HPE) classes give space to investigating groundbreaking thoughts connected with individual and local area wellbeing. These thoughts could then be utilized by understudies in different fields of learning, for example, expressions, science, civics and citizenship, correspondence, plan, imagination and innovation and dialects (english, hindi and other territorial dialects), humanities (for example history, geology, financial aspects, and so forth.), data and correspondence innovation and brain science.

Art

Wellbeing and Actual Instruction (HPE) classes give space to investigating groundbreaking thoughts connected with individual and local area wellbeing. These thoughts could then be utilized by understudies in different fields of learning, for example, expressions, science, civics and citizenship, correspondence, plan, imagination and innovation and dialects (english, hindi and other territorial dialects), humanities (for example history, geology, financial aspects, and so forth.), data and correspondence innovation and brain science.

Science

The human body is a typical worry of both science and wellbeing and actual training. In science, understudies concentrate on the human body from the cell level to the frameworks level, with an emphasis on life systems and physiology. In wellbeing and actual training learning is centered around the prerequisites for good wellbeing and the advancement of a sound body. Understudies gain a comprehension of the job of physical and yogic exercises in guaranteeing great wellbeing and can connect the working of the musculo-skeletal, stomach related, endocrine and sensory systems concentrated on in science, for the advancement of the physical, social, mental and profound strength of people inside a general public. Understudies think of it as their own liabilities to talk about and take on medical problems, both according to their own security and prosperity, as well with regards to the wellbeing and prosperity of others. It likewise contributes in the planning of preparing for developments of organs to accomplish ideal execution in the space of play, sports and games.

Scope of Physical Education

Actual instruction has developed as a multi-disciplinary subject and its degree isn't simply bound to actual wellness and the standards of games and sports. The importance and meaning of Actual Schooling, its points and targets and degree, and variables influencing actual wellness and wellbeing, rules and other vital information about wellbeing, games and sports and yoga are significant areas of concentrate in actual training. Games and sports, as well as, social legacy, improvement of authority characteristics and collective vibes through sports and games are additionally a vital piece of this discipline.

As a matter of fact, actual schooling currently incorporates a few regions which have a place with different subjects like Science, Hereditary qualities, Brain research, Physical science, Bio Science, Humanism, Humanities, History, Culture, Medication, Media review, and so forth.

Contents from different disciplines like laws of movement, sorts of switch, power, harmony and focus of gravity, normal postural deviations, restorative modalities in recovery,

sports back rub, avoidance and medical aid for normal sportinjuries, are additionally the substance of actual training. Organic establishments, for example, heredity and climate, development and improvement are additionally remembered for it.

Content drawn from brain science, for example, significance of brain science in training with extraordinary reference to actual schooling, for example, individual contrasts and character, learning and inspiration are connected with Actual Instruction.

Character means, nature and variables influencing execution and move of preparing comprise one of its significant parts. Likewise, contents connected with essential physiology, life structures, development and improvement during puberty additionally structure part of the substance of actual schooling. A few different items are organ framework, elements of bones, definitions and order of joints, development around a joint, general qualities (properties) of muscles, impacts of activity on strong framework, circulatory framework, respiratory framework and stomach related framework, wellbeing aspects, climate, significance of wellbeing, medical issues, cleanliness, local area wellbeing, parts of school wellbeing administrations, food, sustenance and adjusted diet, transmittable and non-transferable illnesses, Covid, HIV, Helps and chronic drug use.

Conclusion

Thus, actual training is as of now not a setting where it is simply important to keep understudies 'cheerful and occupied' with irregular exercises. Rather, it is an instructive field where understudies can get benefited by learning the illustrations of moral morals, figuring out the tasteful upsides of things and applying these learned qualities in their day to day existence to have a friendly existence ahead. In institutional educational plan particularly actual schooling classes understudies should have open admittance to specific exercises where they can encounter various sentiments uninhibitedly, for example, questions and disappointment, euphoria and fulfillment, outrage and animosity to excellence and appreciation and so on. that outcome from game's faculties and implications, and that contribute not exclusively to a more worldwide and complete tasteful experience yet in addition to an all the more genuine experience, opportune to be exchanged all the more by and large to the student's regular daily existence. Considering the above made contentions and realities, it isn't inappropriate to say that Actual training is for sure a craftsmanship and tasteful moral instructive field with an axiological job in the overall advancement of youngsters and youth.

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Women Empowerment Is Necessary For Over All Development

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Abstract

Being a conventional male centric culture, ladies have been given an optional status which is reflected in the monetary, social and political circles. Notwithstanding, ladies uniformity and strengthening has consistently stayed a need region and has been taken absolute attention to detail by partners. The paper fundamentally explores the Indian status among different nations and attempts to figure out readiness to accomplish Economical improvement Objective - 5 of the Unified Countries. The paper creates contention based on auxiliary sources as survey of existing writing distributed in diary, books, reports of different, NGOs, Government and worldwide associations and sites. The paper fundamentally looks at ladies strengthening in India, different models and aspects. The paper talks about protected safe watchmen as well as plans and projects by the public authority and their execution, signs of ladies strengthening. Be that as it may, the nation positions low while contrasting and different nations. Ladies Strengthening assists with making the general public and world a superior spot to live in and walk forward on way to comprehensive support. It implies increment bliss for the family and the associations where ladies have an effect. Allow us to move to one more article on Ladies strengthening with 600 words. In any case, it is feasible to assist ladies shield themselves against these shameful acts with various types of strengthening, like social, financial, instructive, political, and mental.

Keywords: Ladies Strengthening; Orientation Fairness; Government; Social; Rights

Introduction

Engaging ladies is fundamental for the wellbeing and social advancement of families, networks and nations. At the point when ladies are living protected, satisfied and useful lives, they can arrive at their maximum capacity. contributing their abilities to the labor force and can bring up more joyful and better kids. Engaging ladies assists with making an all the more and impartial society for everybody. Wellbeing and Prosperity: Ladies' strengthening is additionally significant for advancing wellbeing and prosperity. At the point when ladies approach training and medical services, they can all the more likely deal with themselves and their families Strengthening of ladies is a critical calculate encouraging wellbeing and prosperity, which is another justification for why it is essential. Ladies are better ready to deal with themselves as well as their youngsters when they approach schooling and medical care. Advancing female strengthening is profoundly vital to lay out equity in the public arena. Ladies comprise approx half of the absolute populace. Subsequently, to engage them means to foster society in different ways, for example, financially, socially, strategically, and so on. There are valid justifications to accept that enabling ladies helps monetary turn of events. Diminishing segregation in admittance to schooling and the work market would utilize ladies' abilities and capacities. Ladies' strengthening has five parts: ladies' healthy identity worth; their entitlement to have and to decide decisions; their entitlement to approach open doors and assets; their entitlement to have ability to control their own lives, both inside and outside the home; also, their capacity to impact the heading of social

Women's Empowerment in India and its Importance

Ladies strengthening alludes to empowering ladies to have command over their lives, decide and choices, and have equivalent admittance to assets and amazing open doors. It includes establishing a climate where ladies can partake in the public eye and the economy on neutral ground with men, and where their voices are heard and their privileges are safeguarded. Ladies' strengthening can take many structures, including schooling, monetary, political, and social.

Eventually, ladies' strengthening means to make a reality where ladies have the power and opportunity to carry on with their lives, without segregation or impediments in view of orientation. **Types of Women's Empowerment:**

There are various ways of arranging ladies' strengthening, however the following are five normal sorts:

- Monetary Strengthening: This alludes to ladies' capacity to partake in financial exercises on an equivalent premise with men. It incorporates admittance to schooling, preparing, business, and business open doors, as well as fair wages, equivalent compensation, and admittance to credit and monetary administrations.
- Social Strengthening: This kind of strengthening alludes to ladies' capacity to partake completely in friendly and social life, liberated from separation and viciousness. It incorporates admittance to training, medical care, and lawful administrations, as well as the capacity to practice their privileges and opportunities.
- Political Strengthening: This sort of strengthening alludes to ladies' capacity to take part in political life and dynamic on an equivalent premise with men. It incorporates the capacity to cast a ballot and campaign for office, as well as admittance to administrative roles and support in strategy making processes.
- Instructive Strengthening: This alludes to ladies' capacity to get to schooling and foster abilities and information that empower them to go with informed choices, seek after their objectives, and add to society. It incorporates admittance to quality training at all levels and amazing open doors for deep rooted learning.
- Wellbeing Strengthening: This alludes to ladies' capacity to get to medical services and arrive at conclusions about their wellbeing and prosperity. It incorporates admittance to data, administrations, and assets that advance conceptive wellbeing, maternal wellbeing, and generally prosperity.

In general, these kinds of strengthening are interconnected and corresponding, and enabling ladies in a single region can have positive gradually expanding influences in different regions.

Importance of Women's Empowerment:

Ladies' strengthening is significant because of multiple factors, including

- Orientation Fairness: Ladies' strengthening is fundamental for accomplishing orientation correspondence, which is a basic common liberty. Orientation equity implies that ladies and men have equivalent freedoms, open doors, and assets, and can take part similarly in all parts of life.
- Monetary Development: Ladies' strengthening is likewise significant for financial development and improvement. At the point when ladies have equivalent admittance to instruction, business, and different open doors, they are better ready to add to the economy and society all in all.
- Civil rights: Ladies' strengthening is likewise fundamental for accomplishing civil rights. Ladies and young ladies are in many cases subject to segregation, savagery, and different types of mistreatment just as a result of their orientation. Engaging ladies assists with making an all the more and impartial society for everybody.
- Wellbeing and Prosperity: Ladies' strengthening is additionally significant for advancing wellbeing and prosperity. At the point when ladies approach training and medical services, they can more readily deal with themselves and their families.
- Manageable Turn of events: Ladies' strengthening is basic for accomplishing practical turn of events. At the point when ladies are engaged, they are better ready to add to endeavors to address natural difficulties, decrease destitution, and advance civil rights.

To put it plainly, ladies' strengthening is critical for accomplishing a fair, impartial, and maintainable world.

Women’s Empowerment through education

Ladies strengthening through training alludes to the most common way of furnishing young ladies and ladies with the information, abilities, and certainty to take part completely in the public eye and settle on informed conclusions about their lives. Schooling is one of the most incredible assets for enabling ladies, as it can assist them with acquiring information, abilities, and certainty that can assist them with working on their daily routines and the existences of their families and networks. Monetary strengthening, Wellbeing and prosperity, Political interest, and Social strengthening are a few different ways that training can assist with enabling ladies. Generally speaking, ladies' schooling is

fundamental for accomplishing orientation balance and enabling ladies to understand their maximum capacity. By putting resources into young ladies' schooling, we can make an all the more and evenhanded world for all.

The Women empowerment in India and its Importance

Ladies strengthening in India is the best apparatus for advancement as nowadays; ladies across the world are effectively functioning as a pioneer and outperforming others in every one of the circles of life. As the whole world is fastening its breath and imploring each and every day for an extraordinary departure from the Coronavirus Pandemic, it is the ladies lead representatives and countries directed by these astounding figures who are assuming control over the obligation and walking ahead in the fight alone any place required. Ladies strengthening in India is reliant up by and large on various factors that envelop geological setting (metropolitan/country), economic wellbeing (standing and class), instructive status, and age factor. Activities on the ladies strengthening exist at the state, nearby (panchayat), and public levels. Notwithstanding, ladies experience separation in many areas like training, monetary open doors, wellbeing and clinical help, and political support, which exhibits that there are significant holes between methodology progressions and genuine activity at the local area level.

Women Empowerment in India: An Introduction

The term ladies strengthening is about power, or the power set out on ladies sharing unclear privileges. The term alludes to the freedom of ladies from financial restrictions of dependence. Ladies involve around half of the nation's populace, and a heft of them remains monetarily subject to one another without business. In the time of woman's rights, a little part of ladies in India are liberated and can utilize their freedom of thought and are allowed to cut out their lives the manner in which they need. Be that as it may, there is a significant division of the ladies in this country who need hopeful help. In most Indian towns and semi-metropolitan urban communities, ladies are as yet denied principal schooling and are never approved to proceed with advanced education regardless of hoarding the comprehension required. Ladies are known for conveying various jobs easily each day, and in this manner, they are viewed as the foundation of each and every general public. Living in male-overwhelming social orders, ladies play a large number of jobs, like caring moms, cherishing little girls, and able partners. Best of all, they fit the bill totally in each job. In any case, they've likewise remained as an ignored bundle of society in various regions of the planet. Thusly, it has brought about ladies enduring the brunt of lopsidedness, monetary reliability, mistreatment, and particular social wrongs. Ladies have been living under the shackles of subjugation throughout recent centuries that obstructs them from achieving proficient as well as private highs. Being a NGO for ladies strengthening in India, Hindrise Establishment has planned our dynamic and change situated programs in such a way that the preparing of ruined little kids will elevate the state of the country.

Need for Women Empowerment

For days of yore ladies overall been compelled to possess an optional spot corresponding to men. Ladies have been consigned to the edges notwithstanding the way that they are mathematically 50% of the total populace. This has brought about ladies being not able to have a spot of human nobility as free and autonomous elements related with men on a scholarly and proficient equivalent frequency. In the antiquated period ladies were known to participate in numerous useful exercises yet throughout the time proliferation and difficulties of pregnancy and labor bit by bit made her ward on people for security and food. When humankind arrived at more settled presence man controlled society was completely settled. The men were to compose the codes of the general public and administration where ladies were given subordinate job. The men extended the prevailing perspective as well known fact. However even in the periods of severe predominance by guys society has hurled ladies of type who could match even outperform the abilities of men. The noticeable accomplishments of ladies as instructors, specialists, pilots, lawmakers and wayfarers and so forth. have crushed the male centric ideas of binding ladies' job to home and hearth. However, these accomplishments have been made generally at individual levels now and again when ladies confronted separation and analysis at all levels. It is more straightforward to perceive how inconvenient to advance it is to confine ladies to determined jobs and subordinate them to men. Indeed, even to bring youngsters up in the present climate to make them fit to confront the difficulties of a cutthroat future a lady should be completely mindful of her decisions and direction.

The requirement for ladies' strengthening is felt in view of the status they have in the public arena starting from the start. There is a need to rethink the situation with ladies in the general public. A change can be brought through the constitution and steady regulations. The Constitution of India gives a ladies status equivalent to men. There have been endeavors to hold seats for ladies in political bodies. This is no question a positive development. Ladies can decide for them and take right choices. Anyway only considering reservation of ladies in Panchayat and administrative bodies without engaging ladies separately misses the mark concerning genuine liberation. Ladies have been prohibited from focuses of force because of precise connivance by man centric idea most normal in India Khap Panchayat that has consigned ladies to an assigned and restricted space. A reorientation of our perspectives towards ladies must be painstakingly directed for their genuine liberation from the man centric mastery. The ruined and unskilled status of most ladies in the public eye is because of their failure to achieve adequate degrees of monetary power. To support any degree of strengthening ladies must be taught to know about their freedoms and honors in a cutting edge society. It is just when they become mindful of their status in the public eye that they will actually want to make the most of the concessions proposed to them as a remedial measure. Ladies strengthening needs regardless ladies' dynamic support. Except if ladies lose the shackles that overlook their ability, expertise and soul ladies through schooling and monetary independence, can't be engaged. Except if they are engaged to take a definitive part in the social, political and monetary existence of the country the actual improvement of the nation will be trim sided.

Women Empowerment: Need, Steps , And Impact

Ladies' freedoms backing, orientation correspondence, and assurance that ladies have equivalent open door in all parts of life are the objectives of the overall development known as Ladies strengthening. It incorporates the method involved with giving ladies the instruments, data, and organization they need to assume responsibility for their own lives and use sound judgment. Ladies' strengthening is fundamental for social headway and harmless to the ecosystem improvement as well as being an issue of equity and common freedoms. In this article, we will look at the possibility of ladies' strengthening, consider its significance, discuss the hardships ladies experience, and feature the main plans and projects for advancing ladies' strengthening across the globe.

Understanding Women Empowerment

The most common way of fortifying ladies' ability to completely participate in the public eye, practice their freedoms, as well as access amazing open doors on an equivalent premise with men is known as "ladies strengthening." It involves going up against and adjusting the accepted practices, social practices, and power structures that help orientation disparity and segregation. Ladies' strengthening recognizes the innate worth and capability of ladies, including attempting to eliminate the deterrents that substitute the approach to accomplishing their objectives and making a positive commitment to society. It covers points including schooling, business, prosperity, savagery against ladies, and partaking in dynamic activities, as well as monetary, political, social, and individual parts.

Need for Women Empowerment

Ladies' strengthening isn't just a stylish thought; it is fundamental in the present society. In spite of impressive progressions in ladies' privileges as well as orientation correspondence, there are as yet numerous snags and issues that keep ladies from contributing completely to society and arriving at their maximum capacity. Coming up next are a few in number contentions for ladies' strengthening:

Gender Equality: The strengthening of ladies is important to accomplish orientation correspondence. Social shows, social practices, as well as biased mentalities that confine ladies' possibilities and undermined their privileges are at the core of orientation difference. By enabling ladies, we question these assumptions and attempt to make a general public where people are managed the cost of similar freedoms, potential open doors, and commitments.

Economic Development: Monetary development and the strengthening of ladies are personally related. A big part of the total populace is comprised of ladies, and financial maintainability relies upon their dynamic commitment. Whenever ladies have a similar chance for schooling, work, and business, they make a significant commitment to financial creation, the destruction of destitution, and general turn of events.

Education and Knowledge: A strong technique for changing civilizations is instructing and engaging

ladies. Ladies who have gotten a schooling are more taught, more skilled, and more confident, which enables them to address orientation standards and effectively take part in friendly, financial, and political domains. Training builds a lady's penchant to make interests in her family's government assistance, particularly the wellbeing and schooling of her youngsters, which helps people in the future and breaks the pattern of neediness.

Health and Well-being: Ladies' prosperity and actual wellbeing are personally connected with ladies' strengthening. Ladies' strengthening requires approaching great medical services, the right to an early termination, and command over one's own body. Ladies who are engaged are better ready to take satisfactory consideration of their wellbeing, look for clinical consideration when essential, and settle on choices that will further develop their prosperity.

Violence and Discrimination: To conquer brutality and bias against ladies, ladies should be enabled. Homegrown maltreatment, lewd behavior, as well as illegal exploitation are only a couple of the fierce wrongdoings against ladies that they actually need to manage. Difficulties to these unsafe practices, more secure settings, and the progression of a culture of equity and regard are made conceivable by the strengthening of ladies by means of training, mindfulness, and lawful insurance.

Leadership and Decision-making: To make powerful approaches, methodologies, as well as dynamic cycles, ladies' voices and perspectives are essential. For comprehensive administration to be elevated and to satisfy the many requests and targets of society, orientation equality in positions of authority should be achieved in the private as well as open areas. Ladies' strengthening guarantees that they have an equivalent voice in choices that influence their networks and lifestyle.

Social and Cultural Change: To challenge cultural and social shows that help orientation disparity, ladies' strengthening is critical. By engaging ladies, we dissipate bias, eliminate obstructions, and advance a culture that distinctions as well as regards ladies' commitments beyond the bounds of traditional orientation jobs. This outcomes in social change and fabricates a really inviting and enhanced society that is useful to everyone.

Today both young fellows and young women go to classes. Today guidance is the right of both young fellows and young women; no matter what that, 50 % of young women get tutoring. India has measurements as expected which includes the quantity of occupants in the country. This information is used to measure things like schooling, sex extent, etc. Numerous SC and ST kids leave school at an early age. The 2014 insights even show the expense of preparing and the uninterested attitude of instructors and gatekeepers are liable for the imprudence of guidance.

Women Empowerment in India

India is an extremely confounded country. Throughout the span of numerous hundreds of years, we have gathered a wide range of practices, customs, and customs. These ceremonies and practices, both the positive and negative parts of them, are currently imbued in the aggregate mind of our general public. We honor female divinities as gods deserving of love, and we likewise put a high worth on the connections we have with our own moms, little girls, sisters, life partners, and some other female family members or companions. Then again, Indian men are infamous for their unfortunate treatment of their spouses and lady friends, both inside and beyond the house. There are people in Indian culture who stick to pretty much every possible sort of strict conviction. In all of the world's religions, ladies are given a remarkable position, and we are told to treat them with the highest level of love and responsiveness. Be that as it may, for reasons unknown, the improvement of civilization has prompted it being satisfactory for different destructive practices, both physical and mental, to be completed against ladies. This has been the situation for a really long time. For example, the sati pratha, the custom of endowment, the Parda pratha, female child murder, spouse burning, sexual mischief, lewd behavior at the area of work, aggressive behavior at home, as well as different kinds of segregating rehearses all have both a psychological and an actual part. Moreover, there is a huge issue with abusive behavior at home in India. Since the guys accept that ladies are their property, they treat their spouses harmfully and beat them. Considerably more so since most ladies are excessively tentative to communicate their psyches. Along these lines, ladies who take care of business are paid not exactly their male partners who do similar errands. At the point when somebody gets compensated less for a similar measure of work due to their orientation, this conduct must be depicted as chauvinist and totally unreasonable. Subsequently, obviously engaging ladies is an unquestionable necessity nowadays. We have an obligation to give

these ladies the instruments they need to advocate for them and guarantee that they are never the survivors of shamefulness.

Steps For Women Empowerment

Strengthening of ladies should be possible in different ways, through both government plans and individual levels. The public authority has thought of different plans like Beti Bachao Beti Padhao Yojana, Mahila-E-Haat, Sukanya Samriddhi Yojana, and so on., to engage ladies. Aside from this, exclusively, we can work by nullifying social wrongs like share and youngster marriage. Regarding ladies and giving equivalent open doors should be possible independently.

Women's Movements

Ladies have only and, with everything taken into account, endeavored to accomplish changes is known as the Ladies' Development. Different systems have been used to spread care, fight partition, and search for value. These advancements are associated with fighting, uncovering issues, contradicting, and showing strength. Individuals in the public eye are seen as playing unequivocal direction occupations. Ladies have been standing up to inconsistencies at each step since the times from past times. Apparently, their circumstance and status have improved with the distinction in time; in any case, they wait behind men in basically every field.

Breaking Stereotypes and Developments

In this male-managed society, they disregard to benefit identical distinctions and entryways. It has additionally been seen that a few callings are viewed as more fitting for men than for ladies. It implies ladies are reasonable just for a couple of occupations. Numerous people acknowledge that women further develop chaperons since they are all the more tranquil and sensitive. It is similarly acknowledged that women don't bear particular personalities, and along these lines, they are not prepared to oversee specific things. Thusly, they have been summed up as extraordinary specialists, incredible teachers, etc. They are never seen as equipped power authorities, pilots, railroad engine drivers, etc. A bigger piece of Indians confides in these speculations. It is, thus, that young women don't get the very support that young fellows do to study and plan to become subject matter experts and modelers. Ladies are planned to abuse these generalizations by succeeding in fields that were assumed male jam till now. We presently have ladies pilots, engineers, cops, researchers, etc. Bit by bit there came a steadily expanding number of positive changes. The social class that never gotten examining and making started sending their children to school. Before all else, there was a lot of protection from showing young women.

Nonetheless, there were also women and men who set forth endeavors to open schools for young women.

Some Examples of Women's Empowerment

Ladies endeavored to sort out some way to seek after work and make. Here, the experience of Rashsundari Devi (1800-1890) merits zeroing in on. She was a housewife of a rich landowner's friends and family. Around then, at that point, it was trusted that assuming a woman sorted out some way to scrutinize and form, she would transform into a widow. Despite this, she told herself the best way to seek after and compose clandestinely after her marriage. She thought about her self-representation in Bangla named Amar Jiban. Rokeya Sakhawat Hossain was another model who did an incredible arrangement for women's tutoring. She knew how to examine and make Urdu, yet she was stopped from learning Bangla and English. Back then, simply young fellows were taught in English. Anyway, she sorted out some way to parse and make Bangla and English. From there on, she transformed into a writer and formed an uncommon story named Sultana's Fantasy in 1905. She did an incredible arrangement to help different young women with going to class and building their own dreams. In 1910, she began a school for young women in Kolkata which is yet to work.

In all likelihood, an always expanding number of young women have begun going to class, yet, they drop behind young fellows. As per the most recent measurements of 2001, 76% of young fellows and men are taught, yet the figure is generally outstandingly low in case of young women. Only 54% of young women and women are taught in India. As needs be, the level of the male social event is higher than the female get-together. Young ladies who are from Dalit and Adivasi establishments are less disposed to remain in school. One of the many reasons is that couple of families are unnecessarily poor and unequipped for bearing the cost of showing all of their young people. Young fellows get tendencies in such circumstances. The position and status of women have, beyond question, further fostered a ton which is a result of the total undertakings of the women of the country. The Ladies' Development similarly gets the

assistance of men. They used different techniques to spread care, fight partition, and search for value. For example, they coordinate missions to fight isolation and brutality against women. They furthermore challenge women to happen. The women's Development moreover shows courage with various women and causes.

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Chemistry

SYNTHESIS, CHARACTERIZATION AND ANTIMICROBIAL ACTIVITY OF PLANT PATHOGENS: A STUDY OF 4,5-DIHYDRO ISOXAZOLE DERIVATIVES

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ABSTRACT The series of novel substituted phenol derivatives containing isoxazole moieties 2-(5-(substituted)-4,5-dihydroisoxazol-3-yl)-4-methyl-6-nitrophenol and 2-(5-(substituted)-4,5-dihydroisoxazol-3-yl)-4-methylphenol have been designed and synthesized All the compounds were characterized via elemental analysis, IR, 1H, 13CMR and FAB-Mass analysis. The antibacterial and antifungal activities of were evaluated against two plant pathogenic bacteria and two plant pathogenic fungi.

KEYWORDS : Isoxazole, Plant Pathogens, Chalcones, Spectral Studies.

INTRODUCTON

Heterocyclic nitrogen and oxygen containing compounds have received considerable attention due to their significant bioactivities. During the last decades, intensive efforts have been undertaken to discover the highly active chemicals with favourable toxicological and environmental properties for the selective control of weed, insects and fungal disease. In several instances, dihydro isoxazole derivatives have been found as promising agrochemical products,,. The isoxazole constitute a fascinating class of five -membered heterocyclic compounds with one nitrogen and one oxygen ring atom. There are also some herbicidally, insecticidally or fungicidally active dihydro isoxazole derivatives known, which have been isolated from natural sources,. The dihydro isoxazole amino acids acivicin has been isolated from the fermentation broths of streptomyces sviceus and highly active against phytophthora infestans it is casual agnebts of potatolate blight, uncinula necator it is causal agent of grapes powdery mildew and the trehalase inhibiting dihydro isoxazole darevative trehazolin shows potent fungicidal activity against Rhizoctonia soloni it is causal agent of rice sheath blight".

Dihydro isoxazole have been widely applied as pharmaceuticals and agrochemicals because of their antifungal activities. Fluralaner, a commercial insecticide, is a successful example that introduces dihydro isoxazole as the scaffold,. Many studies have also focused on the antibacterial and antifungal activities of dihydro isoxazole derivatives,.

Concerning the synthesis of dihydro isoxazoles, the methods with stable and easily accessed starting materials and those conducted under mild conditions are more acceptable. Usually, the sophisticated way to synthesize dihydro isoxazole is by the cyclization of α, β-unsaturated carbonyl compounds (chalcones) with hydroxylamine. Chalcones can be easily obtained from a simple Claisen–Schmidt reaction,.

Keeping the above observations in view, we designed new compounds by introducing a 2-chloro benzaldehyde, 3-chloro benzaldehyde and indol-3-caoboxyaldehyde structure into a dihydro isoxazole scaffold, which will be expected to exhibit higher fungicidal bactericidal activities through the coexistence of two kinds of pharmacophores,,,.

MATERIALS AND METHODS

The chemicals and solvents used were of highest purity purchased commercially from Merck, S.D. Fine and Alfa Aesar Company Ltd. The melting points of all the synthesized compounds were recorded by Thiele's melting point apparatus as uncorrected values.

The elemental analysis was carried out on Thermo Scientific CHNS elemental analyser. IR spectra were recorded on a Shimadzu instrument using KBr pellets. ^{1}H NMR spectra were scanned by Brucker at 400 MHz using DMSO-d6 as solvent and TMS as an internal reference. ^{13}C NMR spectrum of a sample was recorded on same instrument at 100 MHz. Experimental procedure for synthesis of 2(5-(substituted phenyl)-4,5-dihydroisoxazol-3-yl)-4,6-substituted phenol (5a–5f).

Preparation of p-methylphenyl acetate (1)

The p-cresol was refluxed along with acetic anhydride and anhydrous sodium acetate for an hour. The reaction mixture was cooled and poured into the ice-cold water containing crushed ice. Acetate layer was separated by means of separating funnel and several times washed with water. It was finally purified by distillation and the distillate fraction was collected at about 236^{0}C, to get the compound (1) b.p. 236^{0}C yield: 84.74%.

Preparation of 2-hydroxy-5-methyl acetophenone (2)

p-methyl phenyl acetate (1) was mixed with anhydrous $AlCl_3$ (1) and heated at 120^{0}C for 45minutes on an oil bath. The reaction mixture was decomposed in ice cold water containing 10% hydrochloric acid and allowing the solution to fall drop by drop into ice cold water with constant stirring. Green solid compound i. e crude ketone (2) was obtained, m.p. 47^{0}C, yield: 89%.

Preparation of 2-hydroxy-3-nitro-5-methyl acetophenone (3):

2-hydroxy-5-methyl acetophenone (2) was dissolved in acetic anhydride in a beaker and reaction mixture was kept in ice bath by maintain temperature below 5^{0}C. To this reaction mixture conc. HNO_3 was added dropwise with constant stirring till the solution becomes orange coloured and kept for 4-5 hrs. it was then decomposed with ice cold water. Yellow granules obtained were filtered and washed with water and then crystallized from ethanol, m.p. yield: 72%.

Preparation of β-unsaturated chalcones (4a–4f)

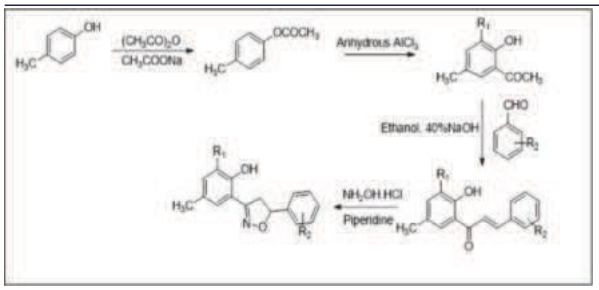
In this study, α, β-unsaturated chalcones 1 were synthesized by using a Claisen–Schmidt reaction,,,. To a solution of substituted acetophenone (0.01mol) and substituted aldehyde (0.01mol) in 15ml of ethanol and 40% sodium hydroxide solution added drop by drop.

The reaction mixture was continuously stirred on magnetic stirrer at room temperature, up to cake formation followed by decomposition with ice cold HCl (1:1). The crude Chalcones precipitate out ware filtered, washed with 10% NaHCO3 solution and then recrystallized from ethanol to obtained compounds (4a-f).

Preparation of 2(5-(substituted phenyl)-4,5-dihydroisoxazol-3-yl)-4,6-substituted phenol (5a–5f)

To a solution of chalcones (0.01 mol) and hydroxylamine hydrochloride (0.02mol) was reflux in 30 mL of ethanol and piperidine (0.5ml) for about 1.5 hrs. Subsequently, the reaction mixture was cooled and poured onto crushed ice acidified with dil. HCl, and then formed solids was collected and washed first with sodium bicarbonate solution (10%) and then with water to obtain crude products of 5a–5f.

Scheme of 2(5-(substituted phenyl)-4,5-dihydroisoxazol-3-yl)-4,6-substituted phenol (5a–5f).



R_1= H, NO_2; R_2=2-Cl, 3-Cl, Indol-3-carboxyaldehyde

Antibacterial and Antifungal activity assay

Tested strains (Pseudomonas, Xanthomonas, Cercospora and Cadophora) were obtained from the Institute of Plant Protection, Chandigarh. The bacterial and fungal strains were maintained in a potato dextrose agar medium (PDA) medium and stored at 4°C. Evaluation of the bactericidal and fungicidal activities was performed according to reported protocol inhibitory activities against two plant-pathogenic fungi was tested in vitro using the mycelia growth test on a PDA medium. Briefly, title compound solutions (in DMSO) and sterile molten PDA were mixed to obtain a final concentration of 100μg·mL^{-1} (containing 5% DMSO). Then the mixture was poured into 90 mm Petri dishes (15 mL·dish^{-1}), on which 10 mm mycelial disks of the two bacteria and two fungi were planted in the centre. Three replicates were conducted for each treatment. DMSO (5% contained in PDA) was used as a negative control, while thiabendazole and azoxystrobin were tested as positive controls. After a 24 hrs incubation period at 37°C (until the colonies in the control treatments had covered two-thirds of the Petri dishes), the mycelial growth diameters were measured using the cross-bracketing method, and the percentage of mycelial growth inhibition was then calculated. The inhibition percentages were calculated with the following equation: I=[(C−T)/(C−5)] ×100%, where T is the mycelial diameter (mm) in the Petri dishes with compounds and C is the diameter (mm) of the DMSO control. Furthermore, the antibacterial and antifungal activities of higher effective compounds (according to the preliminary assay) were evaluated using the inhibition percentages of tested compounds in the final series concentration. The EC50 values were calculated by linear-regression analysis.

RESULTS AND DISCUSSION

1. Chemistry

The reaction sequences for the synthesis of 2(5-(substituted phenyl)-4,5-dihydroisoxazol-3-yl)-4,6-substituted phenol (5a–5f) is outlined in above Scheme according to the reported method. The intermediate chalcones, (E)-3-(Substituted)-1-(2-hydroxy-5-methyl-3-substituted phenyl)prop-2-en-1-one, a kind of α,β-unsaturated ketones, were prepared by reacting the 2-chloro benzaldehyde, 3-chloro benzaldehyde and indol-3-carboxyaldehyde with substituted acetophenones via a facile procedure in the presence of a base with 60–85% yield. The chalcones were then converted into the 4,5-dihydro isoxazole derivatives through different reactions. The 4,5-dihydro isoxazole derivatives 5a–5f were prepared by refluxing a mixture of chalcones, hydroxylamine hydrochloride and piperidine in an ethanol medium with 67-85% yields. Compounds chalcones and isooxazolines were separated using column chromatography (ethyl acetate-petroleum ether). All title compounds were confirmed by IR, NMR and structural analysis data were shown below tables.

Table 1: Physical and analytical data of Compounds.

Compounds	Mol. Formula	Colour	M.P.	C%	H%	N%	Cl%
				Found/ Calculated			
5a	C16H14ClNO2	Pale yellow	101oC	66.77/66.79	4.60/4.90	4.80/4.87	12.00/12.32
5b	C16H14ClNO2	Pale yellow	1220C	66.77/66.79	4.60/4.90	4.80/4.87	12.00/12.32
5c	C18H16N2O2	Pale yellow	1320C	73.90/73.95	5.60/5.52	9.48/9.58	-
5d	C16H13ClN2O4	Dark red	1220C	57.73/57.76	3.91/3.94	8.39/8.42	10.62/10.65
5e	C16H13ClN2O4	Dark red	119oC	57.73/57.76	3.91/3.94	8.39/8.42	10.62/10.65
5f	C18H15N3O4.	Yellow	950C	64.04/64.09	4.42/4.48	12.46	-

5b: IR(KBr, cm-1): 3350(Hydrogen bonded -OH), 3743.83 (-C=N stretching), 3082.25 (-C-H stretch in aromatic), 2926.01 (-C-H aliphatic), 1577.77 (-C=N- stretching), 1083.99 (-C-O stretching), 906.54 (-N-O stretching isoxazole), 786.96 (-C-Cl stretching) ; 1-HNMR($CDCl_3$): δ 2.39 (s, 3H, CH_3), 2.47 (s, 3H, SCH_3).

5d: IR(KBr, cm-1): 3741.90 (Hydrogen bonded -OH), 3743.83 (-C=N stretching), 3068.75 (-C-H stretch in aromatic), 2926.01 (-C-H aliphatic), 1686.64 (-C=N- stretching), 1539.20 (-NO_2 stretching (asymmetric)), 1473.62 (-C=C- stretching), 1045.42 (-C-O stretching), 906.54 (-N-O stretching isoxazole), 752.24 (-C-Cl stretching) ; 1-HNMR(CDCl3): δ 8.0 (d,1H, Ar-H), 7.2 (d,1H, Ar-H), 4.89 (S, 1H, Phenolic -OH), 2.5 (s, 3H, -CH_3), 7.3-7.5 (m, 4H, Ar-H).

5f: IR(KBr, cm-1): 3741.90 (Hydrogen bonded -OH), 3743.83 (-C=N stretching), 3080.32 (-C-H stretch in aromatic), 2926.01 (-C-H aliphatic), 1686.64 (-C=N- stretching), 3221.12 (-N-H stretching in aromatic)1535.34 (-NO_2 stretching (asymmetric)), 1473.62 (-C=C-stretching),; 1-HNMR(CDCl3): δ 6.9 (d,1H, Ar-H), 7.2 (d,1H, Ar-H), 4.7(S, 1H, Phenolic -OH), 2.5 (s, 3H, -CH_3), 7.3-7.5 (m, 4H, Ar-Indol), 8.1 (d,1H,Ar-H), 7.8 (s,1H, N-H).

Antimicrobial Activity in vitro

As shown in table 2 given below , preliminary determination of the inhibition activities of title compounds (100 μg·mL^{-1}) against plant-pathogenic bacteria and fungi (Pseudomonas, Xanthomonas, Cercospora and Cadophora) suggested that all of the compounds showed significant antibacterial and antifungal activities against plant-pathogenic bacteria and fungi, with an inhibition rate higher than 50%. Among the tested bacteria and fungi, Pseudomonas and Cadophora ware completely inhibited by half of the tested compounds with an inhibition rate higher than 90%. It was obvious that these derivatives are particularly efficient against the mycelia growth of Pseudomonas and Cadophora in vitro.

Table 2. Antifungal activities of titled compounds at 100μg.mL^{-1} in vitro

Compounds	Bacteria		Fungi	
	Pseudomonas	Xanthomonas	Cercospora	Cadophora
5a	97.95	75.29	69.56	93.25
5b	96.01	69.27	56.28	94.34
5c	94.37	70.35	73.59	93.25
5d	93.25	55.15	78.29	91.15
5e	93.25	80.22	65.22	90.79
5f	93.25	62.79	57.54	93.25
Thiabendazole	91.20	60.23	65.45	90.32
Azoxystrobin	8765	72.36	57.61	89.54

Among newly synthesized compounds, 5a and 5b showed more potential bioactivities against Pseudomonas than those of thiabendazole and azoxystrobin. Meanwhile, 5a,5b,5c,5d,5e and 5f and showed higher fungicidal activities against cadophora. Surprisingly, the compounds containing a chlorine atom (5a,5b,5d and 5e) displayed excellent antifungal activities, even higher than commercial fungicides (thiabendazole and azoxystrobin). Therefore, the fungicidal activities of the title compounds closely depended on the core structure, substituent groups, and substituent positions Among the tested fungi, cadophora is a serious pathogenic fungus on gram and other cereals, and Cercospora is a harmful fungus on soyabean, various vegetables and crops worldwide. All the tested novel compounds have strongly effective for bacteria Xanthomonas. The title compounds showed significantly antifungal activities against these notorious fungi, suggesting that novel compounds have potential and should undergo further evaluation in vivo or in the field. In the present study, the 4,5-dihydro isoxazole derivatives showed significant antibacterial and antifungal activities against the tested bacteria and fungi, and approximately half of the title compounds exhibited higher inhibitory activities.

CONCLUSIONS

The series of novel 4,5-dihydro isoxazole compounds derived from p-cresol were designed and synthesized and were characterized via 1 H-NMR, 13C-NMR, and HRMS. Results of the preliminary biological activity assay indicated that most of the title compounds showed potential antibacterial and antifungal activities against Pseudomonas, Xanthomonas, Cercospora and Cadophora. Compound 5a and 5b, displaying significant bactericidal and fungicidal activities against

bacteria Pseudomonas and fungus Cadophora are worth being further evaluated in vivo and in the field. Further optimizations of 4,5 dihydro isoxazole derivatives should be carried out to develop more effective antibacterial and antifungal activities.

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Synthesis and Biological Evaluation of Some New 3-Aryl-2-thioxo-2,3-dihydroquinazolin-4(1*H*)-ones and 3-Aryl-2-(benzylthio)quinazolin-4(3*H*)-ones as Antioxidants; COX-2, LDHA, α-Glucosidase and α-Amylase Inhibitors; and Anti-Colon Carcinoma and Apoptosis-Inducing Agents

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Abstract: Oxidative stress, COX-2, LDHA and hyperglycemia are interlinked contributing pathways in the etiology, progression and metastasis of colon cancer. Additionally, dysregulated apoptosis in cells with genetic alternations leads to their progression in malignant transformation. Therefore, quinazolinones **3a–3h** and **5a–5h** were synthesized and evaluated as antioxidants, enzymes inhibitors and cytotoxic agents against LoVo and HCT-116 cells. Moreover, the most active cytotoxic derivatives were evaluated as apoptosis inducers. The results indicated that **3a**, **3g** and **5a** were efficiently scavenged DPPH radicals with lowered IC_{50} values (mM) ranging from 0.165 ± 0.0057 to 0.191 ± 0.0099, as compared to 0.245 ± 0.0257 by BHT. Derivatives **3h**, **5a** and **5h** were recognized as more potent dual inhibitors than quercetin against α-amylase and α-glucosidase, in addition to **3a**, **3c**, **3f** and **5b–5f** against α-amylase. Although none of the compounds demonstrated a higher efficiency than the reference inhibitors against COX-2 and LDHA, **3a** and **3g** were identified as the most active derivatives. Molecular docking studies were used to elucidate the binding affinities and binding interactions between the inhibitors and their target proteins. Compounds **3a** and **3f** showed cytotoxic activities, with IC_{50} values (μM) of 294.32 ± 8.41 and 383.5 ± 8.99 (LoVo), as well as 298.05 ± 13.26 and 323.59 ± 3.00 (HCT-116). The cytotoxicity mechanism of **3a** and **3f** could be attributed to the modulation of apoptosis regulators (Bax and Bcl-2), the activation of intrinsic and extrinsic apoptosis pathways via the upregulation of initiator caspases-8 and -9 as well as executioner caspase-3, and the arrest of LoVo and HCT-116 cell cycles in the G2/M and G1 phases, respectively. Lastly, the physicochemical, medicinal chemistry and ADMET properties of all compounds were predicted.

Keywords: colorectal cancer; oxidative stress; inflammation; COX-2; Warburg effect; LDHA; post prandial hyperglycemia; apoptosis; quinazolinone; ADMET

EXPERT OPINION ON DRUG DISCOVERY
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ORIGINAL RESEARCH

Leveraging nitrogen occurrence in approved drugs to identify structural patterns

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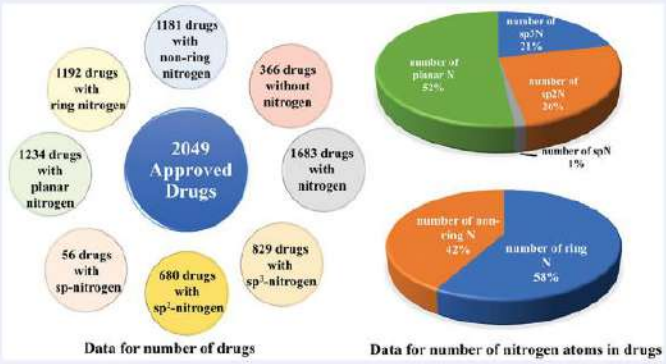
ABSTRACT

Background: The process of drug development and discovery is costly and slow. Although an understanding of molecular design principles and biochemical processes has progressed, it is essential to minimize synthesis-testing cycles. An effective approach is to analyze key heteroatoms, including oxygen and nitrogen. Herein, we present an analysis focusing on the utilization of nitrogen atoms in approved drugs.

Research design and methods: The present work examines the frequency, distribution, prevalence, and diversity of nitrogen atoms in a dataset comprising 2,049 small molecules approved by different regulatory agencies (FDA and others). Various types of nitrogen atoms, such as sp^3-, sp^2-, sp-hybridized, planar, ring, and non-ring are included in this investigation.

Results: The results unveil both previously reported and newly discovered patterns of nitrogen atom distribution around the center of mass in the majority of drug molecules.

Conclusions: This study has highlighted intriguing trends in the role of nitrogen atoms in drug design and development. The majority of drugs contain 1–3 nitrogen atoms within 5Å from the center of mass (COM) of a molecule, with a higher preference for the ring and planar nitrogen atoms. The results offer invaluable guidance for the multiparameter optimization process, thus significantly contributing toward the conversion of lead compounds into potential drug candidates.



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Drug design; drug discovery; heteroatoms; molecule distribution; multiparameter optimization; nitrogen atoms

1. Introduction

Advancements in the fields of drug design and biomedical research have enhanced the understanding of biomolecules, molecular interactions, pharmacophoric patterns, and biochemical processes, driving dynamic and progressive developments in these domains [1]. The conversion of compounds to drugs requires a collaboration of diverse disciplines and involves a series of sequential steps [2]. In general, the process of successful drug development involves five major steps, which have been depicted in Figure 1.

Early drug discovery requires multiple efforts, which involve disease and target identification, assay development along with wet lab synthesis of a library of molecules. A lot of researchers nowadays use contemporary methods like pharmacophore modeling, LBDD (Ligand-based Drug Designing), and SBDD (Structure-based Drug Designing) in combination to identify

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Design, synthesis, docking studies and biological screening of 2-pyrimidinyl-2, 3-dihydro-1*H*-naphtho [1, 2-*e*][1, 3] oxazines as potent tubulin polymerization inhibitors

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ABSTRACT

A series of novel substituted 2-pyrimidinyl-2,3-dihydro-1*H*-naphtho[1,2-*e*][1, 3]oxazine analogs have been designed and synthesized based on structure-activity relationships from 2-naphthol, substituted pyrimidinyl amines and formalin through ring closure by one-pot three component reaction. These derivatives were evaluated for their *in vitro* cytotoxicity, cell cycle assay and their inhibitory effect on tubulin polymerization. From the MTT assay, it is clear that most of the synthesized compounds displayed potent cytotoxic activities on HeLa (cervical cancer) and B16F10 (melanoma) cancerous cell lines. The compounds **6b** and **6k** were found to be more effective against HeLa cell lines and exhibited significant cytotoxicity (with IC_{50} values 1.26 ± 0.12 μM and 1.16 ± 0.27 μM respectively), accumulation of HeLa cells in G2/M phase and exhibiting induced apoptosis. The immunohistochemistry and fluorescence assays showed that these compounds **6b** and **6k** inhibited the microtubule assembly in human cervical cancer cells (HeLa) at 2 μM concentration. Furthermore, molecular docking studies of these molecules revealed their better-fit potential as anticancer molecules and have a high affinity for colchicine binding site, indicating more inhibitory potential at the cellular level. Our studies suggest that the newly synthesized compounds may become promising leads for the development of new anti-cancer agents.

Abbreviations: MTT: 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide; HeLa: Henrietta Lacks; IC_{50}: 50% Inhibitory Concentration; μM: Micromoles; DNA: Deoxyribose Nucleic Acid; kDa: kilodalton; CA-4: Combretastatin A-4; HIV: Human Immunodeficiency Virus; rt: room temperature; h: hour; IR: Infrared; ^{1}H NMR: Hydrogen-1Nuclear Magnetic Resonance; ^{13}C NMR: Carbon-13 Nuclear Magnetic Resonance; Mol. Wt.: Molecular Weight; M.P.: Melting Point; PI: Propodeum Iodide; RMSD: Root Mean Square Deviation; TLC: Thin Layer Chromatography; TMS: Tetramethyl silane; LCMS: Liquid Chromatography Mass Spectroscopy; MHz: Megahertz; DMEM: Dulbecco's Modified Eagle Medium; FBS: Foetal Bovine Serum; DMSO: Dimethyl Sulphoxide; PBS: Phosphate Buffer Saline; BSA: Bovine Serum Albumin; FITC: Fluorescein Isothiocyanate; PBST: Phosphate Buffered Saline with Tween 20; FlexAID: Flexible Artificial Intelligence Docking

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2-Pyrimidinyl naphthoxazine derivative; cytotoxicity; cell viability; cell cycle assay; tubulin polymerization inhibition assay; anti-cancer; molecular docking

1. Introduction

Cancer is one of the major causes of death worldwide. Several drugs being used for cancer treatment follow different mechanisms of action. During the past few decades, targeted therapy has emerged as an idealistic approach for the evolution of selective anti-cancer agents and this therapy is often recommended along with chemotherapy and other treatment to restrict the growth and spread of cancer cells. The anti-cancer drug discovery and its development have focused on malignant tumor which appears at different stages in different organs of the body. The antitumor activity is achieved through multiple approaches such as inhibition of microtubule function using tubulin targeting agents (Barreca et al., 2020; Hawash, 2022; Obydennov et al., 2021; Perez, 2009), DNA intercalators (Goftar et al., 2014; Kadagathur et al., 2022; Shankaraiah et al., 2015; 2016), DNA synthesis inhibitors (Zhou et al., 2013), transcription regulators (Mees et al., 2009), enzyme inhibitors (Zhao et al., 2013), etc.

The microtubules are the crucial target for the synthesis of most of the anticancer drugs and these drugs get bind to the tubulin, affecting microtubule dynamics. Tubulin in molecular biology can refer either to the tubulin protein superfamily of globular proteins, or one of the member proteins of that superfamily. The microtubules are major component of the eukaryotic cytoskeleton which are composed of

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RESEARCH ARTICLE

Application of in-silico drug discovery techniques to discover a novel hit for target-specific inhibition of SARS-CoV-2 Mpro's revealed allosteric binding with MAO-B receptor: A theoretical study to find a cure for post-covid neurological disorder

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Abstract

Several studies have revealed that SARS-CoV-2 damages brain function and produces significant neurological disability. The SARS-CoV-2 coronavirus, which causes COVID-19, may infect the heart, kidneys, and brain. Recent research suggests that monoamine oxidase B (MAO-B) may be involved in metabolomics variations in delirium-prone individuals and severe SARS-CoV-2 infection. In light of this situation, we have employed a variety of computational to develop suitable QSAR model using PyDescriptor and genetic algorithm-multilinear regression (GA-MLR) models (R^2 = 0.800–793, Q^2_{LOO} = 0.734–0.727, and so on) on the data set of 106 molecules whose anti-SARS-CoV-2 activity was empirically determined. QSAR models generated follow OECD standards and are predictive. QSAR model descriptors were also observed in x-ray-resolved structures. After developing a QSAR model, we did a QSAR-based virtual screening on an in-house database of 200 compounds and found a potential hit molecule. The new hit's docking score (-8.208 kcal/mol) and $_pIC_{50}$ (7.85 M) demonstrated a significant affinity for SARS-CoV-2's main protease. Based on post-covid neurodegenerative episodes in Alzheimer's and Parkinson's-like disorders and MAO-B's role in neurodegeneration, the initially disclosed hit for the SARS-CoV-2 main protease was repurposed against the MAO-B receptor using receptor-based molecular docking, which yielded a docking score of -12.0 kcal/mol. This shows that the compound that

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Mechanistic QSAR modeling derived virtual screening, drug repurposing, ADMET and *in-vitro* evaluation to identify anticancer lead as lysine-specific demethylase 5a inhibitor

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ABSTRACT

A lysine-specific demethylase is an enzyme that selectively eliminates methyl groups from lysine residues. KDM5A, also known as JARID1A or RBP2, belongs to the KDM5 Jumonji histone demethylase subfamily. To identify novel molecules that interact with the LSD5A receptor, we created a quantitative structure-activity relationship (QSAR) model. A group of 435 compounds was used in a study of the quantitative relationship between structure and activity to guess the IC50 values for blocking LASD5A. We used a genetic algorithm-multilinear regression-based quantitative structure-activity connection model to forecast the bioactivity ($_pIC_{50}$) of 1615 food and drug administration pharmaceuticals from the zinc database with the goal of repurposing clinically used medications. We used molecular docking, molecular dynamic simulation modelling, and molecular mechanics generalised surface area analysis to investigate the molecule's binding mechanism. A genetic algorithm and multi-linear regression method were used to make six variable-based quantitative structure-activity relationship models that worked well (R^2 = 0.8521, Q^2_{LOO} = 0.8438, and Q^2_{LMO} = 0.8414). ZINC000000538621 was found to be a new hit against LSD5A after a quantitative structure-activity relationship-based virtual screening of 1615 zinc food and drug administration compounds. The docking analysis revealed that the hit molecule 11 in the KDM5A binding pocket adopted a conformation similar to the pdb-6bh1 ligand (docking score: −8.61 kcal/mol). The results from molecular docking and the quantitative structure-activity relationship were complementary and consistent. The most active lead molecule 11, which has shown encouraging results, has good absorption, distribution, metabolism, and excretion (ADME) properties, and its toxicity has been shown to be minimal. In addition, the MTT assay of ZINC000000538621 with MCF-7 cell lines backs up the in silico studies. We used molecular mechanics generalise borne surface area analysis and a 200-ns molecular dynamics simulation to find structural motifs for KDM5A enzyme interactions. Thus, our strategy will likely expand food and drug administration molecule repurposing research to find better anticancer drugs and therapies.

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Protein KDM5A; drug repurposing; QSAR; molecular docking; MD simulation

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ORIGINAL RESEARCH

Unveiling dynamics of nitrogen content and selected nitrogen heterocycles in thrombin inhibitors: a *ceteris paribus* approach

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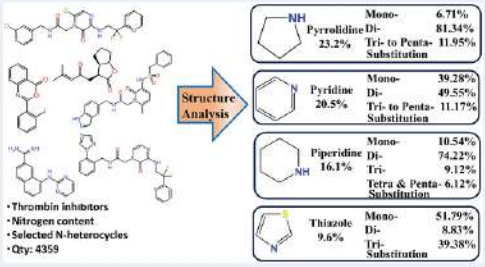
ABSTRACT

Background: Despite the progress in comprehending molecular design principles and biochemical processes associated with thrombin inhibition, there is a crucial need to optimize efforts and curtail the recurrence of synthesis-testing cycles. Nitrogen and N-heterocycles are key features of many anti-thrombin drugs. Hence, a pragmatic analysis of nitrogen and N-heterocycles in thrombin inhibitors is important throughout the drug discovery pipeline. In the present work, the authors present an analysis with a specific focus on understanding the occurrence and distribution of nitrogen and selected N-heterocycles in the realm of thrombin inhibitors.

Research design and methods: A dataset comprising 4359 thrombin inhibitors is used to scrutinize various categories of nitrogen atoms such as ring, non-ring, aromatic, and non-aromatic. In addition, selected aromatic and aliphatic N-heterocycles have been analyzed.

Results: The analysis indicates that ~62% of thrombin inhibitors possess five or fewer nitrogen atoms. Substituted N-heterocycles have a high occurrence, like pyrrolidine (23.24%), pyridine (20.56%), piperidine (16.10%), thiazole (9.61%), imidazole (7.36%), etc. in thrombin inhibitors.

Conclusions: The majority of active thrombin inhibitors contain nitrogen atoms close to 5 and a combination of N-heterocycles like pyrrolidine, pyridine, piperidine, etc. This analysis provides crucial insights to optimize the transformation of lead compounds into potential anti-thrombin inhibitors.



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Drug discovery; nitrogen rings; pyrrolidine; pyridine; piperidine; thrombin inhibitors

1. Introduction

Thrombosis is a dangerous health condition characterized by the formation of a blood clot, also known as a thrombus, within a blood vessel [1–3]. This clot can obstruct the normal flow of blood through the vessel, potentially leading to various health complications. Thrombosis can occur in both arteries (arterial thrombosis) and veins (venous thrombosis) [1–5]. Thrombosis is dangerous for several reasons: (a) obstruction of blood flow [3], (b) risk of embolism [4], (c) chronic health conditions [6], and (d) mortality [7]. According to a study by Singer *et al.*, the risk of death remains high up to 8 years after a thrombotic event, even without additional comorbidities [8]. Mortality rates can vary based on the type and location of thrombosis. For example, pulmonary embolism (PE) has a more significant risk of mortality than deep vein thrombosis (DVT) [9]. Thrombosis, including venous thromboembolism (VTE), can be associated with significant morbidity and mortality, especially in old age, obesity, and black and Latina women in the U.S.A. due to the high

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Multi-Target In-Silico modeling strategies to discover novel angiotensin converting enzyme and neprilysin dual inhibitors

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Cardiovascular diseases, including heart failure, stroke, and hypertension, affect 608 million people worldwide and cause 32% of deaths. Combination therapy is required in 60% of patients, involving concurrent Renin–Angiotensin–Aldosterone-System (RAAS) and Neprilysin inhibition. This study introduces a novel multi-target *in-silico* modeling technique (mt-QSAR) to evaluate the inhibitory potential against Neprilysin and Angiotensin-converting enzymes. Using both linear (GA-LDA) and non-linear (RF) algorithms, mt-QSAR classification models were developed using 983 chemicals to predict inhibitory effects on Neprilysin and Angiotensin-converting enzymes. The Box-Jenkins method, feature selection method, and machine learning algorithms were employed to obtain the most predictive model with ~ 90% overall accuracy. Additionally, the study employed virtual screening of designed scaffolds (Chalcone and its analogues, 1,3-Thiazole, 1,3,4-Thiadiazole) applying developed mt-QSAR models and molecular docking. The identified virtual hits underwent successive filtration steps, incorporating assessments of drug-likeness, ADMET profiles, and synthetic accessibility tools. Finally, Molecular dynamic simulations were then used to identify and rank the most favourable compounds. The data acquired from this study may provide crucial direction for the identification of new multi-targeted cardiovascular inhibitors.

Keywords Cardiovascular diseases, Multi-target inhibitors, Machine learning, Heterocyclic Scaffold, Molecular Simulations, ADMET, Drug-likeness

CVDs such as heart failure, stroke, and hypertension affect 607.6 million people worldwide and are responsible for > 30% of all deaths[1,2]. Minimization of high blood pressure to normal is preferred to reduce the risk of CVD[3]. To achieve the desired goal of hypertension, a single targeting agent failed, and combination therapy was required in more than 60% of patients[4,5], evident from clinical trials [ALLHAT (60%)[6]; PROGRESS (58%)[7], INVEST (70%)[8], INCLUSIVE (70%)[9], and SHIELD (74%)[10]]. Randomized controlled trials (RCTs) are recommended to include four primary classes of antihypertensive medications viz. ACE Inhibitors (ACEIs), Angiotensin Receptor Blocker (ARBs), Calcium Channel Blocker (CCBs), and Thiazides-Type Diuretics (TTDs)[11]. Experimental evidence suggests ACEIs and/or ARBs are crucial for preventing and managing CVD, with JNC8 guidelines suggesting preferred classes of drugs like ACEIs and Neprilysin Inhibitor[12–14]. ACE which catalyzes the conversion of angiotensin-I to angiotensin-II is a membrane-bound dipeptidyl carboxyl peptidase that has two important active sites viz. zinc-binding site and cationic binding site and occupies an important niche in the regulation of extracellular volume by the rennin angiotensin system[15,16]. Selective inhibition of C-domain ACE (cACE) has the advantage of reducing angiotensin II production, a potent vasoconstrictor implicated in hypertension while preserving N-domain ACE (nACE) activity involved in bradykinin degradation, leading to increased vasodilatory effects and lower blood pressure. Furthermore, selective cACE inhibition may result in fewer side effects

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GA-XGBoost, an explainable AI technique, for analysis of thrombin inhibitory activity of diverse pool of molecules and supported by X-ray

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ABSTRACT

The present work involves extreme gradient boosting in combination with shapley values, a thriving amalgamation under the terrain of Explainable artificial intelligence, along with genetic algorithm for the analysis of thrombin inhibitory activity of diverse pool of 2803 molecules. The methodology involves genetic algorithm for feature selection, followed by extreme gradient boosting analysis. The eight parametric genetic algorithm - extreme gradient boosting analysis has high statistical acceptance with $R^2_{tr} = 0.895$, $R^2_{L10\%O} = 0.900$, and Q2F3 = 0.873. Shapley additive explanations, which provide each variable in a model an importance value, served as the foundation for the interpretation. Then, *ceteris paribus* approach involving comparison of counterfactual examples has been used to understand the influence of a structural feature on activity profile. The analysis indicates that aromatic carbon, ring/non-ring nitrogen in combination with other structural features govern the inhibitory profile. The genetic algorithm - extreme gradient boosting model's simplicity and predictions suggest that "Explainable AI" is useful in the future for identifying and using structural features in drug discovery.

1. Introduction

The field of artificial intelligence (AI) has emerged as a prominent tool in the recent times for drug discovery. The advantages such as rapid analysis of large-scale data sets [1], efficient design of new molecules [1,2], cost reduction by streamlining processes and optimizing resource allocation [3], increased success rates by enhancing the overall efficiency and effectiveness of the discovery process [4], screening process acceleration [5], revolutionizing drug development by paving the way for more precise and personalized medicine [6], a few to mention, makes it attractive choice for drug discovery pipeline optimization. AI is basically a broader concept than Machine learning (ML) [7]. The use of ML has a long cherishing history in the field of drug discovery [8,9]. The utilization of ML in drug discovery through molecular modeling involves different statistical methodologies to acquire insights and predict molecular properties or biological activity [10,11]. Commonly utilized machine learning algorithms in the realm of drug design and discovery encompass Linear Regression (LR), Decision Trees (DT), Random Forests (RF), Gradient Boosting (GB), Naive Bayesian (NB), Multilayer Perceptron (MLP), and Neural Networks (NN) [12,13].

Of these, recent study by Wu et al. [14] involving comparison of 14 ML algorithms indicates that Extreme Gradient Boosting (XGBoost), an advanced GB symbolist algorithm, is suitable for small as well as large data sets for ML. And, its performance is better than other ML algorithms like LR, RF, Deep Neural networks (DNN), linear-SVM, etc. [14]. Another advantage is its accuracy and speed in training [15], which are essential throughout drug discovery pipeline. It is a relatively novel thriving approach belonging to supervised ML regression methods. Fundamentally, in XGBoost, an "additive strategy" is used for training, in which a tree ensemble model employs 'n' additive functions to predict

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RESEARCH ARTICLE

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Synthesis, molecular modelling, and biological evaluation of novel quinoxaline derivatives for treating type II diabetes

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ABSTRACT

Quinoxalines are benzopyrazine derivatives with significant therapeutic impact in the pharmaceutical industry. They proved to be useful against inflammation, bacterial, fungal, viral infection, diabetes and other applications. Very recently, in January 2024, the FDA approved new quinoxaline containing drug, erdafitinib for treatment of certain carcinomas. Despite the diverse biological activities exhibited by quinoxaline derivatives and the role of secretory phospholipase A2 (sPLA2) in diabetes-related complications, the potential of sPLA2-targeting quinoxaline-based inhibitors to effectively address these complications remains unexplored. Therefore, we designed novel sPLA2- and α-glucosidase-targeting quinoxaline-based heterocyclic inhibitors to regulate elevated post-prandial blood glucose linked to patients with diabetes-related cardiovascular complications. Compounds **5a–d** and **6a–d** were synthesised by condensing quinoxaline hydrazides with various aryl sulphonyl chlorides. Biological screening revealed compound **6a** as a potent sPLA2 inhibitor (IC_{50} = 0.0475 μM), whereas compound **6c** most effectively inhibited α-glucosidase (IC_{50} = 0.0953 μM), outperforming the positive control acarbose. Moreover, compound **6a** was the best inhibitor for both enzymes. Molecular docking revealed pharmacophoric features, highlighting the importance of a sulfonohydrazide moiety in the structural design of these compounds, leading to the development of potent sPLA2 and α-glucosidase inhibitors. Collectively, our findings helped identify promising candidates for developing novel therapeutic agents for treating diabetes mellitus.

HIGHLIGHTS

- A small, focused library comprising 8 novel compounds was synthesised using a series of substituted quinoxaline sulfonohydrazide derivatives.
- All synthesised compounds were tested against phospholipase A2 (sPLA2) and α-glucosidase enzymes.
- The compounds exhibited activities against α-glucosidase and were potent at nanomolar concentrations against sPLA2 isozymes.
- Structure-based molecular modelling was employed to rationalise the SAR of the compounds.

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KEYWORDS
α-Glucosidase; coronary heart disease; diabetic complications; phospholipase A2; quinoxaline

Introduction

Quinoxaline, characterised by a pyrazine moiety fused with benzene ring, is a constituent of various commercially available drug molecules, including riboflavin. Notably, quinoxaline also accounts for various biological activities; for instance, echinomycin[1] and erdafitinib[2] containing quinoxaline moiety, the first is an antibacterial and antineoplastic agent with nucleic acid inhibitory activity, the second is approved to treat urothelial carcinoma. Similarly, varenicline is a cholinergic and partial agonist for nicotinic receptor whereas dioxidine and mequindox are antibacterial agents[1]. Carbadox controls swine dysentery[2], panadipion acts as a hepatoprotective agent, and sulfoquinoxaline is a veterinary medicine used for treating coccidiosis in cattle and sheep[3]. Moreover, quinoxaline analogues with diverse biological activities and synthetic pathways have been patented (Figure 1).

The primary global public health concerns among patients with diabetes are heart disease, stroke, circulatory failure, and kidney insufficiency[4]. Demir's studies explore the impact of quinone chemicals, particularly naphthoquinones, benzoquinones, and anthraquinones, on human blood paraoxonase-1 (PON1), an enzyme associated with high-density lipoprotein (HDL). PON1 functions to shield LDL from oxidation and eliminate harmful chemicals through detoxification. The findings emphasise the potential of quinone derivatives as inhibitors and their significance in the treatment of cardiovascular disorders and cancer. Demir concluded that reduced PON1 levels are associated with conditions such as diabetes mellitus, cardiovascular diseases, hyperthyroidism, and chronic renal failure. Demir's study investigated the interactions between some antihypertension drugs and PON1. Notably, these drugs exhibited potential inhibitor properties for

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Synthesis and Study of Impact of p-Chloro-m-cresol Incorporated Pyrazole and Isoxazole Derivatives on Phytotic Growth of Some Food Grain & Vegetable Crop Plants

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Abstract: A series of 3,5-disubstituted-1-phenyl pyrazoles (6a-d) and 3,5-disubstituted isoxazoles (7a-d) incorporating 4-chloro-3-methylphenol viz. p-chloro-m-cresol moiety have been effectively synthesized and studied their impact on phytotic growth of some food grain and vegetable crop plants. Initially, 5-chloro-2-hydroxy-4-methylacetophenone (2) has been prepared by an acetylation of p-chloro-m-cresol followed by Fries rearrangement with anhydrous $AlCl_3$. The acetophenone (2) on treatment with substituted aromatic carboxylic acids in dry pyridine with $POCl_3$ affords substituted 2-benzoyloxy acetophenones (3a-d) which on Baker-Venkatraman transformation (BVT) in dry pyridine with pulverized KOH yielded corresponding 1-(5'-chloro-2'-hydroxy-4'-methylphenyl)-3-(substituted phenyl) propane-1,3-diones (4a-d) i.e. β-diketones. All the newly synthesized β-diketones underwent dehydrative cyclization in acidic media affords the respective 2-(substituted phenyl)-6-chloro-7-methyl-4*H*-chromen-4-ones (5a-d) as key intermediates which were refluxed with phenyl hydrazine hydrochloride and hydroxylamine hydrochloride in DMF solvent with small amount of piperidine yielded novel 3,5-disubstituted-1-phenyl pyrazoles (6a-d) and 3,5-disubstituted isoxazoles (7a-d) respectively. All the newly synthesized titled compounds were screened for their impact on phytotic growth of some food grain crop plants viz. *Cicer arientinum*, *Glycine max*, *Vigna radiata*, *Vigna mungo* and some vegetable crop plants viz. *Solanum lycopersicum*, *Trigonella foenum-graecum* and *Capsicum annuum* with reference to their shoot height and number of leaves at definite periodicity and found to have remarkable growth promoting, antifungal and antimicrobial activity on plants.

IndexTerms **- Pyrazoles, isoxazoles, p-chloro-m-cresol, phytotic growth, food grain and vegetable crop plants.**

1. INTRODUCTION

Heterocyclic compounds are very widely distributed in nature and are essential for the sustainable of life in various ways. Pyrazoles and isoxazoles are well known and important class of nitrogen containing five membered heterocycles widely found as the core structure in a large variety of compounds those possess important pharmacological and agrochemical activities. The azoles containing two nitrogen atoms at 1,2-positions are designated as pyrazoles while azoles with one oxygen and one nitrogen atoms at 1,2-positions are designated as isoxazoles. They are one of the most studied groups of compounds among the azole family. Various methods have been worked out for their synthesis[1-9]. Pyrazole derivatives exhibits a broad spectrum of pharmacological and biological activities such as inhibitors of protein glycation, antimicrobial, antibacterial, antifungal, anti-inflammatory and analgesic, anti-obesity drug rimonabant, anticancer, antitumor, anti-tubercular, antioxidant, anticonvulsant and antidepressant, antidiabetic, antipyretic, antiarrhythmic, antiviral, anti-AIDS, antiproliferative, anti-hyperglycemic, anti-anxiety, anti-enzymatic, anti-FAAH, etc[10-17]. As well, a good number of isoxazole derivatives have also been reported to have promising anti-inflammatory, antibacterial, antifungal, antimicrobial, analgesic, anticancer, antitumor, anticonvulsant, antileishmanial, anti-tubercular, ulcerogenic, anti-HIV, antioxidant, antiplatelet, anxiolytic, antiepileptic, antiarthritic, anesthetic, antiviral, anti-nociceptive, immunological and CNS (central nervous system) activity and miscellaneous activities like GABA (γ-amino butyric acid) agonistic activity, inhibitory activity, antihypertensive activity and glutamate transporter activity[18-21]. A survey of literature reveals that several pyrazoles and isoxazoles derivatives have been reported to have promising insecticidal, pesticidal, fungicidal, herbicidal, acaricidal activity which render them valuable active ingredients of plant protecting agents[22-30]. We know the grains, fruits and vegetables have huge importance in human nutrition as these are the rich sources of vitamins and minerals. Today the India is almost self-sufficient to produce food grains, vegetables and fruits. Our greatest achievement is self-sufficient in cereals, foods and vegetables. Yet researchers are continuously working for improvement of quality as well as yield of agricultural products due to continuous increase in population. Now-a-days scientists across the globe are emphasizing more on an interdisciplinary approach to control plant disease, to enhance vegetative growth and to increase the yield of various crops. Pyrazoles and isoxazoles have played a crucial role in the history of heterocyclic chemistry and have been extensively instrumental as pharmacophores and synthons in the field of organic chemistry and drug designing**.** Recently in the field of agricultural sciences they have attracted considerable attention due to their phytotic growth promoting and hormonal activities. Nimbalkar[31] synthesized and studied dichlorosubstituted

4-aroyl-1-substituted pyrazoles for their impact on the phytotic growth of some vegetable crop plants and showed that pyrazoles have remarkable effects on some plants growth and protect the plant from fungal and microbial infections. Deotalu[32] *et al* also synthesized some chlorosubstituted 4-aroyl/alkoyl pyrazoles and isoxazoles and studied their impact on phytotic growth of some vegetable crop plants. Bhade[33] *et al* and Hushare[34] *et al* have reported the growth promoting hormonal activity of chlorosubstituted pyrazoles and isoxazoles on some flowering plants. Keeping in view the phytochemical profile of pyrazoles and isoxazoles, we have decided to study the impact of our newly synthesized p-chloro-m-cresol incorporated pyrazole and isoxazole derivatives on the phytotic growth of some food grain viz. *Cicer arientinum* (Chana), *Glycine max* (Soyabean), *Vigna radiata* (Mung), *Vigna mungo* (Udid) and some vegetable viz. *Solanum lycopersicum* (Tomato), *Trigonella foenum-graecum* (Methi) and *Capsicum annuum* (Mirchi) crop plants particularly with reference to their height of shoots and number of leaves at definite periodicity.

2. MATERIALS AND METHODS

All the chemicals used were of synthetic grade. Melting points were determined in open glass capillaries and were uncorrected. The purity of compounds was monitored on silica gel-G coated TLC plate. Elemental analyses were carried out with a Thermo Scientific FLASH 2000 instrument. IR spectra were recorded on Shimadzu IR Afinity-1 CE spectrophotometer in KBr matrix. ^{1}H NMR spectra were recorded on Bruker Avance Neo 500 MHz spectrometer in DMSO-d_6 with TMS as internal standard. Meanwhile, LC-MS mass spectra were recorded on Waters Micromass Alliance 2795 Q-TOF micromass spectrometer.

2.1 General procedure for the synthesis of pyrazole (6a-d) and isoxazole (7a-d) derivatives[35]

The synthesis of titled compounds involves the following synthetic steps:

2.1.1 Synthesis of p-Chloro-m-cresyl acetate (1): A p-chloro-m-cresol (50g) was mixed with acetic anhydride (60 ml) and anhydrous sodium acetate (5g). The reaction mixture was refluxed for about 1½ hrs. The reaction mixture was allowed to cool followed by their decomposition in ice-cold water. Two layers aqueous and acetate were formed out of which lower acetate layer was separated by means of separating funnel and purified by distillation to obtained a p-chloro-m-cresyl acetate viz. 4-chloro-3-methylphenyl acetate (1).

2.1.2 Synthesis of 5-Chloro-2-hydroxy-4-methylacetophenone (2): A mixture of p-chloro-m-cresyl acetate (1) (50 ml) and anhydrous aluminium chloride (120g) in Kjeldal's flask were heated at about 120 ^{0}C for about 1 hr in an oil bath (Fries migration). The reaction mixture was cooled and decomposed with ice-cold water containing a little HCl (10%) to get crude ketone. It was purified by dissolving it in an acetic acid and allowing the solution to fall drop wise into ice-cold water with continuous stirring to get 5-chloro-2-hydroxy-4-methylacetophenone viz. 1-(5'-chloro-2'-hydroxy-4'-methylphenyl) ethanone (2).

2.1.3 Synthesis of 2-(Substituted benzoyloxy)-4-methyl-5-chloroacetophenones (3a-d): 5-chloro-2-hydroxy-4-methylaceto-phenone (2) (0.04 mol) and appropriate aromatic carboxylic acids (i.e. substituted benzoic acids) (0.05 mol) were dissolved in dry pyridine and $POCl_3$ was added dropwise with stirring and cooling simultaneously till the viscous mass was obtained. Temperature was maintained below 10 ^{0}C during the addition of $POCl_3$. The reaction mixture was allowed to stand for overnight at room temperature and then decomposed by dil. HCl (10%) in an ice bath. The solid product thus separated was filtered, washed with water followed by 10% sodium bicarbonate ($NaHCO_3$) solution and then several times with water. Finally, it was purified by recrystallization from hot ethanol to afford corresponding 2-(substituted benzoyloxy)-4-methyl-5-chloroacetophenones (3a-d).

2.1.4 Synthesis of 1-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-3-(substituted phenyl) propane-1, 3-diones (4a-d) i.e. β-diketones: 2-(substituted benzoyloxy)-4-methyl-5-chloroacetophenones (3a-d) (0.05 mol) was dissolved in dry pyridine (40 ml). The solution was warmed up to 60 ^{0}C and pulverized KOH was added slowly with constant stirring (Baker-Venkataraman rearrangement). Vigorous reaction took place and mixture began to thicken when yellowish-brown mass was obtained. The reaction mixture was kept overnight and then worked up by the dilution and acidification with ice-cold dil. HCl (1:1). The yellowish-brown solid thus obtained was filtered, washed with water followed by 10% sodium bicarbonate ($NaHCO_3$) solution to remove unhydrolysed acid and then again with excess of water. The dried product was purified by recrystallization from ethanol-acetic acid mixture to get yellow crystals of respective 1-(5'-chloro-2'-hydroxy-4'-methylphenyl)-3-(substituted phenyl) propane-1,3-diones (4a-d) i.e. β-diketones with good yield.

2.1.5 Synthesis of 2-(Substituted phenyl)-6-chloro-7-methyl-4*H*-chromen-4-ones (5a-d) i.e. substituted flavones: To a solution of 1-(5'-chloro-2'-hydroxy-4'-methylphenyl)-3-(substituted phenyl) propane-1,3-diones (4a-d) (0.025 mol) in glacial acetic acid (30 ml), sulphuric acid (5 ml) was added. The content of reaction mixture was refluxed on water bath for 2 hrs. followed with occasional stirring. The reaction mixture was allowed to cooled at room temperature and poured into crushed ice to precipitate the product. The separated product was filtered, washed with water followed by 10% sodium bicarbonate ($NaHCO_3$) solution and then with sufficient cold water until the washings were neutral to litmus. The dried product was purified by recrystallization from hot ethanol to get shiny yellow crystals of corresponding 2-(substituted phenyl)-6-chloro-7-methyl-4*H*-chromen-4-ones (5a-d) i.e. substituted flavones with satisfactory yield.

2.1.6 Synthesis of 3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(substituted phenyl)-1-phenyl pyrazoles (6a-d): A mixture of 2-(substituted phenyl)-6-chloro-7-methyl-4*H*-chromen-4-ones (5a-d) (0.01 mol) and phenylhydrazine hydrochloride (0.02 mol) was refluxed in DMF solvent with few drops of piperidine for about 1½ hrs. The reaction mixture was cooled and then acidified with ice-cold dil. HCl (1:1). The product thus separated was filtered, washed with water followed by 10% sodium bicarbonate ($NaHCO_3$) solution and then again with plenty of water. It was dried and purified by recrystallization from ethanol-acetic acid mixture to get shiny coloured crystals of corresponding 3-(5'-chloro-2'-hydroxy-4'-methylphenyl)-5-(substituted phenyl)-1-phenyl pyrazoles (6a-d) as desired products with excellent yield.

2.1.7 Synthesis of 3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(substituted phenyl) isoxazoles (7a-d): A mixture of 2-(substituted phenyl)-6-chloro-7-methyl-4*H*-chromen-4-ones (5a-d) (0.01 mol) and hydroxylamine hydrochloride (0.02 mol) was refluxed in DMF solvent with few drops of piperidine for about 1½ hrs. The reaction mixture was cooled and then acidified with ice cold dil. HCl (1:1). The product thus separated was filtered, washed with water followed by 10% sodium bicarbonate ($NaHCO_3$) solution and then again with plenty of water. It was dried and purified by recrystallization from ethanol-acetic acid

mixture to get shiny coloured crystals of corresponding 3-(5'-chloro-2'-hydroxy-4'-methylphenyl)-5-(substituted phenyl) isoxazoles (7a-d) as desired products with excellent yield. The general reaction scheme outlined for the synthesis of 3,5-disubstituted-1-phenyl pyrazoles (6a-d) and 3,5-disubstituted isoxazoles (7a-d) is depicted below in **Figure 1** and their physical characterization data is shown in **Table 1**.

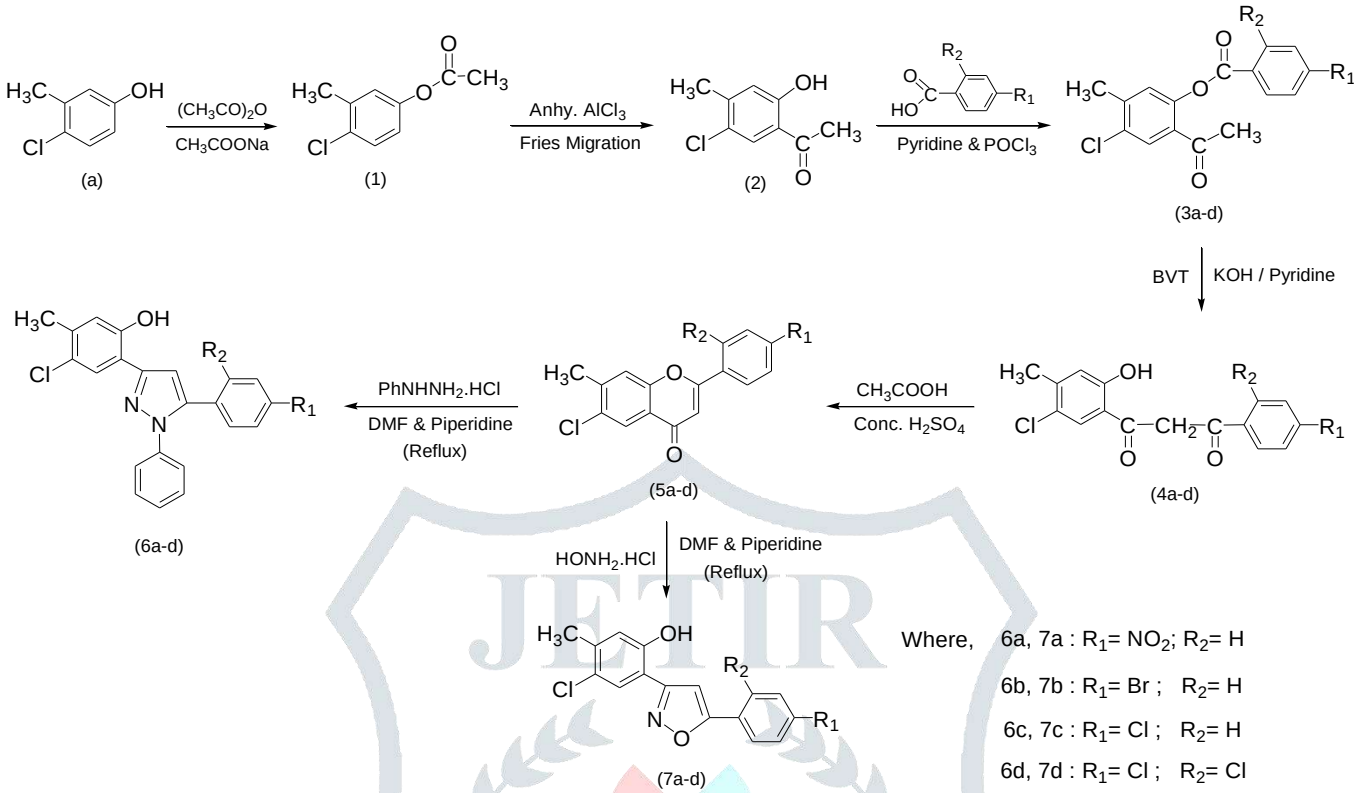

Figure 1: The general reaction scheme for the synthesis of novel pyrazole (6a-d) and isoxazole (7a-d) derivatives

Table 1: Physical characterization data of newly synthesized pyrazole (6a-d) and isoxazole (7a-d) derivatives

Compound Code	Compound Name	Mol. Formula	Mol.Wt. (g/mol)	M.P. (^{0}C)	Yield (%)	R_f value
6a	*3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-nitrophenyl)-1-phenyl pyrazole*	$C_{22}H_{16}ClN_3O_3$	405.83	220-222	79	0.70
6b	*3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-bromophenyl)-1-phenyl pyrazole*	$C_{22}H_{16}BrClN_2O$	439.73	218-222	86	0.67
6c	*3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-chlorophenyl)-1-phenyl pyrazole*	$C_{22}H_{16}Cl_2N_2O$	395.28	218-224	84	0.82
6d	*3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(2',4'-dichlorophenyl)-1-phenyl pyrazole*	$C_{22}H_{15}Cl_3N_2O$	429.73	238-240	90	0.80
7a	*3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-nitrophenyl) isoxazole*	$C_{16}H_{11}ClN_2O_4$	330.72	228-230	85	0.65
7b	*3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-bromophenyl) isoxazole*	$C_{16}H_{11}BrClNO_2$	364.62	254-258	87	0.76
7c	*3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-chlorophenyl) isoxazole*	$C_{16}H_{11}Cl_2NO_2$	320.17	218-222	88	0.82
7d	*3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(2', 4'-dichlorophenyl) isoxazole*	$C_{16}H_{10}Cl_3NO_2$	354.62	240-244	90	0.70

2.2 Phytotic growth effects of the titled compounds on some food grain and vegetable crops plants[31-34]

The experimental set up of the present study was divided into two segments:

2.2.1 Seed treatment: Pregerminated quality seeds of some food grains viz. *Cicer arientinum* (Chana/Chana), *Glycine max* (Soyabean), *Vigna radiata* (Mung), *Vigna mungo* (Udid) and vegetables viz. *Solanum lycopersicum* (Tomato), *Trigonella foenum-graecum* (Methi/Fenugreek) and *Capsicum annuum* (Mirchi/Chilli) have been procured from authorized agroagency. With a view to safeguard dormant seed potential from harmful external agencies, the seeds of all the grain and vegetable crops were treated before sowing with test compounds 3-(5'-chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-nitrophenyl)-1-phenyl pyrazole (6a), 3-(5'-chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-bromophenyl)-1-phenyl pyrazole (6b), 3-(5'-chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-chlorophenyl)-1-phenyl pyrazole (6c), 3-(5'-chloro-2'-hydroxy-4'-methylphenyl)-5-(2', 4'-dichlorophenyl)-1-phenyl pyrazole (6d), 3-(5'-chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-nitrophenyl) isoxazole (7a), 3-(5'-chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-bromophenyl) isoxazole (7b), 3-(5'-chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-chlorophenyl) isoxazole (7c), and 3-(5'-

chloro-2'-hydroxy-4'-methylphenyl)-5-(2', 4'-dichlorophenyl) isoxazole (7d) by immersing dry seeds in their solutions prepared by 1,4-dioxane solvent having concentration (0.01 mg/ml) at room temperature for 6-8 hrs by soaking method i.e. treated.

2.2.2 Field experiment: The pots of black cotton soil were prepared on an open field by using 8 x 12-inch size high density polythene (HDPE) nursery bags and labelled it. The sowing of seeds of all seven species under examination were done in these pots separately by conventional sowing method and irrigated it by water whenever required. The plants from these pots were divided into two groups i.e. A and B. The plants from group A were kept untreated and unsprayed which were termed as 'Control' group whereas plants from group B were treated with test compounds as well as sprayed and designated as 'Treated' group plants. The spraying solutions of newly synthesized 3,5-disubstituted-1-phenyl pyrazoles (6a-d) and 3,5-disubstituted isoxazoles (7a-d) containing p-chloro-m-cresol moiety have been prepared in 1,4-dioxane (0.01 M) separately and the plants from group B were sprayed with these test compounds solutions at fortnightly intervals after germination to screen their impact on test plants. The field experiments were conducted to compare the treated plants of group B with untreated plants of controlled group A. In this context, the plants were carefully examined and the observations were recorded on 7th, 14th, 21th, 28th, 35th and 42th days after sowing stage with special reference to their number of leaves and height of their shoots. The results obtained subjected to analysis of phytotic growth parameters during the field experiments with test compounds are tabularized in the following tables:

Table 2: Effects of newly synthesized substituted pyrazoles (6a-d) and isoxazoles (7a-d) derivatives on phytotic growth of *Cicer arientinum* (Chana/Gram) crop plants

Periodicity of observation in Days	Observation of shoot height (in cm) and number of leaves of control (C) and treated (T) crop plants									
	Compd. code →	Control (C)	(6a)	(6b)	(6c)	(6d)	(7a)	(7b)	(7c)	(7d)
7th Days	Shoot height	6	8	7	7	7	7	8	8	8
	No. of leaves	18	25	24	25	25	26	26	26	20
14th Days	Shoot height	8	9.5	10	9.5	9	9	10.5	10	11
	No. of leaves	47	56	66	55	66	63	58	58	52
21th Days	Shoot height	10	11	14	14	15	14	14	15	15
	No. of leaves	81	97	99	95	90	98	105	96	92
28th Days	Shoot height	13	13.5	17	16.5	17	15	15.5	17	17
	No. of leaves	125	136	146	144	172	136	139	139	143
35th Days	Shoot height	16	17	18	18	18	19	20	19	18.5
	No. of leaves	188	199	190	219	209	224	215	220	216
42th Days	Shoot height	20	19	22	24	20	20	22	22	21
	No. of leaves	204	210	220	229	218	239	227	232	228

Table 3: Effects of newly synthesized substituted pyrazoles (6a-d) and isoxazoles (7a-d) derivatives on phytotic growth of *Glycine max* (Soyabean) crop plants

Periodicity of observation in Days	Observation of shoot height (in cm) and number of leaves of control (C) and treated (T) crop plants									
	Compd. code →	Control (C)	(6a)	(6b)	(6c)	(6d)	(7a)	(7b)	(7c)	(7d)
7th Days	Shoot height	5	6	7	5	6	7	7	5.5	5
	No. of leaves	4	4	4	4	4	4	4	4	4
14th Days	Shoot height	6	7	8	6	7	8	8	7	6
	No. of leaves	4	4	5	4	4	4	4	4	4
21th Days	Shoot height	8	9	10	9	9	10	10	9	9
	No. of leaves	7	7	8	9	9	8	8	8	9
28th Days	Shoot height	10	12	12	12	11	14	13	11	10.5
	No. of leaves	8	10	12	11	11	10	10	10	10
35th Days	Shoot height	15	22	21	16	20	20	21	20	20
	No. of leaves	15	17	25	20	13	20	17	19	16
42th Days	Shoot height	17	22	22	23	22	22	22	22	22
	No. of leaves	17	20	28	26	22	24	26	22	21

Table 4: Effects of newly synthesized substituted pyrazoles (6a-d) and isoxazoles (7a-d) derivatives on phytotic growth of *Vigna radiata* (Mung) crop plants

Periodicity of observation in Days	Observation of shoot height (in cm) and number of leaves of control (C) and treated (T) crop plants									
	Compd. code →	Control (C)	(6a)	(6b)	(6c)	(6d)	(7a)	(7b)	(7c)	(7d)
7th Days	Shoot height	1.8	4.5	2.5	5	4.5	5	3.5	4	3
	No. of leaves	2	2	2	2	2	2	2	2	2
14th Days	Shoot height	5	10.5	5	13	10	12	11	12	11
	No. of leaves	2	2	2	2	2	2	2	2	2
21th Days	Shoot height	12	15	8.5	18	19	16	15	17.5	17.5
	No. of leaves	5	5	5	8	5	5	5	8	5

28th Days	Shoot height	13	16	11	20	20	18	18.5	19	19
	No. of leaves	8	8	9	8	8	8	8	8	6
35th Days	Shoot height	14	16.5	15	22	20.5	19	22	20	20
	No. of leaves	9	8	12	9	8	10	11	10	8
42th Days	Shoot height	15	18	16	23	23	22	24	22	21
	No. of leaves	14	10	15	14	9	12	14	13	9

Table 5: Effects of newly synthesized substituted pyrazoles (6a-d) and isoxazoles (7a-d) derivatives on phytotic growth of *Vigna mungo* (Udid) crop plants

Periodicity of observation in Days	**Observation of shoot height (in cm) and number of leaves of control (C) and treated (T) crop plants**								
	Compd. code →	**Control (C)**	**(6a)**	**(6b)**	**(6c)**	**(6d)**	**(7a)**	**(7b)**	**(7c)**	**(7d)**
7th Days	Shoot height	0.5	1.2	2.5	1.2	1.5	1	1.5	1.5	2
	No. of leaves	2	2	2	2	2	2	2	2	2
14th Days	Shoot height	5	5	6.5	4	7	5	2.5	4	4.5
	No. of leaves	2	2	2	2	2	2	2	2	2
21th Days	Shoot height	9	9	10	5	12	9	4	8	10
	No. of leaves	5	8	5	5	8	5	5	5	8
28th Days	Shoot height	10.5	10	11	6	13	11	6	8.5	11.5
	No. of leaves	11	14	8	8	14	11	8	8	14
35th Days	Shoot height	12	10.5	11	8	15	12	8	9	13
	No. of leaves	14	20	9	9	29	17	11	11	17
42th Days	Shoot height	16	12	11.5	9	19	16	10	11	18
	No. of leaves	18	21	10	15	47	19	13	14	20

Table 6: Effects of newly synthesized substituted pyrazoles (6a-d) and isoxazoles (7a-d) derivatives on phytotic growth of *Solanum lycopersicum* (Tomato) crop plants

Periodicity of observation in Days	**Observation of shoot height (in cm) and number of leaves of control (C) and treated (T) crop plants**								
	Compd. code →	**Control (C)**	**(6a)**	**(6b)**	**(6c)**	**(6d)**	**(7a)**	**(7b)**	**(7c)**	**(7d)**
7th Days	Shoot height	2	2.3	2.2	2.4	2.4	2.6	2.9	2.5	2.5
	No. of leaves	2	2	2	2	2	2	2	2	2
14th Days	Shoot height	3	3.4	3.3	3.5	3.5	3.5	3.3	2.8	3.5
	No. of leaves	4	4	4	4	4	4	4	4	4
21th Days	Shoot height	4.5	7	7	7	7	5	7	7	7
	No. of leaves	7	12	11	17	13	10	12	9	11
28th Days	Shoot height	7	9.5	9.5	9	8.5	9	9	9.2	9.4
	No. of leaves	17	20	22	21	19	18	20	21	18
35th Days	Shoot height	11	12	12	12	12	12	13	12	12
	No. of leaves	22	24	24	25	23	22	25	26	25
42th Days	Shoot height	14	16	19	16	18	18	18	18	20
	No. of leaves	29	34	43	36	47	39	37	42	39

Table 7: Effects of newly synthesized substituted pyrazoles (6a-d) and isoxazoles (7a-d) derivatives on phytotic growth of *Trigonella foenum-graecum* (Methi/Fenugreek) crop plants

Periodicity of observation in Days	**Observation of shoot height (in cm) and number of leaves of control (C) and treated (T) crop plants**								
	Compd. code →	**Control (C)**	**(6a)**	**(6b)**	**(6c)**	**(6d)**	**(7a)**	**(7b)**	**(7c)**	**(7d)**
7th Days	Shoot height	2	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	No. of leaves	2	2	2	2	2	2	2	2	2
14th Days	Shoot height	2.5	3	3	3	3	3.3	3.2	3	3
	No. of leaves	3	3	3	3	3	3	3	3	3
21th Days	Shoot height	9	11	11	12	13	10	10	13	14
	No. of leaves	10	12	11	11	12	6	8	11	14
28th Days	Shoot height	12	17	17	18	18	10.5	11	15	16.5
	No. of leaves	10	15	17	16	20	10	11	16	19

35th Days	Shoot height	20	26	28	28	29	14	17	24	25
	No. of leaves	16	26	25	22	28	15	20	22	24
42th Days	Shoot height	27	36	38	35	40	24	25	36	36
	No. of leaves	27	30	36	40	38	28	29	37	40

Table 8: Effects of newly synthesized substituted pyrazoles (6a-d) and isoxazoles (7a-d) derivatives on phytotic growth of *Capsicum annuum* (Mirchi/Chilli) crop plants

Periodicity of observation in Days	Observation of shoot height (in cm) and number of leaves of control (C) and treated (T) crop plants								
	Compd. code →	Control (C)	(6a)	(6b)	(6c)	(6d)	(7a)	(7b)	(7c)	(7d)
7th Days	Shoot height	1.5	2.3	2.4	2.4	2.5	2.5	2.5	2.5	2.5
	No. of leaves	4	5	5	4	4	4	4	4	4
14th Days	Shoot height	2	2.8	2.8	2.8	3	3	3	3	3
	No. of leaves	4	5	5	5	5	5	5	5	5
21th Days	Shoot height	3	3.5	6.5	6	6.5	7.5	11	5.5	5.5
	No. of leaves	5	5	6	5	8	8	10	5	8
28th Days	Shoot height	3.8	8	8.5	7.5	9	13	17	7.5	8
	No. of leaves	5	8	7	6	10	10	15	8	8
35th Days	Shoot height	4.4	11	12	8.5	11	17	22	9	9
	No. of leaves	6	10	10	7	16	17	22	10	10
42th Days	Shoot height	6	13	16	11	14	23	25	11.5	12
	No. of leaves	8	14	16	9	22	27	29	12	15

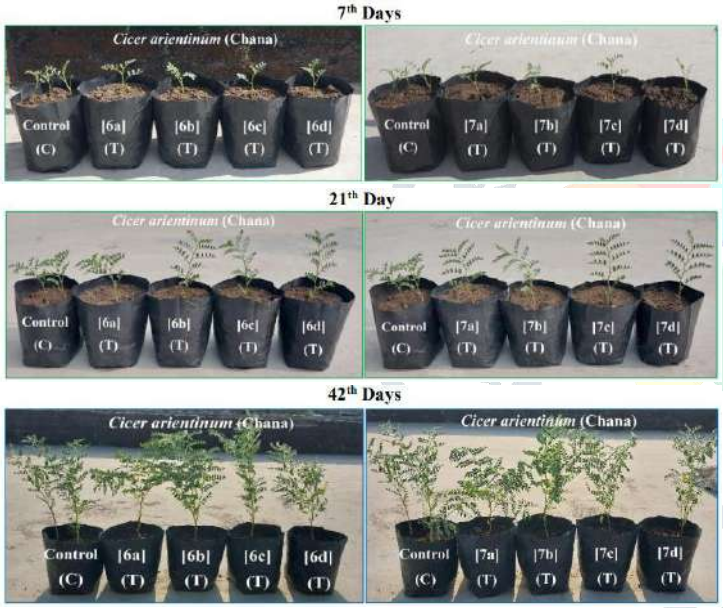

Figure 2: Impact of newly synthesized pyrazoles (6a-d) & isoxazoles (7a-d) derivatives on phytotic growth of *Cicer arientinum* (Chana/Gram) plants

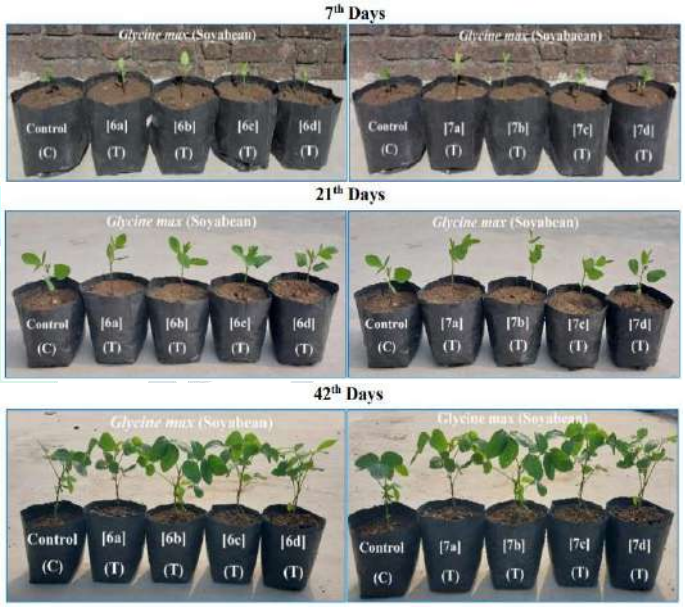

Figure 3: Impact of newly synthesized pyrazoles (6a-d) & isoxazoles (7a-d) derivatives on phytotic growth of *Glycine max* (Soyabean) plants

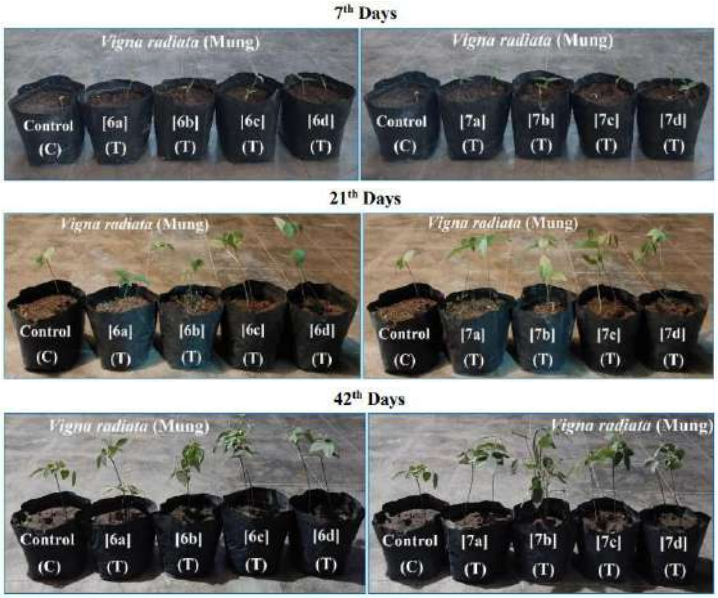

Figure 4: Impact of newly synthesized pyrazoles (6a-d) & isoxazoles (7a-d) derivatives on phytotic growth of *Vigna radiata* (Mung) plants

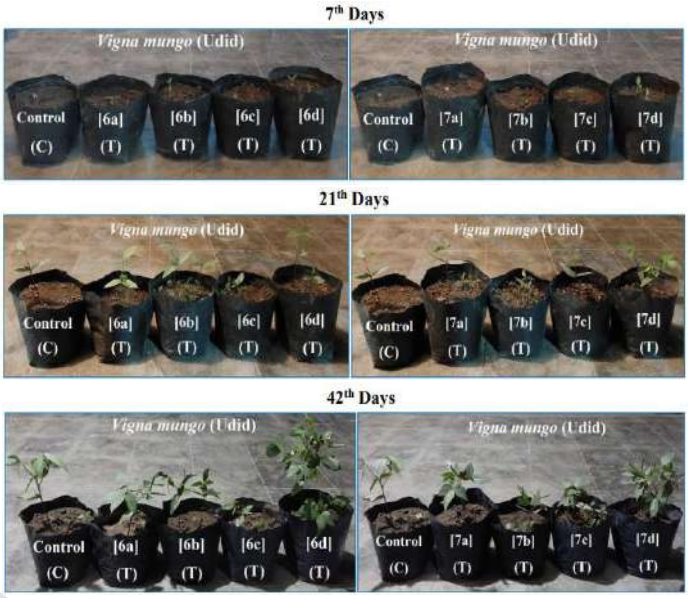

Figure 5: Impact of newly synthesized pyrazoles (6a-d) & isoxazoles (7a-d) derivatives on phytotic growth of *Vigna mungo* (Udid) plants

Figure 6: Impact of newly synthesized pyrazoles (6a-d) & isoxazoles (7a-d) derivatives on phytotic growth of *Solanum lycopersicum* (Tomato) plants

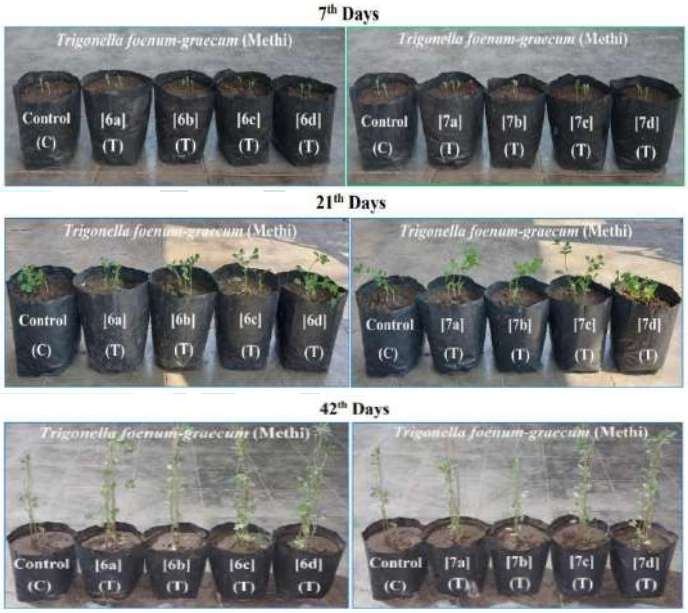

Figure 7: Impact of newly synthesized pyrazoles (6a-d) & isoxazoles (7a-d) derivatives on phytotic growth of *Trigonella foenum-graecum* (Methi/ Fenugreek) plants

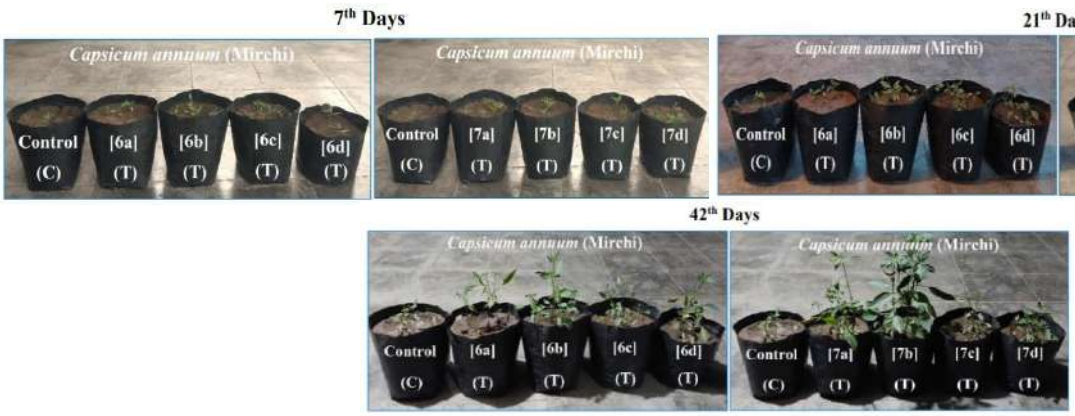

Figure 8: Impact of newly synthesized pyrazoles (6a-d) & isoxazoles (7a-d) derivatives on phytotic growth of *Capsicum annuum* (Mirchi/Chilli) plants

3. RESULTS AND DISCUSSION

The present study was aimed at impact of newly synthesized p-chloro-m-cresol incorporating 3,5-disubstituted-1-phenyl pyrazoles (6a-d) and 3,5-disubstituted isoxazoles (7a-d) on phytotic growth of *Cicer arientinum* (Chana), *Glycine max* (Soyabean), *Vigna radiata* (Mung), *Vigna mungo* (Udid), *Solanum lycopersicum* (Tomato), *Trigonella foenum-graecum* (Methi) and *Capsicum annuum* (Mirchi) crop plants. The seeds of all these plants under investigation fall into the category of dicots. The choice of these crops was made on the basis of their enormously vast utility, distinctive features, and indispensability for the survival of the human race across the globe. The efforts have been made to investigate and analyse the convergence and divergence of the effects of test compounds on morphology of plants under investigation. When the first comparison of morphological character was made between those of controlled (C) and treated (T) group plants, it was interesting to note that all the treated plants exhibited remarkable shoot growth and considerable increase in the number of leaves as compared with the controlled crop plants. When all the treated plants were compared among themselves, it was distinctly observed that the plants of *Cicer arientinum* (Chana), *Glycine max* (Soyabean), *Vigna radiata* (Mung), *Solanum lycopersicum* (Tomato), *Trigonella foenum-graecum* (Methi) and *Capsicum annuum* (Mirchi) showed pronounced and dominant vegetative growth in shoot height and number of leaves. It was noticed that, all the newly synthesized pyrazoles (6a-d) and isoxazoles (7a-d) derivatives showed excellent growth promoting effects on *Cicer arientinum* (Chana), *Glycine max* (Soyabean), *Vigna radiata* (Mung) and *Solanum lycopersicum* (Tomato) plants. In case of *Trigonella foenum-graecum* (Methi), the compounds 6a, 6b, 6c, 6d, 7c and 7d showed excellent growth promoting impact whereas compound 7a, 7b exhibit less to moderate effects on shoot height and number of leaves. In case of treated crop plants of *Capsicum annuum* (Mirchi), the compounds 6a, 6b, 6d, 7a, 7b and 7d showed excellent growth promoting effects while compound 6c and 7c shows less to moderate effects on vegetative growth. As far as *Vigna mungo* (Udid) plants is concern, the compounds 6d, 7a and 7d showed good vegetative growth than compounds 6a, 6b, 6c, 7b, 7c which showed moderate growth. This observation may be attributed to the presence of nitrogen containing heterocyclic rings in the test compounds, which might have encouraged the nitrogen fixation in plant roots. In the first 3-week intervals the growth of treated plants gradually increases but after 21 and 28 days it shows a rapid increase in height of shoots and number of leaves and shows good results. Another fact which was observed during field experiment is that, all the tested plants were free from any pathogenic microbial or fungal infections. This might be due to the presence of p-chloro-m-cresol phenolic moiety in the test compounds.

4. CONCLUSION

From above discussion it is concluded that all the newly synthesized nitrogen containing 3,5-disubstituted-1-phenyl pyrazoles (6a-d) and 3,5-disubstituted isoxazoles (7a-d) compounds incorporating p-chloro-m-cresol moiety shows remarkable effects on phytotic growth of tested grain and vegetable crop plants as compared to controlled ones and they have protected the plants from fungal and microbial infections. However further detailed study in the light of agricultural sciences especially for their pathogenic disease controlling activities in crops would certainly prove to be beneficial tool for service to the mankind and society.

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SYNTHESIS, CHARACTERIZATION AND PHARMACOLOGICAL EVALUATION OF SOME NOVEL PYRAZOLE AND ISOXAZOLE DERIVATIVES CARRYING 4-CHLORO-3-METHYL PHENOL (P-CHLORO-M-CRESOL) MOIETY

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ABSTRACT

A new series of 3,5-disubstituted-1-phenyl pyrazoles (6a-d) and 3,5-disubstituted isoxazoles (7a-d) incorporating phenolic moiety of p-chloro-m-cresol viz. 4-chloro-3-methylphenol have been synthesized in excellent yields via interactions of corresponding substituted flavones (5a-d) with phenyl hydrazine hydrochloride and hydroxylamine hydrochloride respectively in DMF solvent with small amount of piperidine. Initially, disubstituted 2-hydroxy acetophenone (2) was prepared by an acetylation of p-chloro-m-cresol followed by Fries rearrangement which on reactions with different aromatic carboxylic acids in dry pyridine using $POCl_3$ gives substituted 2-benzoyloxyacetophenones (3a-d). A Baker-Venkataraman rearrangement (BVT) of substituted 2-benzoyloxyacetophenones (3a-d) with pulverized KOH in dry pyridine gives respective 1,3-diketone or β-diketone derivatives (4a-d) which on dehydrative cyclization in an acidic media yielded required substituted flavones (5a-d) as key intermediate for the synthesis of titled compounds. The structures of newly synthesized pyrazole and isoxazole derivatives have been confirmed by usual chemical characteristics, elemental analysis, IR, ^{1}H NMR and Mass spectroscopic techniques. All the newly synthesized compounds were evaluated in *vitro* against human pathogenic microorganisms in order to assess their antibacterial and antifungal activities using disc diffusion method. They were also tested for their in *vitro* antioxidant and anti-inflammatory potential by adopting DPPH free radical scavenging and inhibition of protein denaturation method respectively with reference to standard drugs.

KEYWORDS: Pyrazoles, Isoxazoles, p-Chloro-m-cresol, Synthesis, Pharmacological study.

INTRODUCTION

Heterocyclic compounds are versatile, highly valuable and unique class of compounds of chemical and biological interest. Amongst heterocyclics, the five membered heterocycles with two heteroatoms mainly pyrazoles and isoxazoles have gained considerable interest in various fields because of their wide range of pharmacological and physical applications. Pyrazole is a five membered aromatic heterocyclic moiety having two adjacent nitrogen atoms and three carbon atoms.[1] Isoxazole is also an unsaturated aromatic heterocyclic compound containing a ring with three carbon atoms and one oxygen atom next to nitrogen atom.[2] Several pyrazole and isoxazole derivatives possess antimicrobial,[3-7] analgesic and anti-inflammatory,[8-14] anticancer,[15-21] antitumor,[22-23] anti-HIV,[24-25] anticonvulsant,[26-29] antitubercular[30-31] and antioxidant[32-33] properties. Besides, pyrazole containing drugs celecoxib demonstrates anti-inflammation effect and inhibits COX-2[34] rimonabant functions as cannabinoid receptor and is utilized in obesity treatment,[35] fomepizole inhibits alcohol dehydrogenase and sildenafil inhibits phosphodiesterase.[36] Recently, pyrazole molecules have been proved to be as effective drugs for ACE2 infected human cells against COVID-19.[37] In addition, they have been found to played crucial role as agrochemicals in crop protection chemistry such as insecticidal, fungicidal and herbicidal agents.[38-40] Isoxazole motif is ubiquitous in many natural products such as ibotenic acid, muscimol, isoxazole-4-carboxylic acid and drugs like valdecoxib, leflunomide, cloxacillin, oxacillin,[41-45] dicloxacillin,[46] isocarboxazide[47] and sulfisoxazole.[48] Among the various methods for the synthesis of pyrazoles, 1,3-dipolar cycloaddition and [2+3] cyclocondensation reactions are the prominent ones.[49] Among the different methods of isoxazole synthesis, [2+3] cycloaddition of 1,3-dipoles to alkynes and the reaction of hydroxylamine with 1,3-diketone (β-diketone) or an α, β-unsaturated ketones have gained much importance.[50] Moreover, chalcones and flavones

are also valuable substrates in a variety of synthetic transformations and useful as building blocks in synthesis of physiologically active pyrazole and isoxazole derivatives. Nowadays, development of pharmacologically active heterocycles adopting simple methodologies is one of the major challenges for organic chemists. On the other hand, interest towards the synthesis of novel pyrazole and isoxazole derivatives with the aim to discover their therapeutic values remains a main focus of medicinal and pharmaceutical research and much research has been carried out in this direction. Keeping in view the pharmacological profile of these two chemically distinct but pharmacologically compatible molecules, we have decided to prepare some novel 3,5-disubstituted-1-phenyl pyrazoles and 3,5-disubstituted isoxazoles bearing phenolic moiety of p-chloro-m-cresol viz. 4-chloro-3-methylphenol in order to explore their pharmacological properties. Hence, in this present communication, a new series namely 3-(5'-chloro-2'-hydroxy-4'-methylphenyl)-5-(substituted phenyl)-1-phenyl pyrazoles (6a-d) and 3-(5'-chloro-2'-hydroxy-4'-methylphenyl)-5-(substituted phenyl) isoxazoles (7a-d) has been efficiently synthesized by the interactions of newly synthesized flavone analogues (5a-d) with phenylhydrazine hydrochloride and hydroxylamine hydrochloride respectively in DMF solvent with slight amount of piperidine. The success of synthesis and constitutions of the synthesized compounds have been assigned on the basis of chemical characteristics, elemental analysis, and IR, ^{1}H NMR and Mass spectral data studies. All the newly synthesized compounds have been evaluated for their in *vitro* antibacterial and antifungal activities against human pathogenic bacterial and fungal strains by using disc diffusion method. Moreover, they have been also tested for their in *vitro* antioxidant and anti-inflammatory potential against standard reference drugs by adopting DPPH free radical scavenging and inhibition of protein denaturation method respectively with slight modifications.

MATERIALS AND METHODS

All the chemicals and solvents were of synthetic grade procured from commercial sources and used without further purification. Melting points were determined in open glass capillaries and were uncorrected. All the newly synthesized compounds were purified by recrystallization and their purity was ascertained by TLC on silica gel (G) plates. The elemental analyses were carried out on a Thermo Scientific FLASH 2000 elemental analyzer instrument. IR spectra have been recorded on a Shimadzu IR Affinity-1 CE (Japan) spectrophotometer in KBr matrix. A Brucker Avance Neo FTNMR spectrometer of 500 MHz was used to acquire ^{1}H NMR spectra with DMSO-d_6 as solvent and TMS as an internal reference (chemical shifts in δ ppm). Meanwhile, LC-MS spectra were recorded on the Waters Micromass Alliance 2795 Q-TOF micromass spectrometer (SAIF, PU, Chandigarh).

General procedure for synthesis of pyrazole (6a-d) and isoxazole (7a-d) derivatives

The synthesis involves the following synthetic steps:

1. Synthesis of p-Chloro-m-cresyl acetate (1): A p-chloro-m-cresol (50g) was mixed with acetic anhydride (60 ml) and anhydrous sodium acetate (5g). The reaction mixture was refluxed for about 1½ hrs. The reaction mixture was allowed to cool followed by their decomposition in ice-cold water. Two layers aqueous and acetate were formed out of which lower acetate layer was separated by means of separating funnel and purified by distillation to obtained a p-chloro-m-cresyl acetate viz. 4-chloro-3-methylphenyl acetate (1) as a colourless liquid.

2. Synthesis of 5-Chloro-2-hydroxy-4-methyl acetophenone (2): A mixture of p-chloro-m-cresyl acetate (1) (50 ml) and anhydrous aluminium chloride (120g) in Kjeldal's flask were heated at about 120 ^{0}C for about 1 hr in an oil bath (Fries migration). The reaction mixture was cooled and decomposed with ice-cold water containing a little HCl (10%) to get crude ketone. It was purified by dissolving it in an acetic acid and allowing the solution to fall drop wise into ice-cold water with continuous stirring to get 5-chloro-2-hydroxy-4-methyl acetophenone viz. 1-(5'-chloro-2'-hydroxy-4'-methylphenyl) ethanone (2) as a white solid.

3. Synthesis of 2-(Substituted benzoyloxy)-4-methyl-5-chloroacetophenones (3a-d): 5-chloro-2-hydroxy-4-methylacetophenone (2) (0.04 mol) and appropriate aromatic carboxylic acids (i.e. substituted benzoic acids) (0.05 mol) were dissolved in dry pyridine and $POCl_3$ was added drop by drop with stirring and cooling simultaneously till the viscous mass was obtained. Temperature was maintained below 10 ^{0}C during the addition of $POCl_3$. The reaction mixture was allowed to stand for overnight at room temperature and then decomposed by dil. HCl (10%) in an ice bath. The solid product thus separated was filtered, washed with water followed by 10% sodium bicarbonate ($NaHCO_3$) solution and then again several times with water. Finally, it was purified by recrystallization from hot ethanol to afford corresponding 2-(substituted benzoyloxy)-4-methyl-5-chloroacetophenones (3a-d) as pale-yellow solids.

4. Synthesis of 1-(5'-Chloro-2'-hydroxy-4'-methyl phenyl)-3-(substituted phenyl) propane-1, 3-diones (4a-d) i.e. β-diketones: 2-(substituted benzoyloxy)-4-methyl-5-chloroacetophenones (3a-d) (0.05 mol) was dissolved in dry pyridine (40 ml). The solution was warmed up to 60 ^{0}C and pulverized KOH was added slowly with constant stirring (Baker-Venkataraman rearrangement). Vigorous reaction took place and mixture began to thicken when yellowish-brown mass was obtained. The reaction mixture was kept overnight and then worked up by the dilution and acidification with ice-cold dil. HCl (1:1). The yellowish-brown solid thus obtained was filtered, washed with water followed by 10% sodium bicarbonate ($NaHCO_3$) solution to remove

unhydrolysed acid and then again with excess of water. The dried product was purified by recrystallization from ethanol-acetic acid mixture to get yellow crystals of respective 1-(5'-chloro-2'-hydroxy-4'-methylphenyl)-3-(substituted phenyl) propane-1,3-diones (4a-d) i.e. β-diketones with good yield.

5. Synthesis of 2-(Substituted phenyl)-6-chloro-7-methyl-4*H*-chromen-4-ones (5a-d) i.e. substituted flavones: To a solution of 1-(5'-chloro-2'-hydroxy-4'-methylphenyl)-3-(substituted phenyl) propane-1,3-diones (4a-d) (0.025 mol) in glacial acetic acid (30 ml), sulphuric acid (5 ml) was added. The content of reaction mixture was refluxed on water bath for 2 hrs. followed with occasional stirring. The reaction mixture was allowed to cooled at room temperature and poured into crushed ice to precipitate the product. The separated product was filtered, washed with water followed by 10% sodium bicarbonate ($NaHCO_3$) solution and then with sufficient cold water until the washings were neutral to litmus. The dried product was purified by recrystallization from hot ethanol to get shiny yellow crystals of corresponding 2-(substituted phenyl)-6-chloro-7-methyl-4*H*-chromen-4-ones (5a-d) i.e. substituted flavones with satisfactory yield.

6. Synthesis of 3-(5'-Chloro-2'-hydroxy-4'-methyl phenyl)-5-(substituted phenyl)-1-phenyl pyrazoles (6a-d): A mixture of 2-(substituted phenyl)-6-chloro-7-methyl-4*H*-chromen-4-ones (5a-d) (0.01 mol) and phenyl hydrazine hydrochloride (0.02 mol) was refluxed in DMF solvent with few drops or little amount of piperidine for about 1½ hrs. The reaction mixture was cooled and then acidified with ice-cold dil. HCl (1:1). The product thus separated was filtered, washed with water followed by 10% sodium bicarbonate ($NaHCO_3$) solution and then again with plenty of water. It was dried and purified by recrystallization from ethanol-acetic acid mixture to get shiny coloured crystals of corresponding 3-(5'-chloro-2'-hydroxy-4'-methyl phenyl)-5-(substituted phenyl)-1-phenyl pyrazoles (6a-d) as desired products with excellent yield.

7. Synthesis of 3-(5'-Chloro-2'-hydroxy-4'-methyl phenyl)-5-(substituted phenyl) isoxazoles (7a-d): A mixture of 2-(substituted phenyl)-6-chloro-7-methyl-4*H*-chromen-4-ones (5a-d) (0.01 mol) and hydroxylamine hydrochloride (0.02 mol) was refluxed in DMF solvent with few drops or little amount of piperidine for about 1½ hrs. The reaction mixture was cooled and then acidified with ice cold dil. HCl (1:1). The product thus separated was filtered, washed with water followed by 10% sodium bicarbonate ($NaHCO_3$) solution and then again with plenty of water. It was dried and purified by recrystallization from ethanol-acetic acid mixture to get shiny coloured crystals of corresponding 3-(5'-chloro-2'-hydroxy-4'-methyl phenyl)-5-(substituted phenyl) isoxazoles (7a-d) as desired products with excellent yield. The general reaction scheme outlined for the synthesis of 3,5-disubstituted-1-phenyl pyrazole (6a-d) and 3,5-disubstituted isoxazole (7a-d) derivatives is depicted below in Figure 1 and their physical characterization data is shown in Table 1.

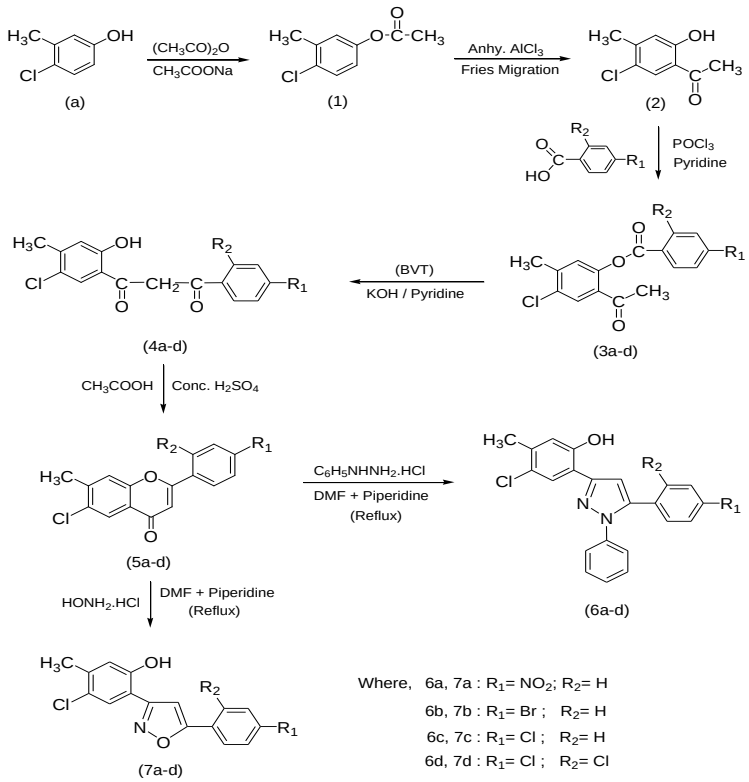


Figure 1: The general reaction scheme for the synthesis of 3,5-disubstituted-1-phenyl pyrazoles (6a-d) and 3,5-disubstituted isoxazoles (7a-d).

Table 1: Physical characterization data of newly synthesized pyrazole (6a-d) & isoxazole (7a-d) derivatives.

Code	Compound Name	Mol. Formula	Mol.Wt. (g/mol)	M.P. (^{0}C)	Yield (%)	R_f value
6a	3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-nitrophenyl)-1-phenylpyrazole	$C_{22}H_{16}ClN_3O_3$	405.83	220-222	79	0.70
6b	3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-bromophenyl)-1-phenylpyrazole	$C_{22}H_{16}BrClN_2O$	439.73	218-222	86	0.67
6c	3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-chlorophenyl)-1-phenylpyrazole	$C_{22}H_{16}Cl_2N_2O$	395.28	218-224	84	0.82
6d	3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(2',4'-dichlorophenyl)-1-phenylpyrazole	$C_{22}H_{15}Cl_3N_2O$	429.73	238-240	90	0.80
7a	3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-nitrophenyl)isoxazole	$C_{16}H_{11}ClN_2O_4$	330.72	228-230	85	0.65
7b	3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-bromophenyl)isoxazole	$C_{16}H_{11}BrClNO_2$	364.62	254-258	87	0.76
7c	3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-chlorophenyl)isoxazole	$C_{16}H_{11}Cl_2NO_2$	320.17	218-222	88	0.82
7d	3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(2', 4'-dichlorophenyl)isoxazole	$C_{16}H_{10}Cl_3NO_2$	354.62	240-244	90	0.70

Spectroscopic characterization of compounds

3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-nitrophenyl)-1-phenyl pyrazole (6a): Solid; Dark Brown colour; IR (KBr, cm^{-1}): 3356 (Ar-OH stretch), 3100 (Ar-C-H stretch), 2927 (C-H stretch of $-CH_3$), 1624 (C=N stretch), 1523 ($-NO_2$ asym. stretch), 1429 (C=C stretch), 1359 ($-NO_2$ sym. stretch), 1249 (C-N stretch), 1123 (C-O stretch), 841 (C-Cl stretch). ^{1}H NMR (500 MHz, DMSO-d_6, δ ppm): δ 2.5 (s, 3H of $-CH_3$), δ 3.38 (s, 1H of Phenolic -OH), δ 6.98 (s, 1H of pyrazole-H), δ 6.71-8.06 (m, 11H of Ar-H). LC-MS (m/z): 404.05, 406.04 (M+); Anal. Calcd. for $C_{22}H_{16}ClN_3O_3$ (Mol.wt. 405.83 g/mol): C, 65.11; H, 3.97; N, 10.35; Cl, 8.74; O, 11.83%; Found: C, 65.18; H, 3.86; N, 10.45; Cl, 8.78; O, 11.73 %.

3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-bromophenyl)-1-phenyl pyrazole (6b): Solid; Brown colour; IR (KBr, cm^{-1}): 3374 (Ar-OH stretch), 3055 (Ar-C-H stretch), 2927 (C-H stretch of $-CH_3$), 1631 (C=N stretch), 1430 (C=C stretch), 1248 (C-N stretch), 1091 (C-O stretch), 817 (C-Cl stretch), 654 (C-Br stretch). ^{1}H NMR (500 MHz, DMSO-d_6, δ ppm): δ 2.5 (s, 3H of $-CH_3$), δ 3.5 (s,1H of Phenolic -OH), δ 7.11 (s, 1H of pyrazole-H), δ 7.10-8.32 (m, 11H of Ar-H). LC-MS (m/z): 439.0, 437.0 (M+); Anal. Calcd. for $C_{22}H_{16}BrClN_2O$ (Mol.wt. 439.73 g/mol): C, 60.09; H, 3.67; N, 6.37; Cl, 8.06; O, 3.64 %; Found: C, 60.32; H, 3.36; N, 6.49; Cl, 7.98; O, 3.60 %.

3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-chlorophenyl)-1-phenyl pyrazole (6c): Solid; Brown colour; IR (KBr, cm^{-1}): 3380 (Ar-OH stretch), 3044 (Ar-C-H stretch), 2927 (C-H stretch of $-CH_3$), 1627 (C=N stretch), 1435 (C=C stretch), 1248 (C-N stretch), 1102 (C-O stretch), 822 (C-Cl stretch). ^{1}H NMR (500 MHz, DMSO-d_6, δ ppm): δ 2.5 (s, 3H of $-CH_3$), δ 3.4 (s,1H of Phenolic -OH), δ 6.69 (s, 1H of pyrazole-H), δ 7.31-8.69 (m, 11H of Ar-H). LC-MS (m/z): 393.05, 395.05, 396.05 (M+); Anal. Calcd. for $C_{22}H_{16}Cl_2N_2O$ (Mol.wt. 395.28 g/mol): C, 66.85; H, 4.08; N, 7.09; Cl, 17.94; O, 4.05 %; Found: C, 66.60; H, 4.18; N, 7.20; Cl, 18.09; O, 3.93 %.

3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(2',4'-dichlorophenyl)-1-phenyl pyrazole (6d): Solid; Brown colour; IR (KBr, cm^{-1}): 3283 (Ar-OH stretch), 3071 (Ar-C-H stretch), 2930 (C-H stretch of $-CH_3$), 1630 (C=N stretch), 1450 (C=C stretch), 1239 (C-N stretch), 1154 (C-O stretch), 857 (C-Cl stretch). ^{1}H NMR (500 MHz, DMSO-d_6, δ ppm): δ 2.5 (s, 3H of $-CH_3$), δ 3.51 (s,1H of Phenolic -OH), δ 7.10 (s, 1H of pyrazole-H), δ 6.82-8.13 (m, 10H of Ar-H). LC-MS (m/z): 429.01, 429.06, 427.01 (M+); Anal. Calcd. for $C_{22}H_{15}Cl_3N_2O$ (Mol.wt. 429.73 g/mol): C, 61.49; H, 3.52; N, 6.52; Cl, 24.75; O, 3.72 %; Found: C, 61.38; H, 3.80; N, 6.29; Cl, 25.0; O, 3.53 %.

3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-nitrophenyl) isoxazole (7a): Solid; Brownish-yellow colour; IR (KBr, cm^{-1}): 3436 (Ar-OH stretch), 2928 (C-H stretch of $-CH_3$), 1621 (C=N stretch), 1525 (N-O stretch), 1450 (C=C) stretch, 1398 ($-NO_2$ sym. stretch), 1262 (C-O-N stretch), 1102 (C-O stretch), 855 (C-Cl stretch). ^{1}H NMR (500 MHz, DMSO-d_6, δ ppm): δ 2.5 (s, 3H of $-CH_3$), δ 3.43 (s, 1H of Phenolic -OH), δ 7.07 (s, 1H of isoxazole-H), δ 6.64-8.38 (m, 6H of Ar-H). LC- MS (m/z): 328.04, 329.03, 331.02 (M+); Anal. Calcd. for $C_{16}H_{11}ClN_2O_4$ (Mol.wt. 330.72 g/mol): C, 58.11; H, 3.35; N, 8.47; Cl, 10.72; O, 19.35 %; Found: C, 58.20; H, 3.41; N, 8.44; Cl, 10.43; O, 19.52 %.

3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-bromophenyl) isoxazole (7b): Solid; Brownish-yellow colour; IR (KBr, cm^{-1}): 3450 (Ar-OH stretch), 2930 (C-H stretch of $-CH_3$), 1629 (C=N stretch), 1571 (N-O stretch), 1404 (C=C sym. stretch), 1259 (C-O-N stretch), 1086 (C-O stretch), 648 (C-Cl stretch), 509 (C-Br stretch). ^{1}H NMR (500 MHz, DMSO-d_6, δ ppm): δ 2.5 (s, 3H of $-CH_3$), δ 3.50 (s,1H of Phenolic -OH), δ 7.39 (s, 1H of isoxazole-H), δ 7.05-8.03 (m, 6H of Ar-H). LC-MS (m/z): 363.95, 365.95 (M+); Anal. Calcd. for

$C_{16}H_{11}BrClNO_2$ (Mol.wt. 364.62 g/mol): C, 52.70; H, 3.04; N, 3.84; Cl, 9.72; O, 8.78 %; Found: C, 52.84; H, 2.85; N, 3.97; Cl, 9.65; O, 8.60 %.

3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(4'-chlorophenyl) isoxazole (7c): Solid; Brownish-yellow colour; IR (KBr, cm^{-1}): 3399 (Ar-OH stretch), 2940 (C-H stretch of -CH_3), 1650 (C=N stretch), 1546 (N-O stretch), 1438 (C=C stretch), 1160 (C-O-N stretch), 1031 (C-O stretch), 875 (C-Cl stretch). ^{1}H NMR (500 MHz, DMSO-d_6, δ ppm): δ 2.5 (s, 3H of -CH_3), δ 3.81 (s,1H of Phenolic -OH), δ 7.09 (s, 1H of isoxazole-H), δ 7.39-8.13 (m, 6H of Ar-H). LC-MS (m/z): 319.00, 320.00, 322.00 (M+); Anal. Calcd. for $C_{16}H_{11}Cl_2NO_2$ (Mol.wt. 320.17 g/mol): C, 60.02; H, 3.46; N, 4.37; Cl, 22.15; O, 9.99 %; Found: C, 59.93; H, 3.61; N, 4.54; Cl, 22.01; O, 9.91 %.

3-(5'-Chloro-2'-hydroxy-4'-methylphenyl)-5-(2', 4'-dichlorophenyl) isoxazole (7d): Solid; Brown colour; IR (KBr, cm^{-1}): 3382 (Ar-OH stretch), 2943 (C-H stretch of -CH_3), 1675 (C=N stretch), 1555 (N-O stretch), 1437 (C=C stretch), 1255 (C-O-N stretch), 1036 (C-O stretch), 804 (C-Cl stretch). ^{1}H NMR (500 MHz, DMSO-d_6, δ ppm): δ 2.5 (s, 3H of -CH_3), δ 3.71 (s,1H of Phenolic -OH), δ 6.78 (s, 1H of isoxazole-H), δ 6.67-7.99 (m, 5H of Ar-H). LC-MS (m/z): 353.96, 354.00, 355.96, 356.00 (M^+); Anal. Calcd. for $C_{16}H_{10}Cl_3NO_2$ (Mol.wt. 354.62 g/mol): C, 54.19; H, 2.84; N, 3.95; Cl, 29.99; O, 9.02 %; Found: C, 54.25; H, 2.77; N, 4.02; Cl, 29.82; O, 9.14 %.

Pharmacological Evaluation

Antibacterial and antifungal activity

All the newly synthesized 3,5-disubstituted-1-phenyl pyrazoles (6a-d) and 3,5-disubstituted isoxazoles (7a-d) bearing p-chloro-m-cresol moiety were screened for in *vitro* antibacterial and antifungal activities against the growth of two bacterial strains viz. *Escherichia coli* (gram -ve), *Staphylococcus aureus* (gram +ve) and two fungal strains viz. *Aspergillus niger*, *Candida albicans* by using disc diffusion method.[51-52] Mueller-Hinton agar (MHA) and Potato-Dextrose agar (PDA) plates were employed as culture medium respectively for bacterial and fungal sensitivity and DMSO was used as solvent control. Ofloxacin (2 µg) and amphotericin (50 µg) were used as standard drugs respectively for antibacterial and antifungal activities. The compounds were dissolved in DMSO to give 100 µg/ml, 250 µg/ml, 500 µg/ml solutions. Sterile filter paper discs (Whatmann filter paper No. 40) of 10 mm diameter were dipped in these solutions, dried, and placed on nutrient agar plates spreaded with the bacteria and fungi. The plates were further incubated for 24 hrs. at 37 ^{0}C for antibacterial and 72 hrs. at 28 ^{0}C for antifungal testing and the zones of inhibition were measured in mm using antibiotic zone reader (Hi-Media). The results on antibacterial and antifungal activities of newly synthesized compounds are depicted in Table 2 and Table 3 below and their effects along with zones of inhibition (mm) are shown in Figure 2 and Figure 3 respectively.

Table 2: Antibacterial activity of newly synthesized pyrazole (6a-d) & isoxazole (7a-d) derivatives.

Compound code	Zone of inhibition in millimeter (mm)							
	Escherichia coli (Gram -ve)				*Staphylococcus aureus* (Gram +ve)			
	Concentration of compounds (µg/ml)				Concentration of compounds (µg/ml)			
	100	250	500	Std. (2 µg)	100	250	500	Std. (2 µg)
6a	10.5	11	11.5	20 mm	10	11	12	22 mm
6b	10	11	12		NI	NI	NI	
6c	10	12	14		10.5	11	12	
6d	NI	NI	14		10.5	11	12	
7a	NI	NI	NI		NI	NI	NI	
7b	NI	NI	NI		10	12	13	
7c	10	11	12		10	11	12	
7d	11	12	14		12	13	14	
Control	NI	NI	NI		NI	NI	NI	
*Std.: Ofloxacin drug (2 µg/ml); NI: No zone of inhibition; Control: DMSO solvent								

Table 3: Antifungal activity of newly synthesized pyrazole (6a-d) & isoxazole (7a-d) derivatives.

Compound code	Zone of inhibition in millimeter (mm)							
	Aspergillus niger				*Candida albicans*			
	Concentration of compounds (µg/ml)				Concentration of compounds (µg/ml)			
	100	250	500	Std. (50 µg)	100	250	500	Std. (50 µg)
6a	NI	NI	11	15 mm	10.5	11	12	14 mm
6b	NI	NI	NI		NI	NI	NI	
6c	NI	NI	NI		10	11	12	
6d	NI	NI	NI		NI	NI	12	
7a	NI	NI	NI		11	12	13	
7b	NI	NI	NI		10	11	12	
7c	NI	NI	NI		10	11	12	

7d	10	11	12		12	17	18	
Control	NI	NI	NI		NI	NI	NI	
*Std.: Amphotericin drug (50 µg/ml); NI: No zone of inhibition; Control: DMSO solvent								

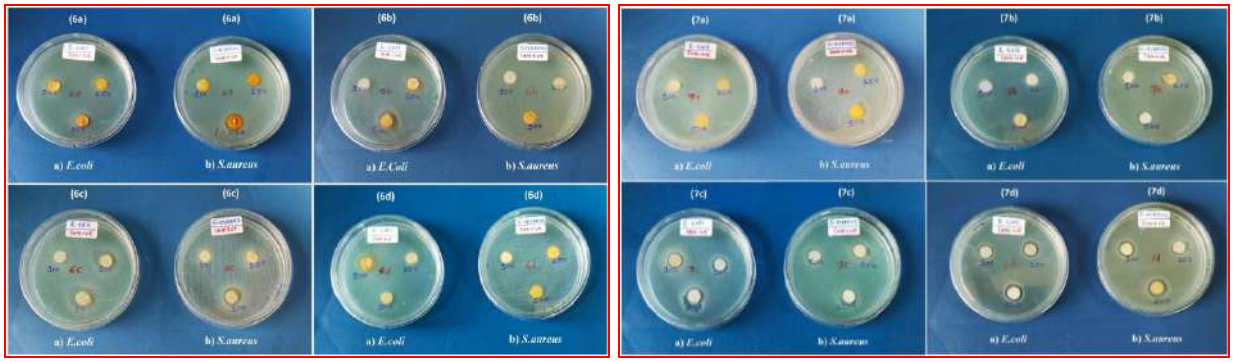


Figure 2: Effects of newly synthesized pyrazole (6a-d) & isoxazole (7a-d) derivatives on the growth response of bacterial strains viz. a) *E. coli* b) *S. aureus.*

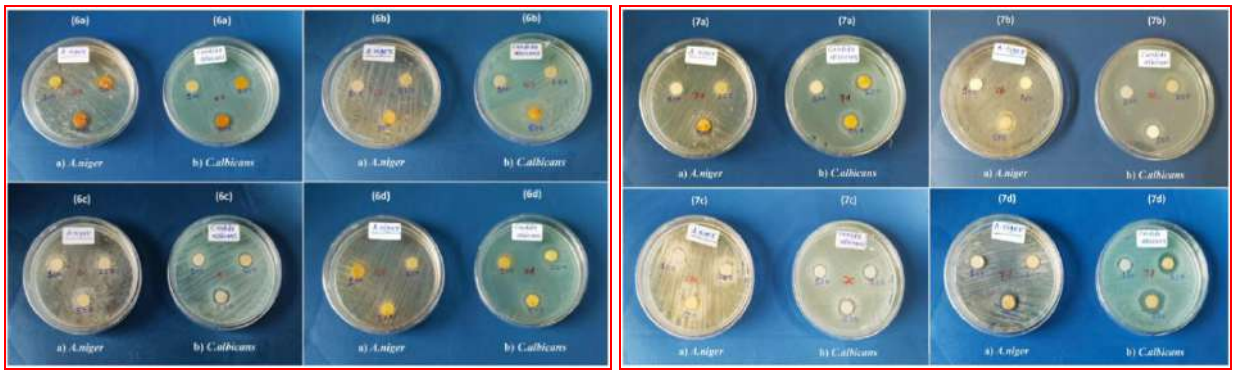


Figure 3: Effects of newly synthesized pyrazole (6a-d) & isoxazole (7a-d) derivatives on the growth response of fungal strains viz. a) *A. niger* b) *C. albicans.*

Antioxidant activity

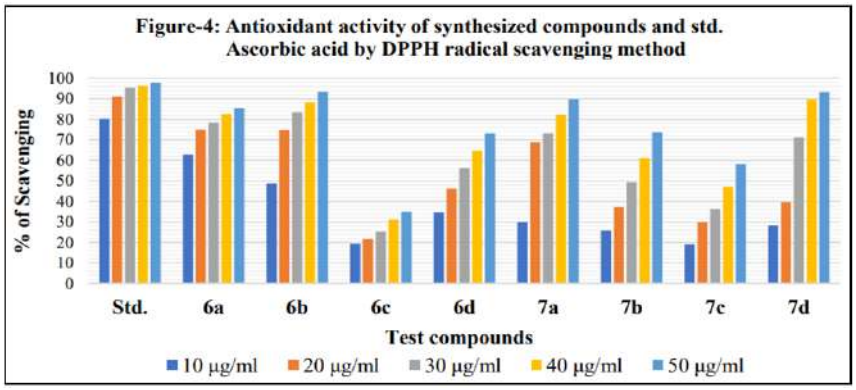
The in *vitro* antioxidant activity of newly synthesized compounds was performed based on DPPH radical scavenging assay with free radical scavenging effect of the stable 2, 2-diphenyl-1-picrylhydrazyl (DPPH) with slight modifications.[53-56] A stock solution of DPPH (1.3 mg/ml) was prepared by dissolving 13.0 mg in 10 ml of methanol. The stock solutions of test compounds 6a-d & 7a-d take (100 µg/ml) were prepared by dissolving 1mg of sample in 10ml of methanol. From this stock solution, further dilutions were prepared of various concentrations (10, 20, 30, 40 and 50 µg/ml) using methanol. Similarly, a stock solution of standard ascorbic acid (1mg/ml) was prepared by dissolving 10 mg ascorbic acid in 10 ml of methanol. From this stock solution further dilutions of various concentrations (10, 20, 30, 40, and 50 µg/ml) were prepared. Further, 1 ml of DPPH solution was mixed with 1 ml of different concentration of test solutions and standard (ascorbic acid). These solutions were kept for 30 min in dark and absorbance was measured at 517 nm using methanol (5 ml) with DPPH (1 ml) solution as blank (positive control). The percentage of scavenging activity was calculated by following formula, whose results are summarized in Table 4 and shown in Figure 4.

% Scavenging = [Abs. of control – Abs. of test sample/Abs. of control] × 100

Table 4: Antioxidant activity of newly synthesized pyrazole (6a-d) & isoxazole (7a-d) derivatives.

Sr. No.	Compound code	% Scavenging of synthesized compounds and std. Ascorbic acid				
		Concentration of compounds (µg/ml)				
		10 µg/ml	20 µg/ml	30 µg/ml	40 µg/ml	50 µg/ml
1.	6a	62.93	75.00	78.50	82.64	85.46
2.	6b	48.68	74.78	83.55	88.33	93.36
3.	6c	19.51	21.71	25.43	31.22	35.09
4.	6d	34.86	46.27	56.35	64.70	73.00
5.	7a	29.82	68.85	73.02	82.34	89.76
6.	7b	25.87	37.28	49.34	61.03	73.56
7.	7c	19.29	29.82	36.26	47.22	58.09

8.	7d	28.50	39.69	71.19	89.70	93.19
9.	Std. Ascorbic acid	80.26	91.22	95.61	96.27	97.80



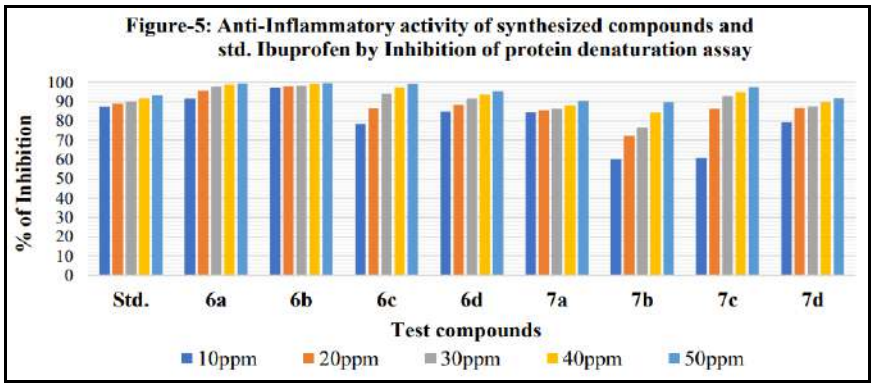
Anti-Inflammatory activity

The in *vitro* anti-inflammatory activity of newly synthesized compounds was performed by employing inhibition of protein denaturation assay.[57,58] Stock solution of NSAID Ibuprofen as a reference drug (positive control) was prepared by dissolving 10mg of Ibuprofen in 10 ml of distilled water. Serial dilution from above stock solution takes 0.1 ml, 0.2 ml, 0.3 ml, 0.4 ml, 0.5 ml and prepare 10 ppm, 20 ppm, 30 ppm, 40 ppm, 50 ppm and also it was performed for samples 6a-d & 7a-d. The reaction mixtures were prepared using 2.8 ml of phosphate-buffered saline (pH 6.4) and 0.2 ml of egg-albumin. Then take 2 ml of sample from each different concentration were mixed gently with reaction mixtures. All samples contain 5 ml of total volume. A similar procedure was used for reference Ibuprofen drug solution. The absorbance of these solutions was determined by spectrophotometer at the wavelength of 660 nm. The percentage inhibition of protein denaturation was calculated by following the formula, whose results are summarized in Table 5 and shown in Figure 5.

% Inhibition = [Abs. of blank – Abs. of test sample/Abs. of blank] × 100

Table 5: Anti-inflammatory activity of newly synthesized pyrazole (6a-d) & isoxazole (7a-d) derivatives.

Sr. No.	Compound code	% Inhibition of synthesized compounds and std. Ibuprofen drug				
		Concentration of compounds (ppm)				
		10 ppm	20 ppm	30 ppm	40 ppm	50 ppm
1.	6a	91.61	95.58	97.79	98.65	99.13
2.	6b	97.01	97.95	98.23	98.95	99.36
3.	6c	78.53	86.69	94.20	97.21	98.98
4.	6d	84.87	88.41	91.66	93.67	95.22
5.	7a	84.60	85.32	86.31	88.15	90.43
6.	7b	60.32	72.18	76.71	84.45	89.76
7.	7c	60.70	86.33	92.77	94.78	97.38
8.	7d	79.30	86.81	87.47	89.91	91.87
9.	Std. Ibuprofen	87.36	88.90	90.23	91.74	93.10



RESULTS AND DISCUSSION

A total four derivatives of each pyrazole and isoxazole bearing p-chloro-m-cresol moiety have been synthesized with excellent yield, purified by recrystallization, characterized and further used individually to analyze its in *vitro* antibacterial, antifungal, antioxidant and anti-

inflammatory activity. The IR and ^{1}H NMR spectra of all the compounds showed expected signals which corresponds to various groups present in each compound. Also, the mass spectra of compounds were found in full agreement with the proposed structures and showed expected peaks which confirms the molecular weights of compounds. The results on antibacterial activities (Table 2) reveals that, compounds 6a, 6b, 6c, 7c and 7d showed (10.5,11,11.5), (10,11,12), (10,12,14), (10,11,12) and (11,12,14) mm of zones of inhibition respectively at 100 µg/ml, 250 µg/ml and 500 µg/ml concentrations while compound 6d showed zone of 14 mm at 500 µg/ml against bacteria *E. coli*. The compounds 7a and 7b showed either less or no any zone of inhibition against the growth of *E. coli* strain at all the tested concentrations. In case of pathogen *S. aureus*, only the compounds 6a, 6c, 6d, 7b, 7c and 7d showed respectively (10,11,12), (10.5,11,12), (10.5,11,12), (10,12,13), (10,11,12) and (12,13,14) mm of zones of inhibitions at 100 µg/ml, 250 µg/ml and 500 µg/ml concentrations respectively while compounds 6b and 7a were found to have either less or zero zones of inhibition against the growth response of *S. aureus*. According to the obtained results on antifungal activity (Table 3), it was observed that, only the compounds 6a and 7d were showed 11 mm and (10,11,12) mm of zones respectively at 500 µg/ml and 100 µg/ml, 250 µg/ml and 500 µg/ml concentrations against fungus *A. niger* while other compounds did not show any zones of inhibition against the growth of *A. niger* fungal strain. As well *C. albicans* is concern, compounds 6a, 6c, 7a, 7b, 7c and 7d showed respectively (10.5,11,12), (10,11,12), (11,12,13), (10,11,12), (10,11,12) and (12,17,18) mm of zones at all the tested concentrations while compound 6d showed 12 mm of zone at the concentration of only 500 µg/ml. Only the compound 6b did not show any zone against the growth response of *C. albicans* at all the tested concentrations. Standard ofloxacin (2 µg/ml) and amphotericin (50 µg/ml) showed inhibition zones of diameter 20, 22 and 15, 14 mm against pathogens *E. coli*, *S. aureus*, *A. niger* and *C. albicans* respectively. The experimental data on antioxidant activities (Table 4 & Figure 4) reveals that, compounds 6a, 6b, 6d, 7a, 7b,7d showed good to excellent scavenging activity at all the tested concentrations while only the compound 6c and 7c showed low to mild scavenging activity with reference to standard antioxidant ascorbic acid. From the results on antioxidant activity, it was observed that all the pyrazole derivatives showed 6b > 6a > 6d > 6c and isoxazole derivatives showed 7d > 7a > 7b > 7c order of scavenging power and their scavenging strength was increased with increasing concentration. The results on anti-inflammatory activity (Table 5 & Figure 5) reveals that, all the newly synthesized compounds exhibit excellent and notable inhibition to protein (egg-albumin) denaturation with comparison to standard NSAID ibuprofen drug. The pyrazole derivatives have shown 6b > 6a > 6c > 6d and isoxazole derivatives shown 7c > 7d > 7a > 7b order of inhibition of protein denaturation. Moreover, it is surprising that their inhibition power was also increased as we increased their concentrations. By comparing their inhibition strength with standard reference, it was observed that the inhibition power of all the synthesized compounds was found to be in good agreement with the standard ibuprofen as well as their values were found to be comparable with it.

CONCLUSION

A new class of 3,5-disubstituted-1-phenyl pyrazoles and 3,5-disubstituted isoxazoles incorporating phenolic p-chloro-m-cresol moiety were successfully synthesized with high yield by refluxing substituted flavones with nucleophiles phenylhydrazine hydrochloride and hydroxylamine hydrochloride respectively in DMF-piperidine solvent media and screened for their pharmacological properties such as antibacterial, antifungal, antioxidant and anti-inflammatory in *vitro*. Among all the tested compounds, 6a, 6b, 6c, 6d, 7c and 7d displayed promising but low to moderate antibacterial activity particularly against *E. coli* while 7a and 7b were found to be inactive against *E. coli* pathogen. In case of *S. aureus* bacteria, compounds 6a, 6c, 6d, 7b, 7c and 7d displayed low to moderate antibacterial sensitivity whereas 6b and 7a were found to be inactive. Also, amongst the all compounds, only the compounds 6a and 7d were found to be active and showed low to mild activity against *A. niger* while other compounds were found to be inactive against it. In addition, except compound 6b, all the other compounds showed promising but less to mild or moderate antifungal activity against *C. albicans*. Besides, the compounds 6a, 6b, 6d, 7a, 7b,7d exhibited promising and excellent antioxidant potential due to the presence of electron withdrawing substituents on the aromatic ring while compound 6c and 7c showed promising but low to mild antioxidant activity with respect to ascorbic acid. Furthermore, the results on anti-inflammatory were surprising because all the compounds exhibited superior inhibition to protein denaturation due to an incorporation of p-chloro-m-cresol moiety in the pyrazole and isoxazole nucleus and were found to be potent anti-inflammatory agents. Overall, the experimental findings on anti-inflammatory and antioxidant studies may be implicated as an informative resource for pharmaceutical industries engaged in the drugs manufacturing. In conclusion, all the synthesized novel p-chloro-m-cresol incorporated pyrazole and isoxazole derivatives can be further exploited as lead compounds for drug discovery research in pharmaceutical industries and veterinary sciences as well as future studies. Also, it is conceivable that these newly synthesized titled compounds may be further modified to achieve marketable antioxidants and NSAID agents for welfare of society.

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SYNTHESIS, CHARACTERIZATION AND PHARMACOLOGICAL EVALUATION OF SOME 2-MERCAPTO- 4-SUBSTITUTED PHENYL, 6-(5-BROMO,2-HYDROXY PHENYL) PYRIMIDINES

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ABSTRACT
In the present work a new series of 2-Mercapto-4-substituted phenyl,6-(5-bromo,2-hydroxy phenyl) Pyrimidines(6a-d) derivatives were synthesized from substituted propan-1,3-diones i.e.(β-diketones) (4a-d). The substituted β-diketones (4a-d) react with thiourea in DMF solvent and refluxed it at 75^0C to obtained product. The newly synthesized compounds are characterized by H^1NMR, IR, Mass spectra and elemental analysis. These newly synthesized compounds were also screened for their in -vitro antibacterial, antifungal, anti-oxidant and anti-inflammatory activities.

KEYWORDS: Propan-1,3-diones, Thiourea, 2-Mercapto Pyrimidines, Antibacterial, Antifungal, Anti-oxidant and Anti-inflammatory activities.

INTRODUCTION
In nature heterocyclic compounds are abundant such as alkaloids, vitamins, amino acids, antibiotics, hormones, hemoglobin containing heterocyclic atoms are important for the synthesis of novel drugs. More numbers of synthetic heterocyclic compounds like pyrrole, pyrrolidine, furan, thiophene, piperidine, pyridine, pyrimidines and thiazole show significant pharmacological activity. Among these compounds pyrimidines are of very much important in medicinal field. Nitrogen containing heterocyclic ring play an important role in Medicinal chemistry, Biochemistry and pharmacological studies. Pyrimidine is a six-member heterocyclic compound which contains two nitrogen atoms at positions 1 and 3. Pyrimidine derivatives are known to be biologically active compounds. Pyrimidine and its derivatives exhibited several therapeutic applications.[1] which include antimicrobial,[2] anticancer,[3] anti-inflammatory,[4] anti-malarial,[5] anti-diabetic,[6] anti-HIV,[7] anthelmintic,[8] CNS depressants,[9] Cardiac agents,[10] antioxidant,[11,12] antitubercular.[13,14] The synthesis of 2-mercapto pyrimidine is attracting research work because it involves both S and N atoms in their structures.[15,16] In a view of analytical applications of 2- mercapto pyrimidines, it is interest to know the physiochemical properties such as stability of the complexes with metal ions.[17] The 2-mercapto pyrimidine is a significant class of pyrimidine, exists in tautomeric equilibria with thione forms. In a view of biological applications of substituted pyrimidines, it is interest to study the synthesis, characterization and their biological biological activity. Considerable research work was done in the past, synthesis of propan-1,3-diones (β-diketones)(4a-d) with their antibacterial activity and antifungal activity.[18] Now in the present research work some novel 2-Mercapto- 4-substituted phenyl, 6-(5-bromo, 2-hydroxy phenyl) Pyrimidines(6a-d) compounds have been synthesized from propan-1,3-diones (β-diketones). The structural characterization, antibacterial activity, antifungal activity, antioxidant activity and anti-inflammatory activities of synthesized compounds have been investigated.

MATERIALS AND METHODS
All the chemicals and solvents were of good research grade, highest purity and commercially available. The IR spectra was recorded by using Shimadzu IR affinity-1FTIR spectrophotometer, H1NMR spectra were recorded on Bruker advance II 400 MHz spectrometer, Mass spectra were recorded on ESI and Melting point were determined by open capillary tube method which are uncorrected. All the synthesized compounds (6a-d) were purified by recrystallization method and purity was checked by TLC and elemental analysis.

General procedure for the Synthesis of 2-Mercapto-4-substituted phenyl, 6-(5-bromo,2-hydroxy phenyl) Pyrimidines (6a-d)

The synthesis involves the following steps.

Synthesis of 4-bromo phenyl acetate

Take 4-bromo phenol (0.05M) fused with acetic anhydride (5ml) and sodium acetate. The mixture was refluxed for 1hr. then cooled for 15 min. and poured in ice water. Acetate layer was separate out by separating funnel. The product was obtained 4-bromo phenyl acetate (1).

Synthesis of 5-bromo, 2-hydroxy acetophenone (2)

Take aluminum chloride (120 g) in kjeldal flask and add compound (1) (40 ml) drop wise. Heat the reaction mixture in oil bath for 60 min at 1200C. It was cooled and add in to acidified ice crushed water to get crude product of 5-bromo,2-hydroxy acetophenone (2).

Synthesis of 2-substituted benzoyloxy 5-bromo acetophenone (3a-d)

A mixture of compound (2) (0.05M) and substituted benzoic acid (0.05M) were dissolved in dry pyridine at 00 C. Then add POCl3 dropwise with constant stirring bellow 100C. The reaction mixture was allowed to stand for overnight at room temperature. Then it was poured in ice cold 10% HCl. Then the product was wash by 10% NaHCO3 and water. Recrystallized the product by ethanol to obtained a series of 2- substituted benzoyloxy 5-bromo acetophenone (3a-d).

Synthesis of substituted propane 1,3-diones (4a-d)

Take compound (3a-d) (0.05M) was dissolved in dry pyridine. The reaction mixture was heated up to 600C with pulverized KOH slowly with constant stirring. After 5-6 hr. the reaction mixture was acidified by dil. HCl in ice cold water. The crude product was filtered, washed it with NaHCO3 (10%) and water. Recrystallized the product from ethanol-acetic acid mixture to get substituted propane 1,3-diones (4a-d).

Synthesis of 2-Mercapto- 4-substituted phenyl, 6-(5-bromo,2-hydroxy phenyl) Pyrimidines (6a-d)

A mixture of compound Propan-1,3-dione (β-diketones) (4a-d) (0.02 M) and thiourea (0.02 M) dissolved in DMF solvent. It was refluxed on water bath at 750C for 1hr. The reaction mixture was cooled at room temperature and pour in ice cold water. The product was obtained and recrystallized it by aq. alcohol to obtained a series of 2-Mercapto-4-substituted phenyl, 6-(5-bromo, 2-hydroxy phenyl) Pyrimidines (6a-d).

The general reaction **scheme-I** for the synthesis of final product.

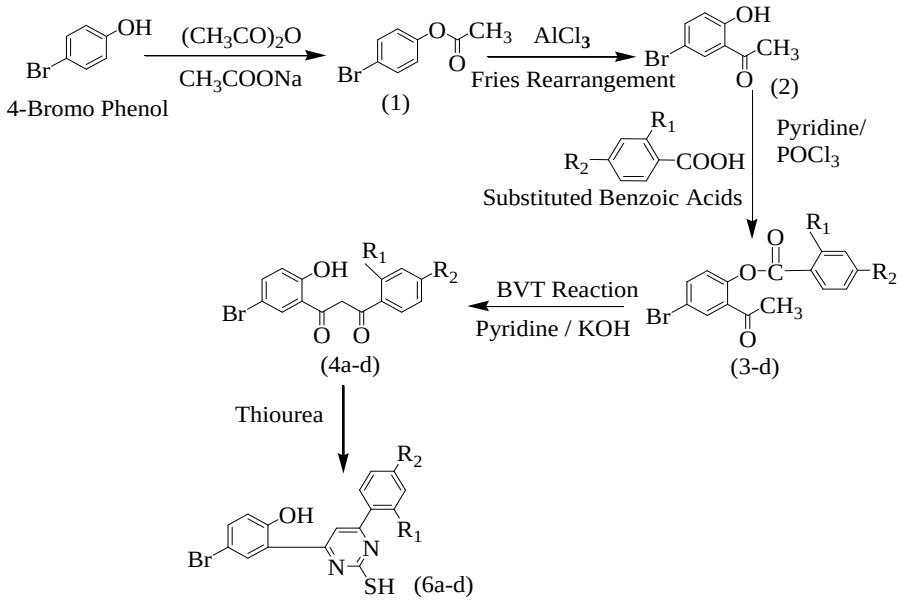

Table 1: Physical data of 2-Mercapto- 4-substituted phenyl, 6-(5 -bromo,2-hydroxy phenyl) Pyrimidines (6a-d).

Code	Compound Name	M.F./M.W.	-R_1	-R_2	Rf value	M.P.(^{0}C)	Yield(%)
6a	2-mercapto-4-(4-methyl phenyl)-6-(5-bromo, 2-hydroxy phenyl) Pyrimidine	$C_{17}H_{13}BrN_2OS$ / (373.27)	-H	-CH_3	0.71	154 -156	74
6b	2-mercapto-4-(4-nitro phenyl)-6-(5-bromo,2-hydroxy phenyl) Pyrimidine	$C_{16}H_{10}BrN_3O_3S$ / (404.24)	-H	-NO_2	0.65	276 -278	81
6c	2-mercapto-4-(2-chloro phenyl)-6-(5-bromo,2-hydroxy phenyl) Pyrimidine	$C_{16}H_{10}BrClN_2OS$ / (393.69)	-Cl	-H	0.62	214 -217	66
6d	2-mercapto-4-(4-chloro phenyl)-6-(5-bromo,2-hydroxy phenyl) Pyrimidine	$C_{16}H_{10}BrClN_2OS$ / (393.69)	-H	-Cl	0.68	254 -256	70

Spectroscopic Characterization

(6a)2-mercapto-4-(4-methyl,phenyl)-6-(5-bromo,2-hydroxy-phenyl) pyrimidine: Solid,Yellow,IR(cm-^{1}): 3389 (Ar-OH),3067(Ar-C-H),2924(ArCH_3), 1632 (C=N), 1444(C=C),649(C-Br), 1283 (C-O).^{1}H-NMR (δppm): 7.0-8.1(m,8H of Ar-H), 2.40 (s,3H of -CH_3), 2.50 (s,1H of -S-H),3.34(S,1H of Ar-OH). MASS (m/z, %): 372(M+). C, H, N, S, O%: Calculated (Found) C: 54.70 (48.24), H:3.67(3.15),N:7.50 (7.32), S:8.59 (8.41), O:4.29 (4.17).

(6b) 2-mercapto -4-(4-nitro phenyl)-6-(5-bromo,2-hydroxy-phenyl) Pyrimidine: Solid,Yellow,IR(cm-^{1}):3364 (Ar-OH), 3100(Ar-C-H),1611(C=N), 1440 (C=C), 630(C-Br), 1115(C-O),1350 (-NO_2).^{1}H-NMR (δ ppm): 7.3-8.3(m,8H of Ar-H),3.38(s,1H of Ar-OH), 2.50 (s,1H of-S-H). MASS (m/z, %):403(M+). C, H, N, S, O% Calculated (Found): C:47.54 (47.19),H:2.49 (2.23), N:10.39(10.26),S:7.93(7.68) O:11.87 (11.59).

(6c) 2-mercapto-4-(2-chloro phenyl)-6-(5-bromo,2-hydroxy-phenyl) pyrimidine: Solid,Yellow,IR(cm^{1}):3077(Ar-OH),2927 (Ar-C-H),1639(C=N), 1459 (C=C),525(C-Br),1271(C-O),755(C-Cl). ^{1}H-NMR (δ ppm):7.31-8.63(m, 8H of Ar-H), 3.38 (s,1H of Ar-OH),2.50 (s,1H of -S-H). MASS(m/z%) :392 (M+).C, H, N, S,O%Calculated (Found): C:48.81(48.54), H:2.56(2.42), N:7.12(7.08), S:8.14(8.09),O:4.06 (4.01).

(6d) 2-mercapto-4-(4-chloro phenyl)-6-(5-bromo,2-hydroxy-phenyl) pyrimidine: Solid,Yellow,IR(cm-^{1}): 3278(Ar-OH),2925(Ar-C-H),1630 (C=N),1442 (C=C), 524 (C-Br),1281(C-O),641 (C-Cl).^{1}H-NMR (δ ppm): 6.90 -8.8 (m,8H of Ar-H),3.34 (s,1H of Ar-OH),2.51 (s,1H of -S-H).MASS (m/z, %):392(M+). C,H,N,S,O% Calculated(Found): C:48.81(48.64), H:2.56(2.48), N:7.12 (7.10), S:8.14(8.09),O:4.06 (4.01).

ANTIBACTERIAL ACTIVITY

Antibacterial screening of newly synthesized 2-Mercapto-4-substituted phenyl, 6-(5-bromo,2-hydroxy phenyl) Pyrimidines (6a-d) was carried out against *staphylococcus aureus (gram +ve)*, *Salmonella typhus* (*gram–ve*) bacteria by disc diffusion method.[19] and compared with standard Ofloxacin (2 µg). Muller Hinton Agar was used as basal medium for test of bacteria. The compounds tested at concentration of 50 µg/ml, 100 µg/ml and 250 µg/ml for bacterial growth in DMSO solvent it was added to the wells made on culture medium. After 24 hrs. of incubation at 37^{0}C for antibacterial activity record the zone of inhibition.

Table 2: Antibacterial activity against2-Mercapto- 4-substituted phenyl,6-(5-bromo, 2-hydroxy-phenyl) Pyrimidines (6a-d).

Compound code	Zone of inhibition in mm							
	Salmonella typhi (gram -tive)				*Staphylococcus aureus(gram +tive)*			
	Concentrations µgm/ml				Concentrations µgm/ml			
	50	100	250	Ofloxacin 2 mcg	50	100	250	Ofloxacin 2 mcg
6a	NI	NI	NI	NI	NI	NI	NI	NI
6b	NI	NI	NI	NI	NI	NI	**11**	NI
6c	NI	NI	NI	NI	NI	NI	NI	NI
6d	NI	NI	NI	NI	NI	NI	NI	NI
Moderate active = 7-12, NI = No Inhibition								

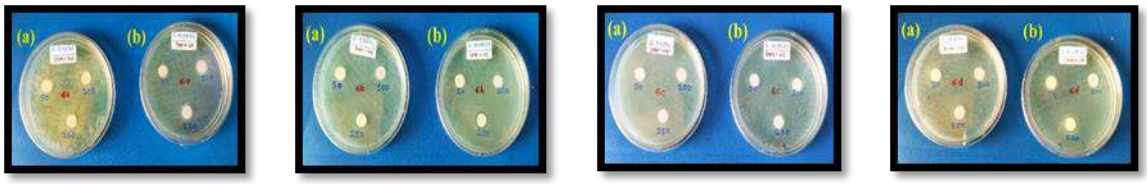

Figure 1: Zone of inhibition of compound 6c and 6d against *Salmonella typhi* and *Staphylococcus aureus.*

ANTIFUNGAL ACTIVITY

Antifungal screening of newly synthesized 2-Mercapto-4-substituted phenyl, 6-(5-bromo,2-hydroxy phenyl) Pyrimidines (6a-d) was carried out against *Candida albicans and Aspergillus niger* fungus by disc diffusion method [20] and compared with standard Fluconazole 25 µgm. Muller Hinton Agar was used as basal medium for test of fungi. The compounds tested at concentration of 50 µg/ml, 100 µg/ml and 250 µg/ml for fungal growth in DMSO solvent it was added to the wells made on culture medium. After 24 hrs. of incubation at room temperature for antifungal activity record the zone of inhibition.

Table 3: Antifungal activity against 2-Mercapto-4-substituted phenyl,6-(5-bromo,2-hydroxy phenyl) Pyrimidines (6a-d).

Compound code	Zone of inhibition in mm							
	Candida albicans				*Aspergillus niger*			
	Concentrations µgm/ml				Concentrations µgm/ml			
	50	100	250	Fluconazole 25 µgm	50	100	250	Fluconazole 25 µgm
6a	NI	NI	NI	NI	NI	NI	NI	NI
6b	NI	NI	NI	NI	**07**	NI	NI	NI
6c	NI	NI	NI	NI	NI	**10**	**11**	NI
6d	NI	NI	NI	NI	**11**	**12**	**14**	NI
Highly active = 13-24, Moderate active = 7-12, NI = No Inhibition								

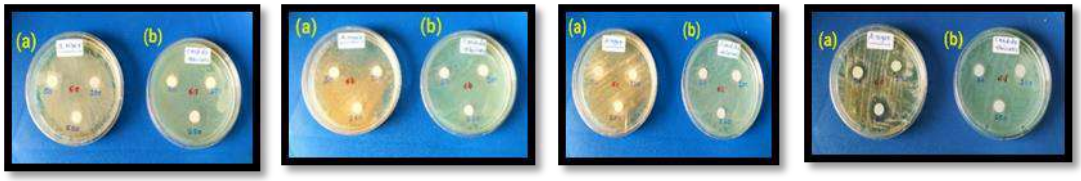

Figure 2: Zone of inhibition of product 6a-d against *Candida albicans and Aspergillus niger*

ANTI-INFLAMMATORY ACTIVITY

Reference drug Ibuprofen was added 10 mg in to10 ml of distilled water. Serial dilution from above stock solution takes 0.1ml, 0.2ml, 0.3ml and prepare 10 ppm, 20 ppm and 30 ppm and also it was performed for sample 2-Mercapto- 4-substituted phenyl, 6-(5-bromo,2-hydroxy phenyl) Pyrimidines (6a-d) extract. The reaction mixture was prepared using 2.8 ml of phosphate-buffered saline (pH 6.4) and 0.2 ml of egg albumin then take 2 ml of sample extract(6a-d) from each different concentration were mixed with reaction mixtures. A similar procedure was used for reference ibuprofen drug solution. The absorbance of these solutions was determined by using spectrophotometer at a wavelength of 660 nm. The % denaturation of the protein (% inhibition) was determined.[21]

Table 4: Anti-inflammatory activity of synthesized 2-Mercapto- 4-substituted phenyl, 6-(5-bromo,2-hydroxy phenyl) Pyrimidines (6a-d).

Sr. No.	Compound Code	% Inhibition		
		Concentration of compound in ppm		
		10 ppm	20 ppm	30 ppm
1	6a	49.77	55.90	65.83
2	6b	73.56	75.49	83.22
3	6c	51.04	52.70	58.05
4	6d	32.33	61.86	84.76
5	Ibuprofen	87.36	88.90	90.23

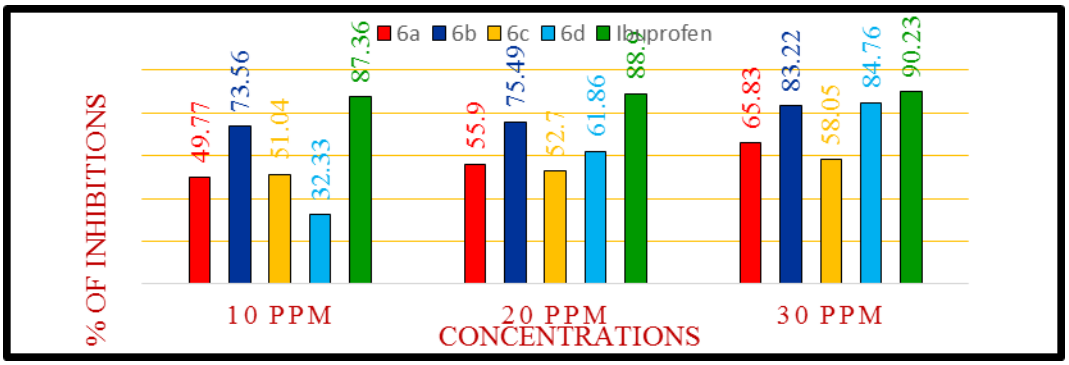

Figure 3: Showing % inhibition in Anti-inflammatory analysis.

ANTI-OXIDANT ACTIVITY

Stock solution of DPPH (2, 2-diphenyl-1-picrylhydrazyl) was prepared by dissolving 1.083 mg in 10 ml of ethanol. Stock solution of sample 2-Mercapto- 4-substituted phenyl, 6-(5-bromo,2-hydroxy phenyl) Pyrimidines(6a-d).100 µg/ml was prepared by dissolving 1 ml of sample in 10 ml of ethanol. From this stock solution, further dilutions were prepared of concentrations 10,20,30,40 and 50 µg/ml using ethanol. Similarly, stock solution of standard ascorbic acid was

prepared by dissolving 10 mg ascorbic acid in 10 ml ethanol. From this stock solution further dilutions of concentrations 1, 2, 3, 4, and 5µg/ml were prepared. Absorbance of blank (5 ml ethanol + 1 ml DPPH solution) as a positive control was recorded using colorimeter at 517 nm. Similarly, the absorbance of sample and comparative standard ascorbic acid was taken at 517 nm and recorded.[22]

Table 5: Anti-oxidant activity of synthesized 2-Mercapto- 4-substituted phenyl, 6-(5-bromo,2-hydroxy phenyl) Pyrimidines (6a-d).

Sr. No.	Compound Code	% Scavenging Activity				
		Concentration of compound in µg/ml				
		10 µg/ml	20 µg/ml	30 µg/ml	40 µg/ml	50 µg/ml
1	6a	34.87	35.53	51.10	52.20	57.24
2	6b	41.45	45.18	56.58	60.53	62.50
3	6c	45.84	56.15	62.07	62.29	67.32
4	6d	37.50	41.23	51.32	52.42	54.61
5	Ascorbic acid (Standard)	80.26	91.22	95.61	96.27	97.80

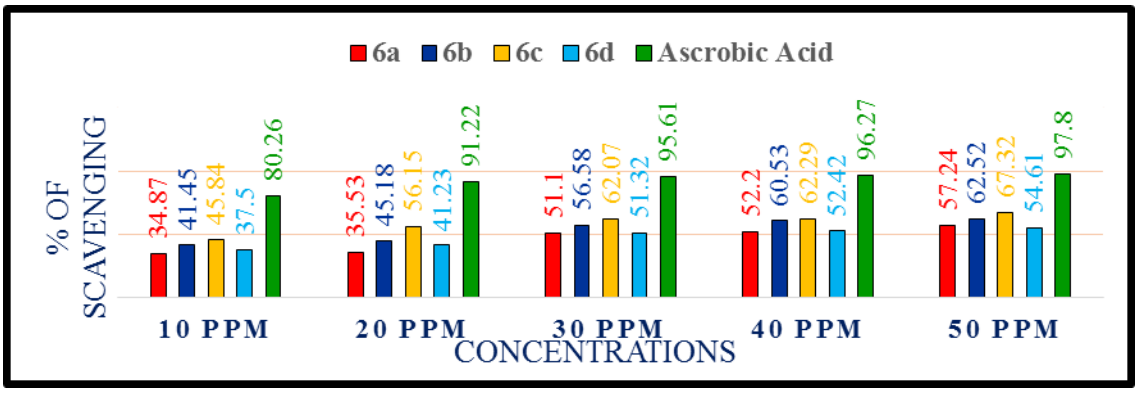

Figure 4: Showing % scavenging in Anti-oxidant analysis.

RESULTS AND DISCUSSION

The elemental analysis, H^1 NMR, Mass and IR spectral data were elucidated the proposed structures. The antibacterial activity of the compounds 6a-d performs against *Salmonella typhi* (gram -tive) and *Staphylococcus aureus* (gram +tive) bacteria at 50 µg/ml,100 µg/ml and 250 µg/ml concentrations and record the zone of inhibition with compare to standard Ofloxacin. In antifungal analysis, the compounds 6a-d shows activity against *Candida albicans* and *Aspergillus niger* at 50 µg/ml,100 µg/ml and 250 µg/ml concentrations by using standard Fluconazole. Anti-inflammatory activity of synthesized (6a-d) compounds determine % Inhibition at 10 ppm, 20 ppm and 30 ppm concentrations using standard drug Ibuprofen. Anti-oxidant activity of synthesized (6a-d) compounds determined % Scavenging at 10 µg/ml,20 µg/ml,30 µg/ml,40 µg/ml and 50 µg/ml concentration by using standard Ascorbic acid.

CONCLUSION

In the present work newly synthesized 2-Mercapto- 4-substituted phenyl, 6-(5-bromo, 2-hydroxy phenyl) Pyrimidines (6a-d) involves different steps to get good yield. The structure of synthesized compound was elucidated on the basis of ^{1}H-NMR, IR and Mass spectral data. In antibacterial activity only 6b compound shows moderate activity against Staphylococcus aureus at concentration 250 µgm.Antifungal activity compound 6b, 6c and 6d showed good activity against Aspergillus niger at concentration 50 µgm,100 µgm and 250 µgm. Antioxidant activity as indicated by absorbance at 517 nm of compounds 6a-d) increased with increasing concentration. Higher value of absorbance of the reaction mixture indicated greater reducing power. The reducing power was found to be in order of 6a>6c>6b>6d.Also compounds 6a-d exhibited significant anti-inflammatory activity by using albumin denaturation technique at 30 ppm concentration.

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JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

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Solvent Less Green Synthesis of Substituted Dihydropyrimidinones and their Sulfur Analogues Using Mild Organic Acids

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Abstract:

One pot three component green synthesis of substituted dihydropyrimidinone and its sulphur Analogues have been reported using mild, simple commercially available organic acids. The reaction was carried out at room temperature without using any solvent by mixing equimolar amount of ethyl acetoacetate, aromatic substituted Benzaldehyde and Urea/Thiourea with catalytic amount of mild acids such as glycine, oxalic acid, maleic acid and vinegar. The kinetics of the reaction was studied by varying the concentration of the acids and substituents on benzaldehyde. It was found that concentration of the acids has significant effect on the kinetics of the reaction. Further there is noticeable effect different acids on duration of product formation mainly attributed to change in pKa of the respective acids. Maleic acid and oxalic acid were found to be excellent catalyst for solvent less synthesis of dihydropyrimidinones and its sulphur analogues using Biginelli reaction with more than 85% yield. Chloro-substituted benzaldehyde moiety gives excellent yield of dihydropyrimidinone with both urea and thiourea. This reaction protocol serves robust and eco-friendly pathway for synthesis of dihydropyrimidinone its sulphur Analogues.

IndexTerms – dihydropyrimidinone, acid catalyst, green synthesis, sustainable

I. INTRODUCTION

Pyrimidine spinoff of heterocyclic compounds such as substituted dihydropyrimidone (DHPM) have attracted masses of scientists working on drugs discovery because of their applications in diverse pharmaceutical utility as drug[1], [2]. These compounds display a huge spectrum of organic activities consisting of anti-inflammatory and antibacterial activity[3].

Pietro Biginelli created the first dihydropyrimidinone molecules. So, the compound is known as Biginelli compound. The reaction involves reflux of aldehydes with urea and a beta ketoester to furnish a tetrahydro pyrimidinone[4].

METALLIC NANOPARTICLES FORMULATION AND EVALUATION OF LEAVES EXTRACT AND ISOLATED COMPOUNDS OF ACACIA CATECHU (L.) WILLD AND ACACIA AURICULIFORMIS A.CUNN

Trishul Subhash Thorat[1], Mahesh P More[2], Jayant R Bansod[3], and Tanuja V Kadre[4]*

Abstract

The aim of this research was to create a green synthesis of metallic nanoparticles using leaves extracts and isolated compounds of *Acacia catechu* (L.) Willd and *Acacia auriculiformis* A.Cunn. Extract and isolated compounds along with excipents were used to prepare Silver nanoparticles and was evaluated for particle size, zeta potential and % EE. The synthesised AgNPs colloidal solution shown superior antibacterial activity against both Gram-positive and Gram-negative bacterial strains i.e., *Klebsiella pneumonia, Bacillus subtilis, E. coli* and *Streptococcus* sp. in testing. The diameters of the inhibition zones of AgNPs at 50 g/ml concentrations against *Klebsiella pneumonia, Bacillus subtilis, E. coli* and *Streptococcus* sp. were reported and it was found that the Silver Nanoparticles have significant antibacterial activity.

Key-words: *Acacia species,* Silver Nanoparticles, Evaluation

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Introduction

Silver nanoparticles have a long history of antibacterial activities. Silver nanoparticles are actively involved in antibacterial action against a wide range of harmful bacteria and fungi that cause disease in food and drink. Various biological and green materials have been used to synthesise silver nanoparticles, including gramme positive and gramme negative bacteria such as Klebsiella pneumonia and Bacillus subtilis, Cladosporium cladosporioides, marine algae Padina tetrastromatica and Turbinaria conoides, green waste peels of banana fruits, carbohydrate molecules such as polysaccharide and disaccharide starch, sucrose, and maltose. [1-2] The plant *Acacia catechu* (L.) Willd and *Acacia auriculiformis* A.Cunn belongs to family Fabaceae is an indigenous plant grown under wild condition in some parts of our country and was chosen for the present investigation. These plants were used in traditional system of medicine for the treatment of bacterial infection, fungal infection, diabetes, liver disorders etc. [3-4] The scanty availability of information on this plant facilitates the study on it. The attempt was made to study anti-microbial activity of extract and isolated compounds.

Material and Methods

Biosynthesis of Silver nanoparticles

$AgNO_3$ powder was dissolved in distilled water to prepare 10 mM $AgNO_3$ stock solution from which a series of 1 mM, 2 mM and 3 Mm $AgNO_3$ solutions were prepared. The AgNO3 solutions were mixed with the ethanolic extract of ACL, AAL, C1, and C2 at a ratio of 1:1 and 1:2 v/v to a volume of 50 mL in a flask. The flask was wrapped with an aluminum foil and was then heated in a water bath at 60°C for 5 hours. Furthermore, the mixture was stored in the refrigerator for the further use. [5-6]

Optimization of formulation of Silver nanoparticles

Table 1: Different formulation of silver nanoparticles using ACL (*Acacia catechu* (L.) Willd)

Formulation Code	Extract (mg)[ACL)	AgNO3 (mM)	Ratio
F1	250	1	1:1
F2	250	2	1:1
F3	250	3	1:1
F4	250	1	1:2
F5	250	2	1:2
F6	250	3	1:2

Table 2: Different formulation of Silver nanoparticles using AAL (*Acacia auriculiformis* A.Cunn

Formulation Code	Extract (mg)[AAL)	AgNO3 (mM)	Ratio
F7	250	1	1:1
F8	250	2	1:1
F9	250	3	1:1
F10	250	1	1:2
F11	250	2	1:2
F12	250	3	1:2

Table 3: Different formulation of Silver nanoparticles using C1 (Lupeol)

Formulation Code	Extract (mg)[C1)	AgNO3 (mM)	Ratio
F13	250	1	1:1
F14	250	2	1:1
F15	250	3	1:1
F16	250	1	1:2
F17	250	2	1:2
F18	250	3	1:2

Table 4: Different formulation of Silver nanoparticles using C2 (Lupenone)

Formulation Code	Extract (mg)[C2)	AgNO3 (mM)	Ratio
F19	250	1	1:1
F20	250	2	1:1
F21	250	3	1:1
F22	250	1	1:2
F23	250	2	1:2

F24	250	3	1:2

Characterization of synthesized silver nanoparticles formulations [5-6]

Microscopic observation of prepared silver nanoparticles

An optical microscope (Cippon, Japan) with a camera attachment (Minolta) was used to observe the shape of the prepared silver nanoparticle formulation.

Percentage Yield

The prepared silver nanoparticle with a size range of 200-300nm were collected and weighed from different formulations. The measured weight was divided by the total amount of all non-volatile components which were used for the preparation of the microspheres[3].

$$\% \text{ Yield } = \frac{\text{Actual weight of product}}{\text{Total weight of drug and polymer}} x\ 100$$

Entrapment efficiency

The entrapment efficiency of the drug was defined as the ratio of the mass of formulations associated drug to the total mass of drug. Entrapment efficiency was determined by dialysis method. Silver nanoparticle entrapped extract were isolated from the free drug using dialysis method. The above said formulations were filled into dialysis bags and the free drug dialyzed for 24 hr. into 50 ml of buffer pH 1.2. The absorbance of the dialysate was measured against blank buffer pH 1.2 and the absorbance of the corresponding blank was measured under the same condition. The concentration of free flavonoids could be obtained from the absorbance difference based on standard curve.

Surface charge and vesicle size

The particle size and size distribution and surface charge were obtained by Dynamic Light Scattering method (DLS) (SAIF RGPV Bhopal, Malvern Zetamaster, ZEM 5002, Malvern, UK). Zeta potential measurement of the silver nanoparticles was based on the zeta potential that was estimated according to Helmholtz–Smoluchowsky from electrophoretic mobility. For measurement of zeta potential, a zetasizer was used with field strength of 20 V/cm on a large bore measures cell. Samples were diluted with 0.9% NaCl adjusted to a conductivity of 50 lS/cm. pH, drug content and drug release were determined for optimized formulation using standard procedure.

Antibacterial Activity of Synthesized Silver Nanoparticles [7-8]

The antibacterial activity of synthesized silver nanoparticles was performed by agar well diffusion method against pathogenic bacteria, *Klebsiella pneumonia, Bacillus subtilis, E. coli* and *Streptococcus* sp. Fresh overnight culture of each strain was swabbed uniformly onto the individuals' plates containing sterile Luria Bertani agar and 5 wells were made with the diameter of 6 mm. Then 25 μL of purified silver nanoparticles, extract, and silver nitrate solution were poured into each well and commercial antibiotic discs are placed as control and incubate for 24 h at 37^0C. After incubation the different levels of zonation formed around the well and it was measured. This experiment was repeated for three times.

Results and Discussion

The synthesized silver nanoparticles containing leaves extracts and isolated compounds of *Acacia catechu* (L.) Willd and *Acacia auriculiformis* A.Cunn. was characterized. The results were presented in table 5. From the results obtained it was showed that formulation code F4, F10, F16 and F22 of each extract and isolated compounds of both the selected plant showed maximum % entrapment efficiency, therefore these formulation were selected to determine the drug content and pH. The in vitro drug release was given in table 7. The results were mentioned in table 6. The results of anti-microbial activity were given in table 8.

Table 5: Characterization of Silver Nanoparticles

Formulation Code	% Yield	% Entrapment efficiency	Average Particle size (nm)	Zeta Potential (mV)
F1	54.10±0.04	64.89	97.93	-30.28
F2	60.42±0.11	72.23	131.22	-31.27
F3	63.73±0.18	70.41	119.10	-33.48
F4	**79.58±0.12**	**86.29**	**126.25**	**- 35.5**
F5	71.81±0.10	84.22	146.89	-32.20
F6	64.10±0.11	71.11	106.04	-30.20

F7	68.29±0.09	77.10	109.11	-31.22
F8	70.42±0.08	78.32	119.23	-33.32
F9	73.21±0.12	69.09	106.17	-32.10
F10	**74.26±0.18**	**79.20**	**121.22**	**-34.39**
F11	70.27±0.12	72.32	110.29	-32.27
F12	69.86±0.24	74.40	120.62	-31.44
F13	72.88±0.04	80.29	131.54	-30.39
F14	75.14±0.22	79.22	129.29	-31.30
F15	76.31±0.02	78.24	126.40	-32.29
F16	82.39±0.05	**86.20**	**146.43**	**-33.11**
F17	80.16±0.06	78.10	136.29	-32.04
F18	79.08±0.14	76.19	129.28	-31.11
F19	71.11±0.12	80.42	113.90	-30.18
F20	73.26±0.18	79.32	122.72	-34.39
F21	76.39±0.10	76.29	129.88	-34.18
F22	81.62±0.26	**85.18**	**135.43**	**-34.78**
F23	80.28±0.18	80.28	130.29	-32.02
F24	79.02±0.11	79.39	129.49	-31.19

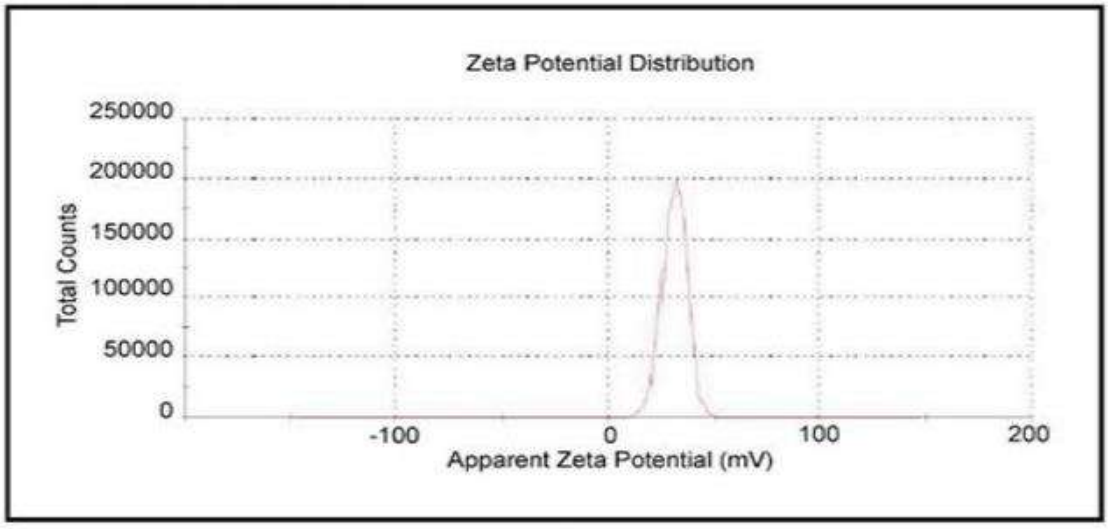

Fig. 1: Zeta Potential of F4

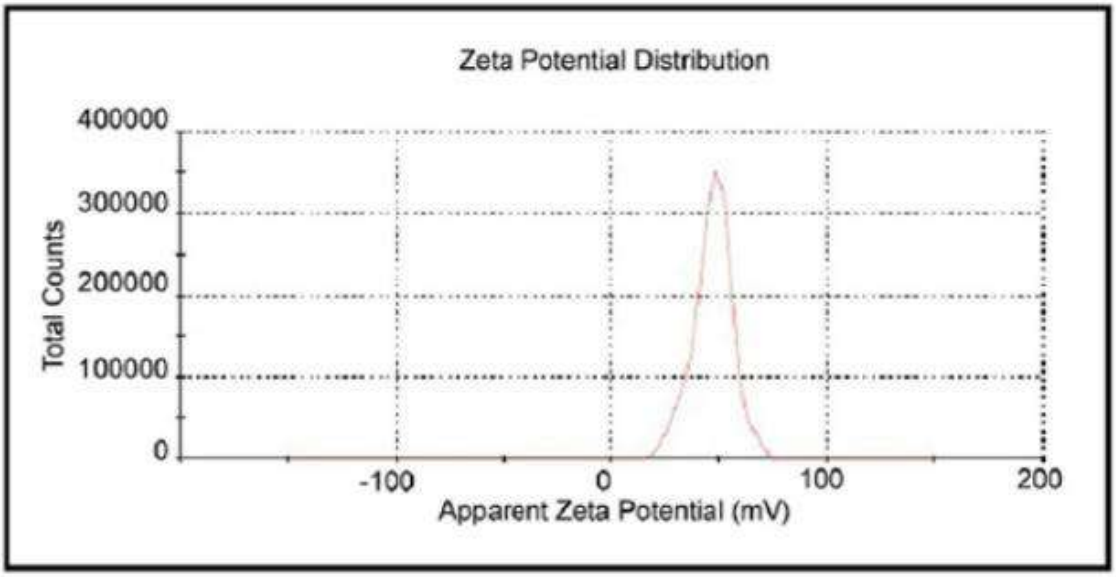

Fig. 2: Zeta Potential of F10

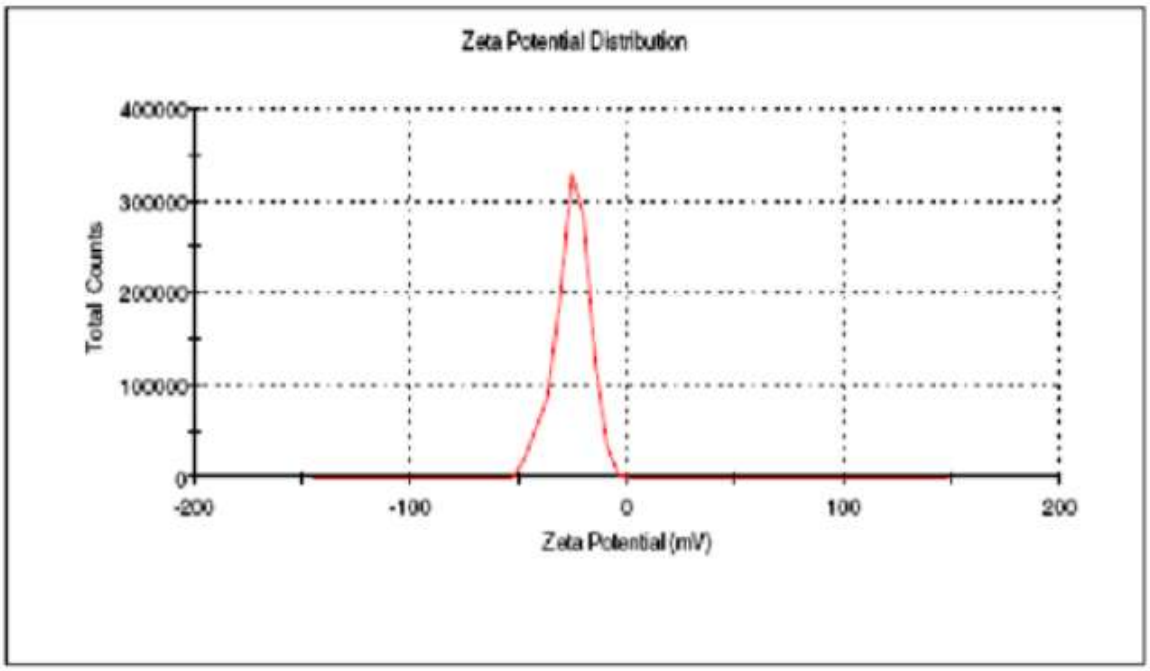

Fig. 3: Zeta Potential of F16

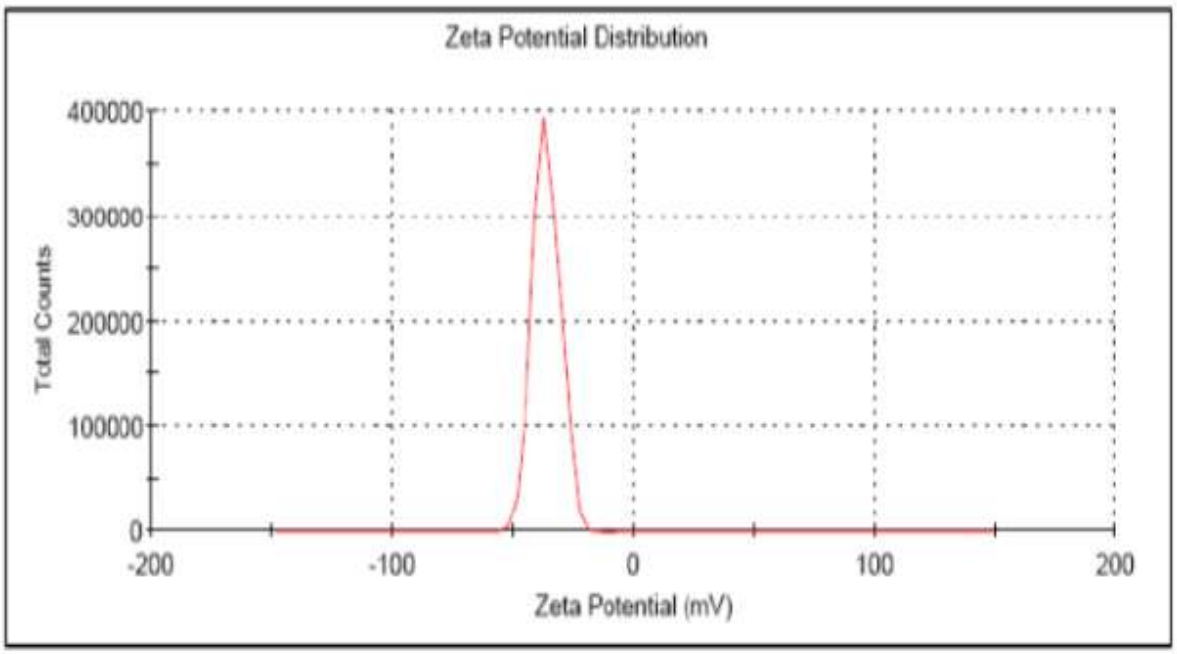

Fig. 4: Zeta Potential of F22

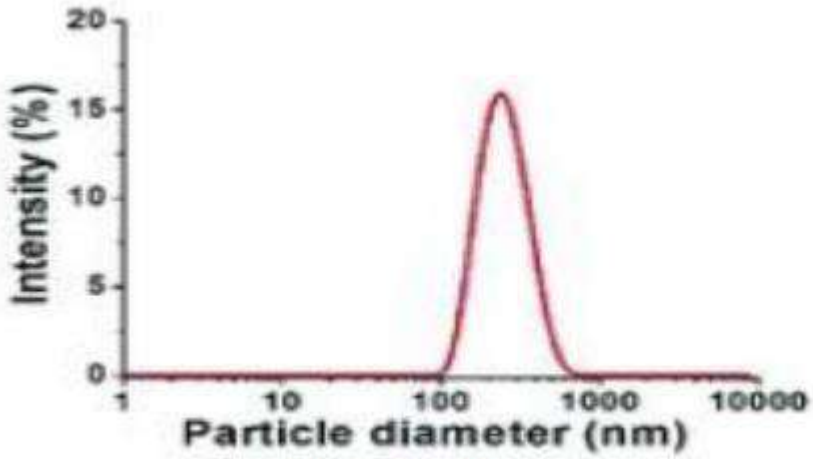

Fig. 5: PDI of F4

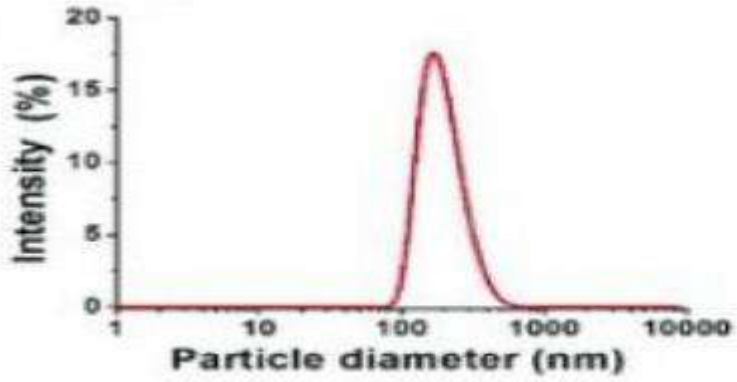

Fig. 6: PDI of F11

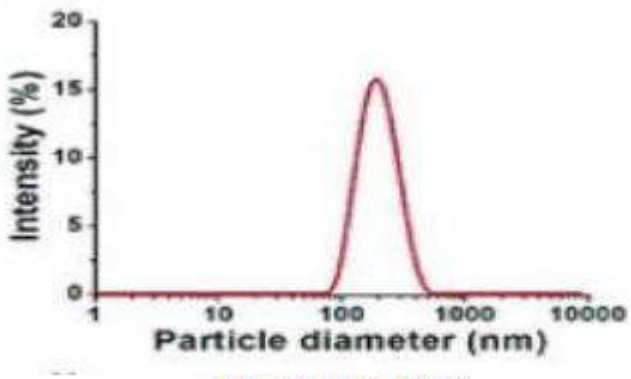

Fig. 7: PDI of F16

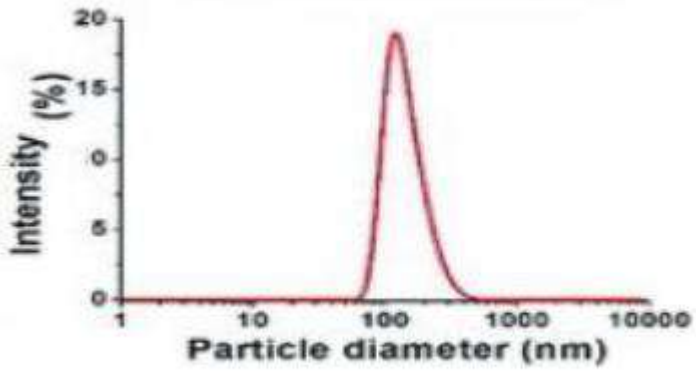

Fig. 8: PDI of F12

Table 6: Evaluation parameters of Silver Nanoparticles

Formulation Code	**pH**	**Drug content (%)**
F4	5.8	76.29
F10	6.9	78.10
F16	6.9	88.20
F22	6.8	86.16

Table 7: In-vitro drug release of Silver Nanoparticles

Time (hr)	**% Drug release**			
	F4	**F10**	**F16**	**F22**
0	0	0	0	0
10	21.5	22.6	25.2	24.5
20	34.3	35.1	38.4	36.1
30	44.2	41.5	48.8	44.9
40	55.8	54.3	59.5	56.3
50	63.4	58.9	62.3	60.0
60	68.6	68.3	77.9	74.4
70	74.8	76.7	84.1	82.0

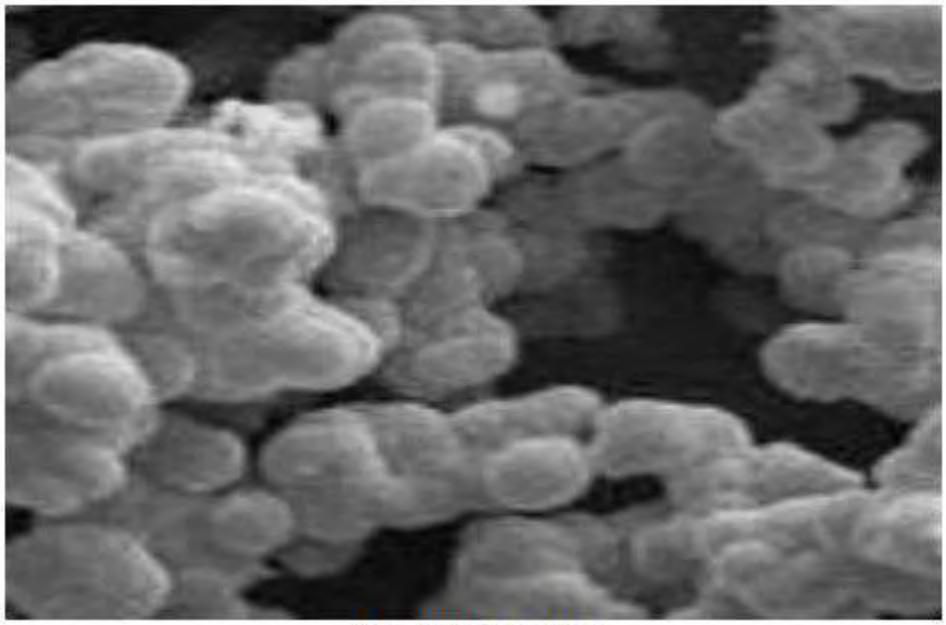

Fig. 9: SEM of F4

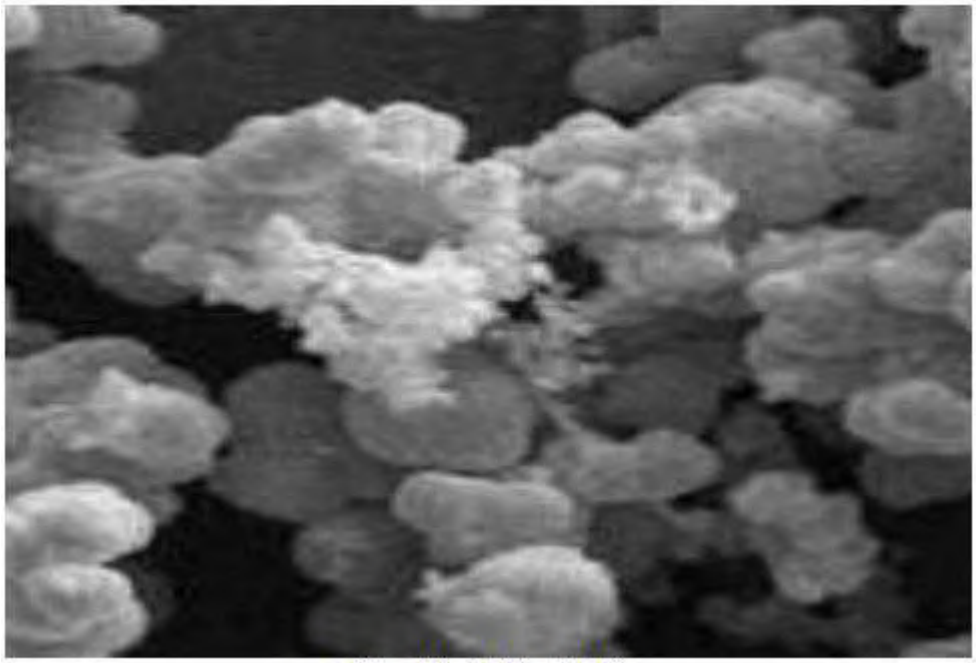

Fig. 10: SEM of F10

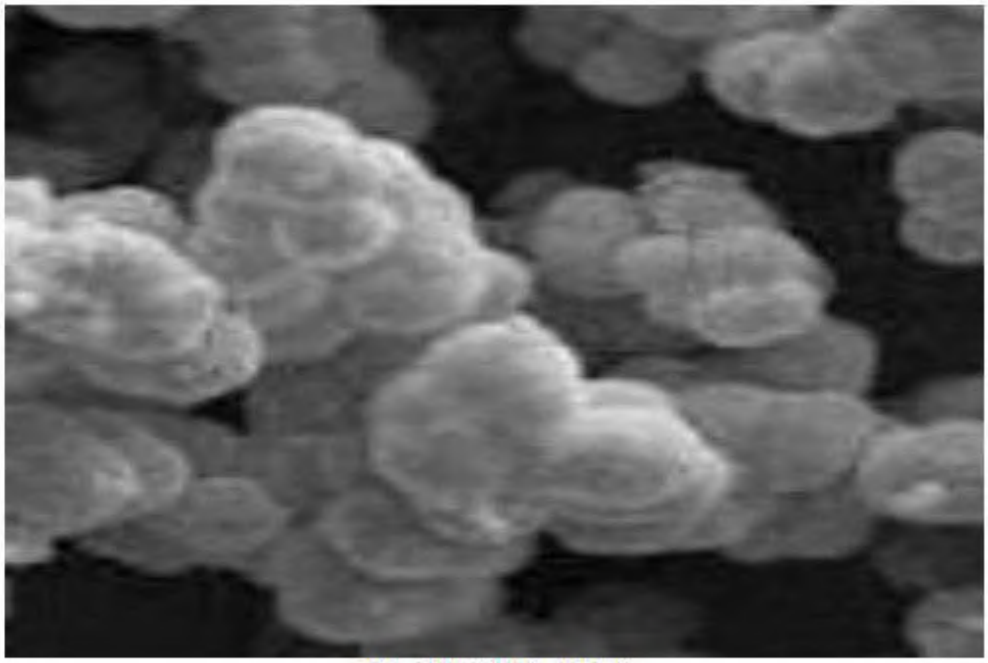

Fig. 11: SEM of F16

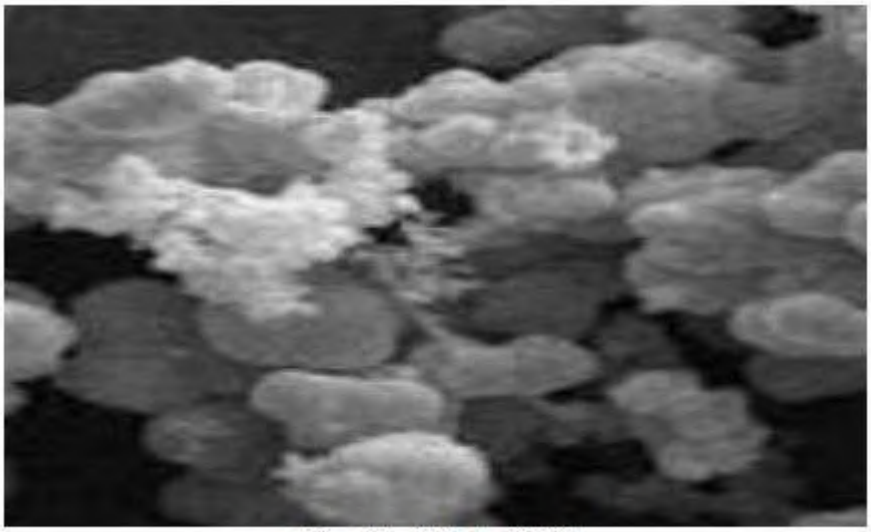

Fig. 12: SEM of F22

Table 8: ZOI of prepared Silver Nanoparticles

Antibacterial agents	**Zone inhibition (mm in diameter)**			
	B. subtilis	***Streptococcus* sp.**	***E. coli***	***K. pneumonia***
Silver nitrate solution	9.9±0.22	12.86±0.17	11.29±0.22	12.18±0.62
Commercial antibiotic disc	10.8±0.16	13.39±0.32	10.18±0.06	12.87±0.03
F4	13.89±0.11	15.26±0.11	13.48±0.02	15.26±0.11
F10	13.63±0.23	16.02±0.08	13.86±0.11	15.38±0.15
F16	11.10±0.04	15.19±0.12	12.82±0.03	13.25±0.04
F22	11.48±0.16	15.20±0.06	12.96±0.02	14.10±0.02

Conclusion

According to the findings, silver nanoparticles made from leaves extract and isolated with extract and AgNO3 in a 1:2 ratio. Formulation F22 demonstrated superior efficacy in terms of yield and % EE, hence it was chosen as the best formulation. F22 antibacterial activity was further tested using four different bacterial strains, and it was discovered that the generated silver nanoparticles have strong antibacterial activity. Because of its remarkable efficiency as an antibacterial agent, this green synthesized nanoparticle could be exploited in the medical field to treat human ailments.

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SCREENING OF ANTIMICROBIAL ACTIVITY OF LEAVES EXTRACT AND ISOLATED COMPOUNDS OF ACACIA CATECHU (L.) WILLD AND ACACIA AURICULIFORMIS A.CUNN

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Abstract
The leaves extract and isolated compounds of *Acacia catechu* (L.) Willd and *Acacia auriculiformis* A.Cunn were screened for antimicrobial activities against some pathogens Extracts and isolated compounds were found to produce significant inhibition against all the pathogens. Results were compared with the standard drug and it was revealed that isolated compounds were more potent than extract in both the plants extract.

Key-words: *Acacia species,* Leaves, Anti-microbial activity

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Introduction

Microbial infections are a leading cause of morbidity and health care expenditures in persons of all ages. Several other populations, including elderly persons and those who are living in unhygienic conditions, are also at major risk. Keeping all these aspects in mind the search of natural anti-microbial agents is essential. [1-2] The plant *Acacia catechu* (L.) Willd and *Acacia auriculiformis* A.Cunn belongs to family Fabaceae is an indigenous plant grown under wild condition in some parts of our country and was chosen for the present investigation. These plants were used in traditional system of medicine for the treatment of bacterial infection, fungal infection, diabetes, liver disorders etc. [3-4] The scanty availability of information on this plant facilitates the study on it. The attempt was made to study anti-microbial activity of extract and isolated compounds.

Material and Methods

Collection of herbs and their authentication

The leaves of *Acacia catechu* (L.) Willd and *Acacia auriculiformis* A.Cunn were collected in the months of July-December 2019 from the Southern region of India and identified & authenticated by Dr. Smruti Sohani, Professor, Faculty of Life Sciences, SAGE University, Indore (M.P.) and was deposited in our Laboratory. Voucher specimen No. SU/LS-ACL36 & SU/LS-AAL37 was allotted.

Successive Extraction of selected herbs

Sample were shattered and screened with 40 mesh. The shade dried coarsely powdered plant material (250gms) were loaded in Soxhlet apparatus and was extracted with n-hexane, pet. ether, benzene, chloroform, ethyl acetate, ethanol and water until the extraction was completed. After completion of extraction, the solvent was removed by distillation. The extracts were dried using rotator evaporator. [5]

Isolation of Compounds

The various extract obtained after extraction were subjected for CC for isolation of compounds and isolated compounds were tested for anti-microbial activity. [6]

Screening of Anti-Microbial Activity [7-8]

Preparation of microorganisms for experiment

The microorganism strains employed in anti-microbial investigations came from pathological lab, Indore. The organisms were sub-cultured in nutrient broth, nutrient agar, Macconky agar, and Blood agar medium for use in research. In the testing of antibiotic sensitivity, Muller Hinton agar was employed.

Preparation and application of disks for experiment

By reconstituting the extracts/isolated compounds with DMSO, various concentrations (10–60 g/ml) were created. By using the streaking plate method, the test microorganisms were transferred to Muller Hinton agar medium. After streaking, flame-sterilized forceps were used to transfer the autoclaved filter paper discs (5 mm in diameter) soaked with extracts onto plates. The antibacterial assay plates underwent a 24-hour incubation period at 37°C. Amoxycillin/Cefitaxime (60 g/ml) was used as a positive control, and DMSO was utilized as a negative control.

Observation of results

Results were noted as either a zone of inhibition was present or not. It was determined that the inhibitory zone surrounding the test paper discs was positive (growth inhibition was seen), and that the absence of the zone was negative. To ensure that the results were reliable, the test was conducted three times over a 24-hour period. The inhibitory zones' sizes were measured in millimeters (after subtraction the diameter of disc i.e.5mm).

Statistical analysis

One-way analysis of variance (ANOVA) and Dunnett's test were used to statistically examine all the values. Significant differences (*P 0.01) were determined between the control and drug-treated groups. Every value is expressed as the mean SEM.

Results and Discussion

In this study the results of the investigations show that extract and isolated compounds i.e., Lupeol and Lupenone from two *Acacia* species viz., *Acacia catechu* (L.) Willd and *Acacia auriculiformis* A.Cunn possess antimicrobial activities against selected micro-organism organisms (Table 1 and 2). Isolated compounds (Table 3) showed more potent anti-microbial activity than leaves extract of the selected plant as compare to the standard.

Table 1: Antimicrobial activity of various extracts of *Acacia catechu* (L.) Willd

Bacterial Strain	Treatments								
	C	SD (µg/ml)	ACL						
			HEACL	PEEACL	BEACL	CEACL	AcEAACL	EEACL	AEACL
Bacillus	-	20.12±0.16	5.01± 0.1	9.19± 0.1	5.41± 0.3	7.60± 0.5	8.32± 0.4	18.69± 0.4	17.18± 0.1
Proteus	-	18.78±0.49	3.11± 0.6	11.21±0.9	11.04±0.6	12.03± 0.4	13.11± 0.5	14.84± 0.5	13.39± 0.6
Pseudomonas	-	24.16±0.72	11.10±0.6	15.12±1.0	13.22±0.7	18.29± 0.4	19.10± 0.4	22.34± 0.4	21.22± 0.8
E. coli	-	22.50±0.76	10.22±1.2	16.04±0.8	18.46±0.2	20.42± 0.2	18.20± 0.3	20.28± 0.3	19.98± 0.3
S. aureus	-	25.16±0.72	16.43±0.8	19.49±0.6	19.23±0.4	21.42± 0.7	20.18± 0.2	22.27± 0.2	21.45± 0.5
Enterobacter	-	19.50±0.28	7.11± 0.2	10.12±0.1	17.33±0.03	10.08± 0.2	11.28± 0.6	17.06± 0.6	16.16± 0.7
Enterococci	-	23.90±0.21	11.10±0.8	17.22±0.4	11.02±0.7	18.42± 0.3	19.32± 0.9	20.19± 0.9	19.28± 0.7
Klebsiella	-	20.41±0.23	5.21 ± 0.2	12.12±0.2	13.29±0.6	19.12± 0.8	18.11± 0.2	18.34± 0.2	17.22± 0.2\2

Values are expressed as Mean (X) ±SEM, n=3 ; **Abbr**.: C: Control (DMSO), SD= Standard (Amoxycillin)

Table 2: Antimicrobial activity of various extracts of *Acacia auriculiformis* A.Cunn

Bacterial Strain	Treatments								
	C	SD (µg/ml)	AAL						
			HEAAL	PEEAAL	BEAAL	CEAAL	AcEAAL	EEAAL	AEAAL
Bacillus	-	20.12±0.16	4.11± 0.3	8.11± 0.6	6.31± 0.5	8.04± 0.2	9.25± 0.3	18.24± 0.5	17.04± 0.4
Proteus	-	18.78±0.49	3.18± 0.5	10.01±0.4	10.18±0.7	11.36± 0.2	11.10± 0.4	14.10± 0.7	13.02± 0.3
Pseudomonas	-	24.16±0.72	9.11±0.7	12.22±0.5	11.39±0.9	17.10± 0.6	15.19± 0.4	22.20± 0.7	21.10± 0.3
E. coli	-	22.50±0.76	11.02±1.8	15.14±0.3	17.23±0.8	21.32± 0.8	17.29± 0.9	20.04± 0.9	19.11± 0.6
S. aureus	-	25.16±0.72	12.13±0.6	18.19±0.7	18.20±0.6	20.37± 0.4	19.11± 0.6	21.21± 0.4	21.03± 0.8
Enterobacter	-	19.50±0.28	8.10± 0.6	9.10±0.6	16.30±0.04	11.11± 0.5	12.27± 0.3	16.09± 0.6	15.11± 0.0
Enterococci	-	23.90±0.21	10.10±0.4	16.02±0.3	10.11±0.4	17.29± 0.9	18.28± 0.4	20.11± 0.8	19.38± 0.1
Klebsiella	-	20.41±0.23	6.22 ± 0.5	11.32±0.3	12.20±0.3	17.39± 0.6	17.39± 0.3	18.20± 0.3	17.26± 0.1

Values are expressed as Mean (X) ±SEM, n=3; **Abbr**.: C: Control (DMSO), SD= Standard (Amoxycillin)

Table 3: Antimicrobial activity of Lupeol and Lupenone

Bacterial Strain	Treatments			
	C	SD (µg/ml)	Lupeol	Lupenone
Bacillus	-	20.12±0.16	19.28± 0.6	18.89± 0.3
Proteus	-	18.78±0.49	18.21± 0.4	17.39± 0.3
Pseudomonas	-	24.16±0.72	22.38± 0.2	21.98± 0.6
E. coli	-	22.50±0.76	21.30± 0.2	21.14± 0.7
S. aureus	-	25.16±0.72	22.38± 0.3	21.09± 0.9
Enterobacter	-	19.50±0.28	18.29± 0.5	17.83± 0.3
Enterococci	-	23.90±0.21	21.11± 0.7	21.12± 0.2
Klebsiella	-	20.41±0.23	19.27± 0.2	19.22± 0.1

Values are expressed as Mean (X) ±SEM, n=3; **Abbr**.: C: Control (DMSO), SD= Standard (Amoxycillin)

Conclusion

In this investigation anti-microbial activity of leaves extract from two *Acacia* species viz., *Acacia catechu* (L.) Willd and *Acacia auriculiformis* A.Cunn and isolated compounds i.e., Lupeol and Lupenone were screened and was found that isolated compound possess more potent activity than extract.

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SYNTHESIS AND ANTIMICROBIAL STUDIES OF NEW 2-*S*-TETRA-*O*-ACETYL-β-D-GLUCOPYRANOSYL-1-ARYL-5-HEPTA-*O*-ACETYL-β-D-MALTOSYL-2-ISOTHIOBIURETS

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ABSTRACT:-
2-*S*-tetra-*O*-acetyl-β-D-glucopyranosyl-1-aryl-5-hepta-*O*-acetyl-β-D-maltosyl-2-isothiobiurets have been synthesized for the first time by the interaction of *S*-tetra-*O*-acetyl-β-D-glucosyl-1-aryl-isothiocarbamides and hepta-*O*-acetyl-β-D-maltosyl isocyanate. All the synthesized compounds were characterized on the basis of elemental analysis and IR, ^{1}HNMR and Mass spectral studies. The polarimetric study of the title compounds have been carried out and evaluated for their in vitro antimicrobial activities using standard cup plate method against bacteria *E.coli, P. aeruginosa*, *P.vulgaris, S.aureus* and fungi *A.niger, C. albicans.*
Key words: Isothiobiurets, Maltosyl Isocyanate, Isothiocarbamides, Antimicrobial.

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Introduction:

Several *S*-glucosylated isothiobiurets with potential microbial activities have been reported [1]. These isothiobiurets were prepared by the interaction of *S*-tetra-*O*-benzoyl-D-glucopyranosyl-1-aryl isothiocarbamides and phenyl isocyanate [2]. Also recently in our laboratory work has been done on the synthesis of *N* and *S*-linked bis lactosyl isothiobiurets involving the interaction of *S*-hepta-O-acetyl-β-D-lactosyl-1-aryl-isothiocarbamides and hepta-*O*-acetyl-β-D-lactosyl isocyanate[3]. Recently several lactosyl isothiocarbamides and lactosyl isocyanate are also reported to form corresponding lactosyl monothio and dithiobiurets [4-5].

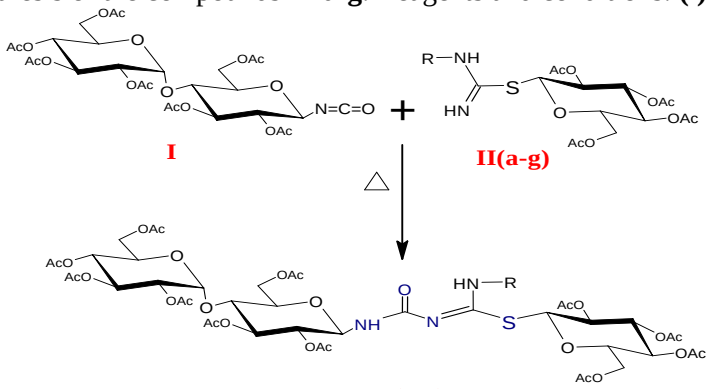
The aryl thiocarbamides because of their basic nature are known to react with alkyl / aryl isocyanate and produce corresponding-2-isothiobiurets [6-7]. It was interesting to study the chemistry of these glucosyl aryl isothiocarbamides with special reference to their reaction with hepta-*O*-acetyl-β-D-maltosyl isocyanate.

EXPERIMENTAL

Chemistry

Melting points were recorded on electrothermal melting point apparatus and are uncorrected. Specific rotations $[\alpha]_D$ were measured on Equip-Tronics digital polarimeter model no. EQ 800 at 30°c in chloroform. IR spectra were recorded on a Perkin-Elmer spectrum RXI (4000-450 cm^{-1}) FTIR spectrometer. ^1H NMR spectrum was obtained on a Bruker DRX-300 (300 MHz) NMR spectrometer using $CDCl_3$ solution with TMS as an internal reference. The Mass spectra were recorded on Jeol SX-102 mass spectrometer. Thin layer chromatography (TLC) was performed in E. Merck precoated Silica Gel G60 aluminum sheets. The elemental analyses (N, S) of all compounds were performed in laboratory.

Scheme 1. Synthesis of the compounds **IIIa-g**. Reagents and conditions: **(i)** Benzene, reflux, 4-5hrs.



2-*S*-tetra-*O*-acetyl-β-D-glucopyranosyl-1-aryl-5-hepta-*O*-acetyl-β-D-maltosyl-2-isothiobiurets

Where, R =a) phenyl, b) *o*-Cl-phenyl, c) *m*-Cl-phenyl, d) *p*-Cl-phenyl, e) *o*-tolyl, f) *m*-tolyl, g) *p*-tolyl Ac = $COCH_3$

General procedure for synthesis of *S*-tetra-*O*-acetyl-β-D-glucosyl-1-aryl isothiocarbamides were prepared in the isopropanolic solution of tetra-*O*-acetyl-α-D-glucosyl bromide (0.01M, 4.10g in 30ml) was added Phenyl thiocarbamides (0.01M, 1.52g). This mixture was warmed over water bath at 70°C until the clear solution was obtained. The clear solution was kept at room temperature for 18 hr. It was then mixed with cold water (100 ml), when small quantity of semisolid mass was separated. The semisolid mass was then triturated with petroleum ether was converted into solid.

General procedure for synthesis of 2-S-tetra-*O*-acetyl-β-D-glucopyranosyl-1-aryl-5-hepta-*O*-acetyl β-D-maltosyl-2-isothiobiurets.

2-S-tetra-*O*-acetyl-β-D-glucopyranosyl-1-aryl-5-hepta-*O*-acetyl β-D-maltosyl-2-isothiobiurets were synthesized in benzene solution of hepta-*O*-acetyl-β-D-maltosyl isocyanate (0.005M, 3.3g in 25ml) was added to *S*-tetra-*O*-acetyl-β-D-glucosyl-1-phenyl isothiocarbamide (0.005M, 2.41g) and reaction mixture was refluxed over boiling water bath for 4-5 hrs. Afterwards, solvent benzene was removed by distillation and resultant syrupy mass was triturated several times with petroleum ether, a granular solid was obtained. It was crystallized from ethanol-water.

2-*S*-tetra-*O*-acetyl-β-D-glucosyl-1-phenyl-5-hepta-*O*-acetyl-β-D-maltosyl-2-isothiobiuret (IIIa): IR (KBr, cm^{-1}): 3483 (N-H), 3068 (Ar-H), 1732 (C=O), 1603 (C = N), 1373 (C-N), 711 (C-S), 1032 & 907 (maltose unit), 803 (glucose unit) . ^1H NMR ($CDCl_3$) δ: 7.26 (m, 5H, Ar-H), 6.89 (s, 1H, NHCO), 5.37–3.17 (m, 14H, maltose unit), 2.14–2.02 (m, 33H, $11COCH_3$), 4.6–3.8 (m, 7H,

glucosyl protons). Mass m/z: 1144 (M+1), 1053, 812, 620, 560, 524, 331, 169, 109. (Anal. Calcd for $C_{48}H_{61}O_{27}N_3S$).

2-*S*-tetra-*O*-acetyl-β-D-glucosyl-1-*m*-Cl-phenyl-5-hepta-*O*-acetyl-β-D-maltosyl-2-isothiobiuret (IIIc): IR (KBr, cm^{-1}): 3468 (N-H), 3010 (Ar-H), 1748 (C=O), 1651 (C = N), 1376 (C-N), 689 (C-S), 1030 & 944 (maltose unit), 901 (glucose unit) . ^{1}H NMR ($CDCl_3$) δ: 7.36-7.29 (m, 4H, Ar-H), 5.59 (s, 1H, NH), 5.54–3.39 (m, 21H, glucosyl unit), 2.15–2.02 (m, 33H, $11COCH_3$). Mass m/z: 1178 (M+1), 1053, 847, 620, 560, 559, 331, 169, 109. (Anal. Calcd for $C_{48}H_{60}O_{27}N_3SCl$).

2-*S*-tetra-*O*-acetyl-β-D-glucosyl-1-*p*-tolyl-5-hepta-*O*-acetyl-β-D-maltosyl-2-isothiobiuret (IIIg): IR (KBr, cm^{-1}): 3497 (N-H), 3048 (Ar-H), 1749 (C=O), 1654 (C = N), 1379 (C-N), 764 (C-S), 1041 & 899 (maltose unit), 809 (glucose unit). ^{1}H NMR ($CDCl_3$) δ: 7.45–7.26 (m, 4H, Ar-H), 6.98 (s, 1H, NH), 4.5–3.17 (m, 21H, glucosyl unit), 2.61–2.02 (m, 33H, $11COCH_3$), 2.26 (s, 3H, CH_3 protons). Mass m/z: 1158 (M+1), 1053, 827, 620, 560, 331, 109. (Anal. Calcd for $C_{49}H_{63}O_{27}N_3S$).

Table 1: Physical characterization and analytical data of synthesized compounds IIIa-g.

Compd.	m.p. ^{0}C	Yield %	$[\alpha]_D^{29}$ [c,0.01 in $CHCl_3$]	Rf EtOA:Hexane 1:1	Found (calcd) % N	S
IIIa	140-141	78.65	+59.57°	0.91	3.65 (3.67)	2.34 (2.79)
IIIb	119-122	81.73	+63.32^0	0.89	3.57 (3.56)	2.64 (2.71)
IIIc	135-136	67.08	+49.92°	0.87	3.55 (3.56)	2.65 (2.71)
IIId	112-118	78.26	+57.26°	0.86	3.54 (3.56)	2.68 (2.71)
IIIe	172-174	72.00	+93.08°	0.73	3.59 (3.63)	2.74 (2.93)
IIIf	180-184	70.17	+74.37°	0.79	3.64 (3.63)	2.74 (2.93)
IIIg	201-202	73.56	+64.58°	0.77	3.63	2.76

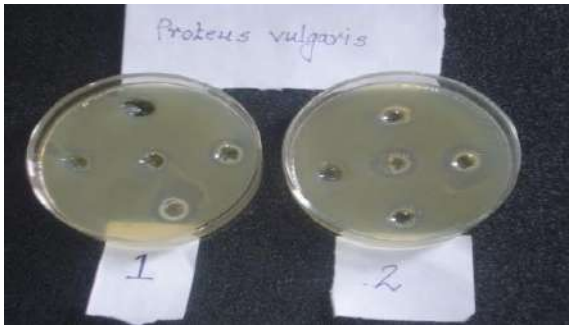
ANTIBACTERIAL /ANTIFUNGAL ACTIVITY

The antimicrobial activities of newly synthesized compounds were tested in vitro against bacteria *E.coli* (MTCC 1680), *P. aeruginosa* (MTCC 7197), *P.vulgaris* (MTCC 1771), *S.aureus* (MTCC 3160) and clinically isolated fungi *A.niger*, *C. albicans* by cup plate agar diffusion method[8]. After incubation at 35^{0}c for 24h for bacteria and for fungi the plates were incubated at 30^{0}c for 24-48h, the diameters of the inhibition zones were measured in millimeters[9]. The compounds were taken at a concentration of 1mg/mL and compared with Gentamicin and Fluconazole as a positive control for different strains of bacteria and fungi for antibacterial and antifungal activities respectively (**Table 2**). The compounds 2-S-tetra-*O*-acetyl-β-D-glucopyranosyl-1-aryl-5-hepta-*O*-acetyl-β-D-maltosyl-2-isothiobiurets **(IIIa-g)** show weak to moderate activity against used micro-organism. The compounds IIIa-d and IIIf showed good activity against *S. aureus*, *P. vulgaris* and *P. aeruginosa* while other showed moderate and weak activity against used micro-organism.

Table 2: Antibacterial and antifungal activities of synthesized compounds **IIIa-g.**

Compd.	Bacteria				Fungi	
	E.coli (MTCC 1680)	*P. aeruginosa* (MTCC 7197)	*P.vulgaris* (MTCC 1771)	*S.aureus* (MTCC 3160)	*A.niger* (clinically isolated)	*C. albicans* (clinically isolated)
IIIa	21	19	15	20	15	21
IIIb	15	20	16	21	15	22
IIIc	20	20	16	20	11	22
IIId	16	17	16	10	10	18
IIIe	15	21	---	22	---	21
IIIf	15	15	16	15	11	15
IIIg	10	16	8	16	11	---
Gentamicin	24	20	23	24	---	---
Fluconazole	---	---	---	---	20	18

(Diameter of inhibition zone, measured in mm[a])
Bore size =7mm
--- No activity was observed.
[a] values are the average of three readings.



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Isocyanates: A Review of Their Chemical Properties, Industrial Uses, And Health Effects

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Abstract:
Isocyanates are a class of highly reactive chemicals widely used in the production of polyurethane foams, coatings, adhesives, and elastomers. Their unique chemical properties make them valuable in various industrial applications, yet they pose significant health risks, particularly in occupational settings. This review explores the chemical structure and reactivity of isocyanates, their industrial uses, and the associated health impacts, including respiratory issues, skin sensitization, and potential carcinogenicity. The paper also examines current regulatory frameworks, exposure limits, and mitigation strategies aimed at reducing occupational hazards and environmental contamination. Understanding the balance between industrial utility and health risks is critical for the safe handling and regulation of isocyanates.
Keywords: Isocyanates, Polyurethane production, Occupational health, Chemical reactivity, Respiratory sensitization, Industrial safety etc.

1. Introduction:

Isocyanates are a group of highly reactive chemicals that play a crucial role in the production of various industrial products, particularly polyurethanes used in foams, coatings, adhesives, and elastomers. Polyurethanes are commonly found in products such as foams, coatings, adhesives, sealants, and elastomers, making isocyanates critical to industries ranging from construction to automotive manufacturing. The two most common types of isocyanates are toluene diisocyanate (TDI) and methylene diphenyl diisocyanate (MDI), both of which are used extensively in polyurethane production. Isocyanates are known for their reactivity with compounds containing active hydrogen atoms, such as alcohols and amines, which facilitate the formation of durable and versatile polyurethane products.

1.1 Scope And Objectives Of The Review:

This review aims to provide a comprehensive analysis of isocyanates, focusing on their chemical properties, industrial uses, and associated health risks. The scope of the review encompasses a detailed examination of the reactivity and behavior of isocyanates in various industrial processes, with a particular emphasis on their role in polyurethane production. Additionally, the review will highlight the diverse applications of isocyanates across multiple industries, from construction to automotive manufacturing, demonstrating their economic importance. By exploring both the beneficial uses and the hazards posed by isocyanates, this review seeks to offer a balanced perspective on their role in modern industrial practices.

2. Chemical Properties Of Isocyanates:

Isocyanates are characterized by the presence of the isocyanate functional group (-N=C=O), which imparts high reactivity, particularly with compounds containing active hydrogen atoms, such as alcohols, amines, and water. This reactivity makes isocyanates essential intermediates in the production of polyurethanes and other polymers, where they facilitate the formation of strong urethane bonds. The reactivity of isocyanates can be influenced by the chemical structure of the compound; for example, aromatic isocyanates like toluene diisocyanate (TDI) tend to be more reactive than their aliphatic counterparts, such as hexamethylene diisocyanate (HDI). This difference in reactivity plays a critical role in determining the specific applications and performance characteristics of the isocyanate compounds.

There are two main types of isocyanates: monoisocyanates, which contain one isocyanate group, and diisocyanates, which contain two. Diisocyanates, such as TDI and methylene diphenyl diisocyanate (MDI), are widely used in the production of polyurethanes due to their ability to create cross-linked polymers with high

durability and versatility. Isocyanates are generally volatile and can be released as vapors during industrial processes, posing inhalation risks. Additionally, isocyanates can react with moisture in the air, leading to the formation of amines and carbon dioxide, which can create foams or cause other unwanted side reactions. Understanding the chemical behavior of isocyanates is crucial for both optimizing industrial processes and managing the health risks associated with exposure.

2.1 Chemical Structure And Reactivity:

Isocyanates are defined by their chemical structure, which features a highly reactive isocyanate functional group (-N=C=O), comprising a nitrogen atom doubly bonded to a carbonyl group. This structure renders isocyanates highly reactive with compounds containing active hydrogen atoms, such as alcohols and amines, facilitating the formation of strong covalent bonds. This reactivity is pivotal in polymer chemistry, enabling the creation of durable polyurethanes through cross-linking, particularly with diisocyanates like toluene diisocyanate (TDI) and methylene diphenyl diisocyanate (MDI). The inherent reactivity of isocyanates also makes them prone to unwanted side reactions, such as hydrolysis with moisture, which can lead to the formation of by-products and impact material properties. Understanding these chemical properties is essential for optimizing their industrial use and managing associated health risks.

2.2 Stability And Degradation:

Isocyanates exhibit varying degrees of stability depending on their chemical structure and environmental conditions. Generally, they are reactive and prone to degradation, particularly when exposed to moisture. In the presence of water, isocyanates undergo hydrolysis, leading to the formation of carbon dioxide and corresponding amines or carbamic acids. This reaction can affect the performance of isocyanate-containing materials by altering their chemical properties and reducing their effectiveness in polymerization processes. Additionally, isocyanates can degrade under UV light or elevated temperatures, which can impact the longevity and stability of polyurethane products. Understanding these stability and degradation characteristics is essential for optimizing the storage, handling, and application of isocyanates, as well as for ensuring the durability and safety of the final products.

3. Industrial Applications Of Isocyanates:

Isocyanates are indispensable in a wide range of industrial applications, primarily due to their critical role in the production of polyurethanes. Polyurethane materials are versatile and can be engineered into rigid and flexible foams, coatings, adhesives, sealants, and elastomers. One of the most significant applications of isocyanates is in the manufacture of polyurethane foams, which are widely used for insulation in buildings, refrigeration systems, and automotive components. Flexible polyurethane foams are commonly found in furniture, bedding, and automotive seating, where their cushioning properties are highly valued. In coatings and adhesives, isocyanates provide durability, chemical resistance, and flexibility, making them essential in industries such as construction, automotive, and aerospace.

3.1 Polyurethane Foams And Elastomers:

Polyurethane foams and elastomers are key applications of isocyanates, leveraging their reactivity to create versatile and durable materials. Polyurethane foams, produced through the reaction of isocyanates with polyols, are widely used for insulation, cushioning, and structural applications due to their lightweight, insulating properties, and adaptability to various densities. Polyurethane elastomers, formed by the reaction of isocyanates with polyols and chain extenders, are prized for their flexibility, abrasion resistance, and resilience, making them ideal for use in seals, gaskets, and industrial components. The ability of isocyanates to form cross-linked networks within these materials imparts their strength and durability, which is crucial for their performance in diverse industrial and consumer applications.

3.2 Coatings And Adhesives:

Isocyanates play a vital role in the formulation of coatings and adhesives due to their ability to create strong, durable bonds and enhance performance characteristics. In coatings, isocyanates are used to cross-link with polyols, forming polyurethane-based finishes that offer superior resistance to abrasion, chemicals, and weathering. These properties make them ideal for protective coatings in automotive, industrial, and architectural applications, where durability and longevity are essential. Similarly, in adhesives, isocyanates contribute to the

formation of robust bonds with various substrates; including metals, plastics, and wood, providing high shear strength and flexibility. Isocyanates are involved in the formulation of specialty chemicals, such as isocyanate-based curing agents for epoxy resins, which are used in high-performance coatings and composites. The broad applicability of isocyanates across different industrial sectors highlights their significance in enhancing material properties and performance, though it also emphasizes the need for stringent safety measures to manage the health risks associated with their use.

4. Health Effects Of Isocyanates:

Isocyanates pose significant health risks primarily due to their high reactivity, which can lead to adverse effects when they come into contact with the human body. The most common health issues associated with isocyanate exposure include respiratory sensitization and asthma. Inhalation of isocyanate vapors or aerosols can trigger allergic reactions in the respiratory system, leading to symptoms such as coughing, wheezing, and shortness of breath. Chronic exposure can result in persistent asthma and other respiratory conditions, which can severely impact an individual's quality of life and ability to work. Direct contact with isocyanate-containing materials or vapors can lead to dermatitis, characterized by redness, itching, and inflammation of the skin. Long-term skin exposure may result in more severe reactions, including chronic eczema. There is also concern about the potential carcinogenicity of isocyanates, as some studies suggest a possible link to cancer, although more research is needed to fully understand these risks.

As such, it is crucial to implement rigorous safety measures and continuous research to better understand and mitigate these risks, ensuring effective protection for workers and reducing potential long-term health effects.

5. Occupational Exposure And Risk Factors:

Occupational exposure to isocyanates is a significant concern in industries where these chemicals are used or manufactured, such as in polyurethane production, automotive repair, construction, and painting. Workers in these environments are at higher risk of exposure due to direct handling of isocyanate-containing materials or inhalation of vapors and aerosols. The risk of health effects, including respiratory sensitization and skin irritation, is heightened in workplaces with inadequate ventilation, insufficient use of personal protective equipment (PPE), and poor adherence to safety protocols.

5.1 Routes Of Exposure:

Isocyanates can enter the body through several routes of exposure, primarily inhalation, skin contact, and, to a lesser extent, ingestion. Inhalation is the most common route, as isocyanate vapors or aerosols can be inhaled during industrial processes such as spraying, mixing, or handling of isocyanate-containing materials. This can lead to respiratory issues, including asthma and other chronic respiratory conditions. Skin contact with isocyanate-containing substances, either through direct handling or accidental spills, can cause dermatitis and sensitization, leading to allergic reactions upon subsequent exposures.

In Case studies of occupational exposure to isocyanates highlight the significant health risks faced by workers in various industries. For example, in the polyurethane manufacturing sector, numerous cases have been reported where workers developed severe respiratory conditions, including occupational asthma and chronic bronchitis, due to prolonged exposure to isocyanate vapors.

6. Regulations And Safety Guidelines:

Regulations and safety guidelines for isocyanates are designed to protect workers and the environment from the associated health risks. Regulatory agencies such as the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH) have established permissible exposure limits (PELs) and recommended exposure limits (RELs) for various isocyanates to minimize health risks. These guidelines include requirements for proper ventilation, use of personal protective equipment (PPE), and regular monitoring of isocyanate concentrations in the workplace. Additionally, safety data sheets (SDS) must be provided to inform workers about the hazards of isocyanates and the necessary safety precautions. Compliance with these regulations, along with comprehensive training programs and effective safety practices, is essential to reduce exposure and prevent occupational illnesses associated with isocyanates.

6.1 Regulatory Standards (Osha, Niosh, Etc.):

Regulatory standards for isocyanates are set by various agencies to ensure workplace safety and minimize health risks. The Occupational Safety and Health Administration (OSHA) establishes permissible exposure limits (PELs) for isocyanates, such as toluene diisocyanate (TDI) and methylene diphenyl diisocyanate (MDI), which are designed to limit the concentration of these chemicals in the air and reduce the risk of respiratory and skin ailments. The National Institute for Occupational Safety and Health (NIOSH) provides recommended exposure limits (RELs) and emphasizes the need for appropriate protective measures, including personal protective equipment and engineering controls. Additionally, the Environmental Protection Agency (EPA) regulates isocyanates under various environmental laws to manage their impact on public health and the environment. Adherence to these regulatory standards is crucial for mitigating exposure risks and safeguarding workers' health in industries where isocyanates are used.

6.2 Exposure Limits And Monitoring:

Exposure limits and monitoring are critical components of occupational safety practices concerning isocyanates. Regulatory agencies like OSHA and NIOSH set permissible exposure limits (PELs) and recommended exposure limits (RELs) for different isocyanates to ensure that their concentrations in the workplace air do not exceed levels that could pose health risks. Regular monitoring of isocyanate levels is essential for maintaining compliance with these limits and identifying potential overexposure incidents. This involves using specialized air sampling and analytical methods to measure isocyanate concentrations and ensure they remain within safe thresholds. Implementing effective monitoring programs helps in promptly detecting and addressing elevated exposure levels, thereby reducing the risk of adverse health effects and ensuring a safer working environment.

6.3 Mitigation Strategies For Workers' Safety:

Mitigation strategies for workers' safety in environments where isocyanates are used involve a multifaceted approach to reduce exposure and protect health. Key strategies include implementing effective engineering controls, such as proper ventilation systems and enclosed workspaces, to minimize airborne concentrations of isocyanates. Personal protective equipment (PPE), such as respirators, gloves, and protective clothing, should be used to shield workers from direct contact and inhalation of isocyanates. Additionally, regular training and education programs are essential to inform workers about the hazards of isocyanates and the correct use of safety measures. Routine monitoring and maintenance of safety equipment, coupled with adherence to established exposure limits and safety guidelines are crucial for ensuring ongoing protection and preventing health issues related to isocyanate exposure.

7. Environmental Impact Of Isocyanates:

The environmental impact of isocyanates is a concern due to their potential for pollution and adverse effects on ecosystems.

7.1 Environmental Contamination And Persistence:

Environmental contamination and persistence of isocyanates pose significant challenges due to their chemical properties and potential for long-lasting effects. Isocyanates can contaminate air, soil, and water through industrial emissions, spills, and improper disposal. Once released, they can react with moisture in the environment, forming by-products like carbon dioxide and amines that can persist and impact ecosystems. While isocyanates themselves may degrade over time, their by-products can contribute to long-term environmental issues, including soil and water contamination. The persistence of these substances necessitates careful management and remediation strategies to prevent long-term environmental damage and protect ecological and human health.

7.2 Impact On Ecosystems:

Isocyanates can have detrimental impacts on ecosystems when they enter the environment, affecting both terrestrial and aquatic systems. In soil, isocyanates and their by-products can disrupt microbial communities, potentially impairing soil fertility and plant health. In aquatic environments, contamination can harm aquatic life by altering water chemistry and affecting the health of fish and other organisms. The reactive nature of isocyanates means they can form secondary pollutants that may persist and accumulate in ecosystems, leading to long-term ecological damage. Additionally, the toxicity of isocyanates to various species underscores the need for stringent

controls and effective waste management practices to minimize their environmental impact and protect ecosystem health.

8. Emerging Research And Future Directions:

Emerging research on isocyanates is focusing on understanding their long-term health effects, environmental impacts, and developing safer alternatives. Research is advancing in the area of environmental impact, aiming to develop more effective methods for monitoring and reducing isocyanate emissions and contamination. Future directions also include the development of novel, less hazardous materials and processes to replace traditional isocyanates, enhancing both worker safety and environmental protection. Continued research is essential for improving safety standards, mitigating health risks, and addressing the ecological challenges associated with isocyanates.

8.1 Advances In Safer Alternatives:

Advances in safer alternatives to isocyanates are emerging as a crucial area of research to reduce health and environmental risks associated with these chemicals. Innovations include the development of non-isocyanate polyurethane systems that utilize alternative cross-linking agents, such as cyclic carbonates or amines, which offer similar performance characteristics without the hazardous properties of isocyanates. Additionally, researchers are exploring bio-based and environmentally friendly materials that can replace traditional isocyanates in various applications, from coatings to adhesives. These alternatives not only aim to maintain or improve product performance but also focus on minimizing toxicity and reducing environmental impact. The ongoing advancement of these safer alternatives is essential for achieving sustainable industrial practices and enhancing worker and environmental safety.

9. Conclusion:

Isocyanates are critical components in the production of polyurethanes and other industrial materials, offering valuable properties such as durability, flexibility, and chemical resistance. Their extensive use across various industries underscores their importance in modern manufacturing and construction. However, the inherent reactivity of isocyanates also presents significant health risks, including respiratory sensitization, skin irritation, and potential long-term health effects such as asthma and dermatitis. These risks are particularly pronounced in occupational settings where exposure can be high.

The review highlights the necessity for stringent safety measures and regulatory oversight to mitigate these health risks. Effective strategies include proper ventilation, the use of personal protective equipment, and adherence to established safety guidelines. Despite existing regulations, ongoing vigilance and research are essential to address gaps in knowledge and improve workplace safety. As industries continue to rely on isocyanates, advancing safer handling practices and exploring alternatives will be crucial in balancing industrial benefits with the health and safety of workers and the environment.

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RESEARCH

Biosynthesis, Spectroscopic, and Antibacterial Investigations of Silver Nanoparticles

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Abstract

Silver nanoparticles can be produced by an array of procedures, such as chemical, physical, and biological processes. The process of biosynthesis is more economical and significantly more environmentally friendly. We describe an environmentally compatible method (biosynthesis) of producing silver nanoparticles (Ag: NPs) with the capping component Artocarpus heterophyllus in this research work. Powder-X-ray crystallography (P-XRD), Fourier Transform Infrared (FT-IR), UV–visible (UV–Vis), Photoluminescence (PL), Field emission scanning electron microscopy (FE-SEM), and an antimicrobial test were all used to examine the synthesized samples. The P-XRD analysis revealed that the produced NPs have an FCC form with a typical particle size of 23 nm. FT-IR spectra further demonstrate the availability of the functional groups in the synthesized nanoparticles. The absorbance and transmittance spectra of the UV–Vis study have shown substantial transparency and less absorbance of the Ag: NPs in the entire visible region. The bandgap of the Ag: NPs was found to be 3.25 eV using the Tauc relation. In the PL study, an emission peak at 472 nm was found, suggesting the fluorescence emission of Ag: NPs. The FE-SEM micrographs provide confirmation of the surface-wide aggregate of nanostructural homogeneities. The FE-SEM micrographs illustrate that Ag: NPs are homogeneous aggregates of very small spheres. Variations in particle size and surface area-to-volume ratios of synthesized NPs have been proven to be responsible for the antibacterial activities. According to the antibacterial study, Ag: NPs restrain the development of both normal and harmful bacteria and so have the potential to be utilized for coating surgical equipment for aseptic operators in the healthcare industry.

Keywords Biosynthesis · XRD · FTIR · UV–vis · Photoluminescence · HR-SEM · Antibacterial effect

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Introduction

Nanotechnology is involved in the development of compounds, electronics, and structures on a nanometer level (1−100 nm) by the manipulation of matter at this level and the utilization of unique nanoscale properties. Because of the relevance of quantum and surface boundary effects, nanomaterials typically have quite different properties than their bulk counterparts. The form, size, surface properties, and interior structure of nanoparticles are the most important parameters. Nanoparticles have a variety of physical or chemical properties due to their small size, such as colloidal capabilities, optical properties, or electric properties [1–3]. Nanoparticles (NPs) have grown in importance in research and development, with numerous potential applications in the fabrication of electronic, optoelectronic, LEDs, storage devices, bio-sensors, and optical and optical fiber systems [4, 5]. Recent studies highlight the significance of ecologically friendly technologies for producing metal oxide nanoparticles, where oxides of metals such as zinc, gold, copper, silver, and nickel are becoming more important [6, 7]. Ag: NPs, on the other hand, stand out among metal oxides because of their significant electron transportation, exciton binding energy, wider bandgap, and good optical transmittance [8].

Silver nanoparticles have remarkable physical, chemical, and organic traits amongst different metal nanoparticles. Extensive studies are being carried out on Ag: NPs owing to their potential applications in clinical devices, pharmaceuticals, biomedical, water purification, optical, and household items [9, 10]. Ag: NPs have different natural applications significantly antimicrobial, antimalarial, anti-inflammatory, wound recuperating, chemo-preventive agent, and so on. Ag: NPs and silver-based materials are exceptionally harmful to microorganisms. Silver is known for inhibiting a wide range of bacterial strains and pathogens commonly seen in clinical and mechanical settings [11, 12]. Antibacterial efficacy refers to the process of eliminating or suppressing disease-causing microbes. A range of antibacterial agents is utilized for this. The fundamental reason for considering NPs as an option for antibiotics is that NPs can effectively reduce microbial drug resistance in specific circumstances [13, 14]. Many public health risks have risen as a result of the misuse of antibiotics such as superbugs that do not respond to any known drug and epidemics against which medicine has no resistance. The hunt for new, effective bactericidal materials is crucial in the fight against resistant bacteria, and nanoparticles (NPs) have emerged as a promising way to address this issue. Biosynthesized Ag: NPs limit the growth of both normal and pathogenic bacteria, and hence could be utilized to coat surgical tools for aseptic operators in the medical industry [15].

For the synthesis of NPs, a variety of approaches are available, including chemical, physical, and bioreduction procedures [16, 17]. Physical and chemical techniques are rather hazardous and expensive, while biological techniques are eco-friendly, secure, and less difficult for nanoparticle synthesis [18]. The concern with chemically producing silver nanoparticles is that they have a short lifespan owing to clustering. The silver nanoparticles generated in the majority of cases are highly unstable, necessitating the inclusion of an additional capping agent to ensure stability. Hence, due to the abrasiveness of traditional chemical procedures, biological organisms have been used to convert silver ions in solution into colloidal nanostructures. Also, with the biosynthesis technique, the size characterization and toxicity of a compound can be adjusted. It could be accomplished by employing appropriate solvents and herbal resources, such as organic products. Presently, diverse biological entities such as bacteria, fungi, yeast, and plant products are extensively used in green approaches to generate nanoparticles [19, 20]. Among the green synthesis methods, exploitation of plant extracts is an easy and clean method to synthesize metal NPs at a large scale compared with the microorganism or fungi-mediated methods. Furthermore, the leaf extracts themselves serve as capping & reducing agents, lowering the overall cost of the method. Plant-via nanoparticle synthesis is fairly quick because, unlike microbial synthesis, it does not require the use of particular media or growth conditions [21]. Ag: NPs synthesized through this approach are quite stable because of plant peptides and proteins. The biological aspect of the biosynthesized NPs relies on different elemental features like size, shape, morphology, cell agglomeration, and reducing agent utilized in the amalgamation of nanoparticles.

Several research groups have reported biological methods for synthesizing Ag: NPs using plant extracts. According to prior reports, Ag: NPs were synthesized by means of leaf extracts such as Calliandra Haematocephala [22], Carica papaya [23], Carissa Carandas [24], Carya illinoinensis [25], Clerodendrum inerme [26], Ixora coccinea [27], Origanum Vulgare [28], Pedalium murex [29], Petroselinum crispum [30], Prosopis Juliflora [31], and Phlomis [32]. In the present work, we have used an extract of fresh Artocarpus heterophyllus (Jack fruit) leaves as a reductant & capping substance to produce Ag: NPs. The jackfruit tree is a member of the mulberry family. The tropical and subtropical parts of the world, particularly Southeast Asia, are home to this tree. The Artocarpus heterophyllus leaf offers an array of therapeutic properties, plus diabetes prevention, antioxidant protection, and anti-aging. It's also high in potassium, which helps to keep blood pressure and heart rate in check. In the present investigation, Ag: NPs are synthesized using the leaves of the Artocarpus heterophyllus plant in the biosynthesis procedure. Several authors have documented the

natural synthesis, spectral description, surface morphology, and antibacterial properties of Ag: NPs in their backyards [33, 34]. In this study, we used P-XRD testing to identify the form and dimension of synthesized Ag-NPs. the structures and size of synthesized Ag: NPs, UV analysis to explore the optical nature of the compound, PL spectroscopy to identify the photoemission, FT-IR analysis to evaluate the existence of vibrational modes, FE-SEM analysis to analyze the surface texture of the compound, and antibacterial assay to analyze the antibacterial effects.

Materials and Methods

Leaf Extract

Fresh *Artocarpus heterophyllus* (Jack fruit) plant leaves were harvested from the central region of Kalpakkam, Tamil Nadu, India. To eliminate the dust, the leaves were cleansed repeatedly with distilled water. In a glass container, 50 g of cleaned, dried leaves were added with 150 ml of purified water to make the extract. The resulting solution was cooled to room temperature and then filtered once boiled for 20 min, until the color changed from watery to dark brown.

Synthesis of Ag: NPs

To produce Ag: NPs, a beaker containing 100 ml solution of *Artocarpus heterophyllus* leaves extract was heated gradually using a stirrer and heating setup. A suitable quantity (10 g) of $AgNO_3$ was introduced into the prepared solution once the temperature attained 60 °C. The combination was then heated until its colour changed from dark brown to brownish-black; revealing the growth of Ag: NPs. *Artocarpus heterophyllus* leaves, its extract, and observed colour change with the addition of $AgNO_3$ are shown in Fig. 1. The synthesized nanoparticles were agitated for about 10 min at 10,000 rpm. Ag: NPs were collected after draining the supernatant. The obtained nanoparticles were allowed to dry after being mixed with a little amount of ethanol and heated in Mantle Heaters. The prepared NPs were used for further characterizations.

Results and Discussion

X-ray Crystallography

X-ray diffraction analysis is a simple technique for determining the chemical structure of crystalline samples and providing information on the particle size [35, 36]. Any

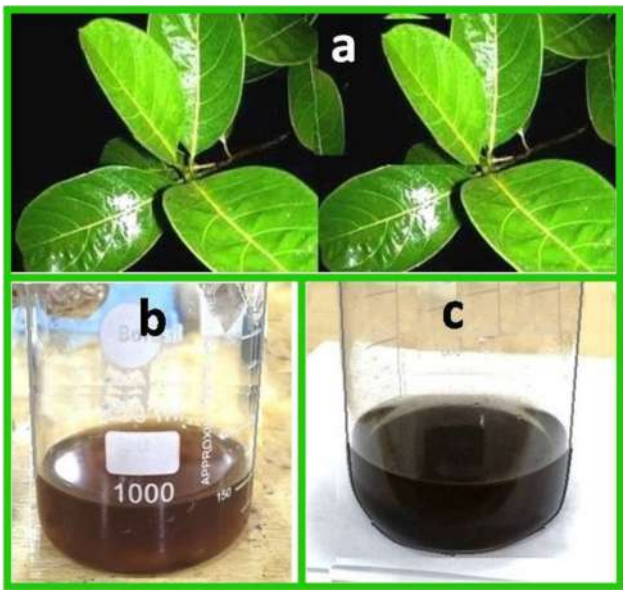

Fig. 1 **a** *Artocarpus heterophyllus leaves,* **b** Leaves extracts, and **c** $AgNO_3$—induced colour shift

crystal could reflect X-ray radiation, resulting in an array of diffraction patterns. These patterns will indicate the physicochemical features of the crystalline materials. Diffraction patterns usually originate from the test samples which represent their structural physiochemical characteristics. Diffraction patterns are crucial for the structural analysis of these materials. By comparing the diffracted patterns with the JCPDS reference database any material may be identified and recognized since it has its own diffraction pattern. The substance under test is finely powdered and blended for the diffraction study. The diffraction patterns were created using CuK_α radiation with a wavelength of 1.541 Å. For diffraction analysis, a small portion of the material was placed on a glass plate. Scanning was performed on the samples at 0.02 min^{-1} rate over the range 20−80°.

Both the crystallinity and the generation of Ag-NPs are confirmed by the appearance of several sharp peaks as in Fig. 2. In this plot, prominent peaks were indexed based on the FCC structural reports (JCPDS file no 04–0783). Specifically, Ag-NPs show six prominent diffraction peaks at the 2θ values 27.95°, 32.20°, 38.12°, 46.29°, 54.66°, and 64.48°, which correspond to the (121), (101), (111), (-112), (020), and (220), respectively. The XRD pattern shows a number of extra peaks that were not assigned. These extra peaks are assumed to be the result of the coagulation of the bioorganic layers on the face of the synthesized samples. The typical particle size of the biosynthesized Ag: NPs was calculated with Debye–Scherrer's formula [37] from the most intense peaks:

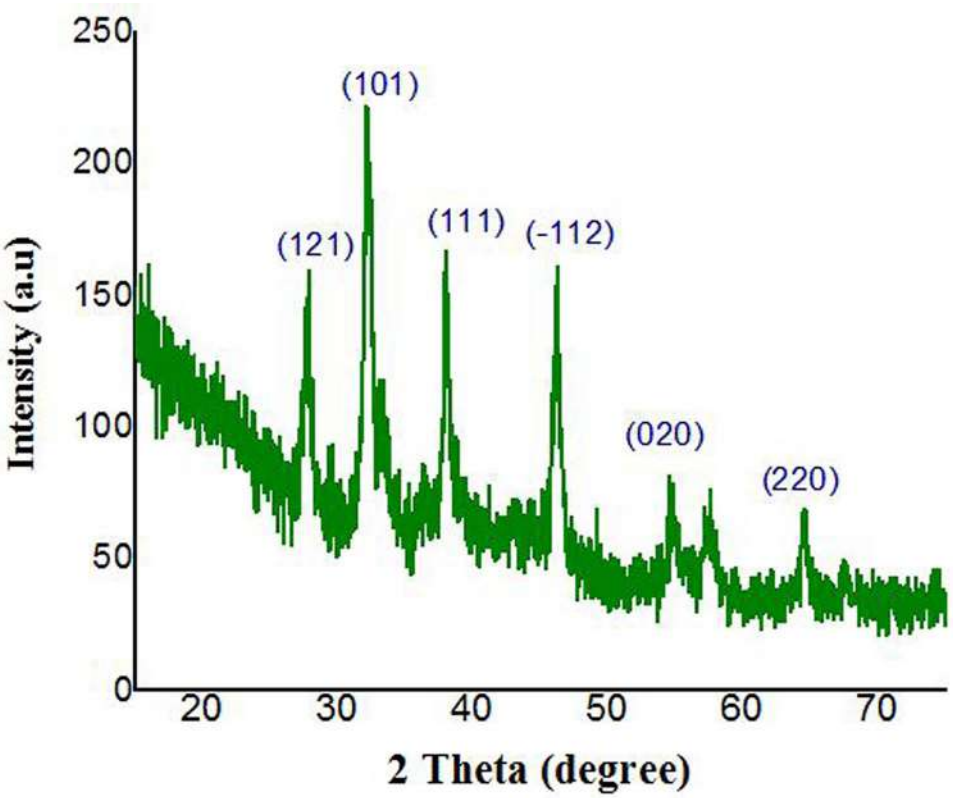

Fig. 2 XRD diffraction patterns of biosynthesized Ag: NPs

$$D = \frac{0.89\lambda}{\beta \mathrm{Cos}\theta} nm$$

where D represents the average crystalline size (nm), λ represents the wavelength (Å), β represents the full-width at half-maximum (radian), and θ represents the scattering angle (degree). The mean size of produced Ag: NPs was determined to be 23 nm using the above relation.

FT-IR Analysis

FT-IR spectroscopy is frequently used in the investigation of pharmaceutical raw materials, with both mid and near-IR spectroscopy acting as standard procedures for assessing both active chemicals and active medical components. Unquestionably, the most popular spectroscopic technique for examining inbound raw materials is near-IR spectroscopy. The mid-IR spectroscopy is particularly helpful for identifying and analyzing active ingredients in pharmaceutical samples as it typically offers the most information about the chemical composition of a sample [38, 39]. The non-intrusive FTIR analysis was applied to classify the functional groups present in the synthesized Ag: NPs. The specimens were made by evenly dispersing Ag: NPs in a matrix of dry KBr. The measurements were taken between 4000−400 cm^{-1} and the recorded FT-IR pattern of Ag: NPs are shown in Fig. 3. FT-IR curve displays some considerable absorbance bands at 3272, 2051, 1631, 1380, 949, and 549 cm^{-1} in the biosynthesized Ag: NPs. The absorbance band at 3272 cm^{-1} is assigned to the intramolecular OH bonding of water molecules. The absorbance band at 2051 cm^{-1} might be attributed to the C = C alkynes. The prominent absorbance band at 1631 cm^{-1} is designated to the C = O stretch of carboxylic group. The band at 1380 cm^{-1} might be attributed to the symmetrical stretch of the carboxyl groups in protein amino acid traces and the absorbance at 949 cm^{-1} is assigned to the C = C alkenes' bend.

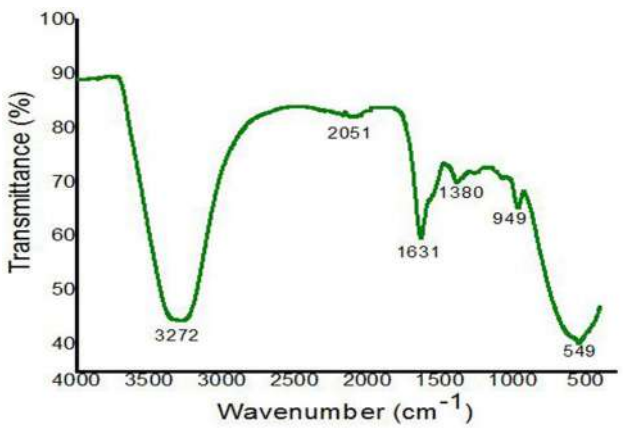

Fig. 3 FT-IR spectrum of biosynthesized Ag: NPs

The absorbance band at 549 cm^{-1} indicates the creation of Ag-NPs. According to the FTIR analysis, the carboxylic acid (-OH), Aromatic (C-H), and Amides (C = O) groups of *Artocarpus heterophyllus* leaves extract are primarily engaged in the transformation of Ag^{+} to Ag: NPs.

UV–Vis Analysis

UV–Vis spectroscopy is a low-cost, adaptable, and non-invasive analytical method that can detect a wide range of the transmission or absorption of light related to the wavelength of organic and inorganic molecules. This spectroscopy is applicable to a wide range of sample kinds, comprising solids, liquids, glasses, thin films, and nanoparticles. The optical nature of the prepared Ag: NPs sample has been evaluated by UV–Vis analysis [40, 41]. The UV–Vis spectra were derived from the "Jasco UV–Vis-NIR (Model: V-670) spectrophotometer" over the range of 800–300 nm in a data interval of 2 nm at a scan speed of 200 nm/min. Figure 4 depicts the optical absorbance spectrum of biosynthesized Ag: NPs. The absorbance is high at 300 nm and decreases abruptly from 300 to 400 nm. From 400 nm, the absorbance slightly decreases and becomes very little at higher wavelengths. Similarly, the optical transmittance of the sample steeply increased from 300 to 400 nm and then gradually increased upto 800 nm. The absorption edge found at 300 nm could be attributed to electronic transitions in the sample. The high optical transmittance or low absorption in the entire visible implies its usefulness for optical applications [41].

The spectral analysis of optical transmittance is also essential in finding the bandgap of the produced samples. The bandgap is one of the significant characteristics of the NPs because it substantially influences both the electrical and optical characteristics. The bandgap of the Ag: NPs is calculated using the Tauc relationship by means of UV absorbance spectra. According to the Tauc relationship [35], the absorption coefficient (α) is defined by

$$\alpha h\upsilon = A(h\upsilon - E_g)^n$$

where, A is a constant that changes in transition process, E_g represents the bandgap of the substance, $h\nu$ represents photon energy, and n is an integer that may have values such as 1/2, 3/2, 2, or 3 based on the kind of transitions. For a permitted transition, n value is set to 1/2. A plot between $h\nu$ and $(\alpha h\nu)^2$ can be obtained from the UV curve and is shown in Fig. 5. The bandgap of the Ag: NPs is calculated by tracing a straight line in the graph's linear section at $(\alpha h\nu)^2 = 0$. The bandgap of the Ag: NPs is determined as 3.25 eV.

Photoluminescence Study

The Photoluminescence (PL) study is a versatile method for analyzing a compound's electronic structure and optical properties [42, 43]. PL analysis can be subjectively and statistically applied to investigate compounds depending on the properties and intensity of light emitted by the substance. It is now frequently used to describe the physical and chemical aspects of a system and its evolution [44]. The homogeneous Ag-NPs were disseminated equally in a solution of water and the PL spectrum was taken out for Ag: NPs in the 400−750 nm region, by a 270 nm excitation wavelength source. The recorded PL spectrum of the biosynthesized Ag-NPs from *Artocarpus heterophyllus* leaves extract is illustrated in Fig. 6. From the curve, a highly intensive emission peak has been observed at 472 nm. After that, the intensity of emission gradually decreases and reaches a minimum at 600 nm. Jiang et al. have reported that the emission peak in the water phase was formed at 465 nm in the PL spectra of Ag: NPs [45]. Hence, in the present case, the emission peak formed at 472 nm in the PL spectrum is slightly higher-shifted.

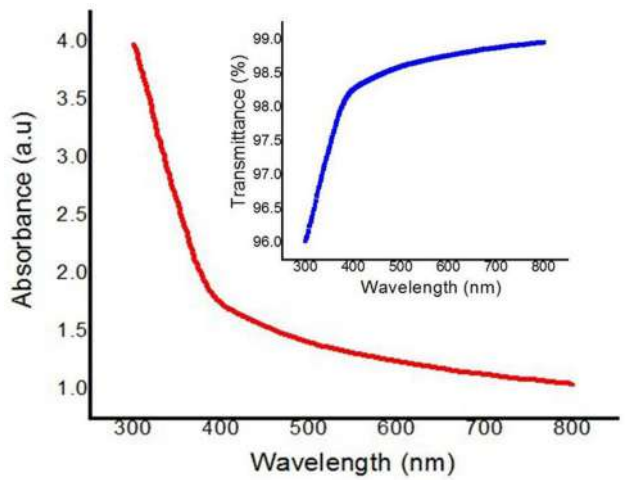

Fig. 4 UV–Vis absorbance and transmittance spectra of Ag: NPs

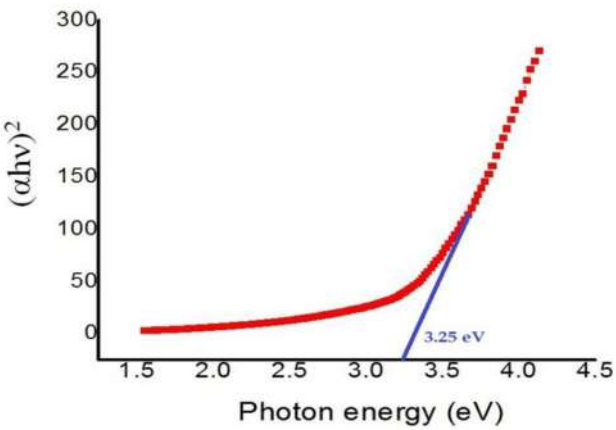

Fig. 5 Plot of $h\nu$ versus $(\alpha h\nu)^2$ for Ag: NPs

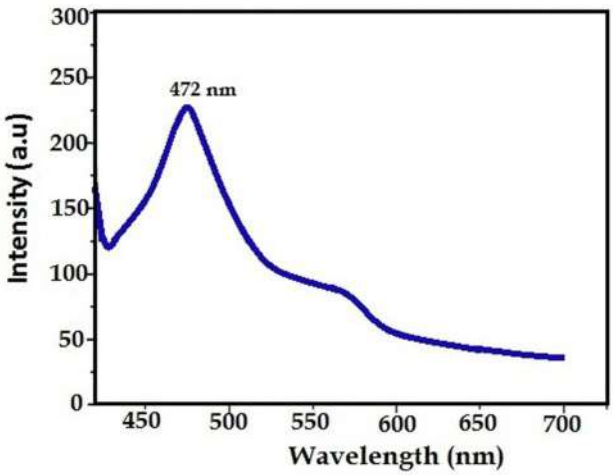

Fig. 6 Photoluminescence spectra of Ag-NPs

FE-SEM Investigation

The FE-SEM technique is used to capture incredibly fine topographic details on the surface of entire or fragmented materials [46]. The FE-SEM can be used, for instance, to investigate polymeric materials, coatings on microchips, and the organelles and DNA material found in living things. For this purpose, prepared samples were coated with an extremely thin layer (2 nm) of gold palladium. The coating on the sample forms a conductive layer which improves the secondary electron signals and also protects the sample from overheating. The morphology of the sample is replicated by the appearance of a real-time image on the monitor. The FESEM images of the biosynthesized Ag: NPs are provided in Fig. 7. Figure 7a represents the observation of the Ag: NPs at 30.0 K X focuses, whereas Fig. 7b represents the view at 80.0 K X resolution across the 5.8 mm width of the Ag: NPs sample. The FESEM images confirm that the Ag: NPs made from leaf extract of *Artocarpus heterophyllus* are well-dispersed, versatile, and spherical. The nanoparticles are of a comparatively open, quasi-linear substructure instead of a closely packed assembly. A closer examination indicates that Ag-NPs are poly-disperse groups of tiny spheres with high uniformity.

Antibacterial Efficacy

Due to the large surface-to-volume proportion and unique physiochemical characteristics, Ag: NPs have proven to be an effective antibacterial against multidrug-resistant bacteria [47]. Moreover, Ag: NPs can pass through bacterial cell walls, altering the structure of cellular membranes and even perhaps resulting in cell death [48]. The antibacterial activity of biosynthesized Ag: NPs towards pathogenic bacteria such as *Escherichia coli* and *Salmonella typhi*, was tested with Mueller–Hinton agar plates. The zone of inhibition encircling the well was observed shortly after the incubation time (30 min). The antibacterial efficacy of the biosynthesized Ag: NPs was observed by measuring the inhibition zone. The antibacterial efficiency of as-synthesized Ag: NPs was examined at three distinct concentrations: 20, 40, and 60 µl. At all concentrations (20, 40, and 60 µl), a clear inhibition zone was found in *E. coli* and S. *typhi* plates. Particularly, *E. coli* is more responsive to Ag: NPs than *S. typhi*. According to the experimental data, *E. coli* had inhibitions of 6, 10, and 12 mm while *S. typhi* had inhibition of 4, 7, and 9 mm respectively, for 20, 40, and 60µl concentrations. Figure 8 depicts the inhibition zones and Fig. 9 displays the comparison of inhibition zones of biosynthesized Ag: NPs by *E. coli* and *S. typhi* species. The experimental findings show that the Ag: NPs might control the growth of both normal and harmful bacterium species. It has also been discovered that increasing the concentration boosts antibacterial efficacy.

Following is an explanation of how the antibacterial mechanism originated from the Ag: NPs. When Ag: NPs

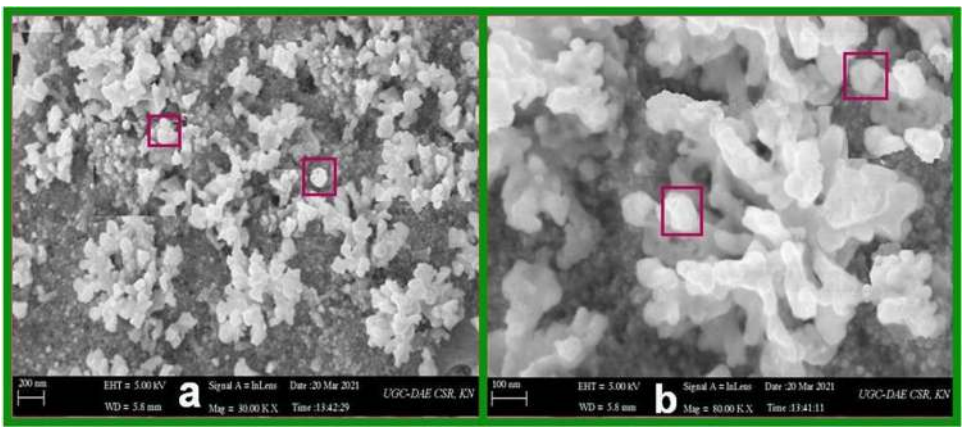

Fig. 7 FE-SEM micrographs of Ag: NPs with **a** 30.0 K X, and **b** 80.0 K X magnification

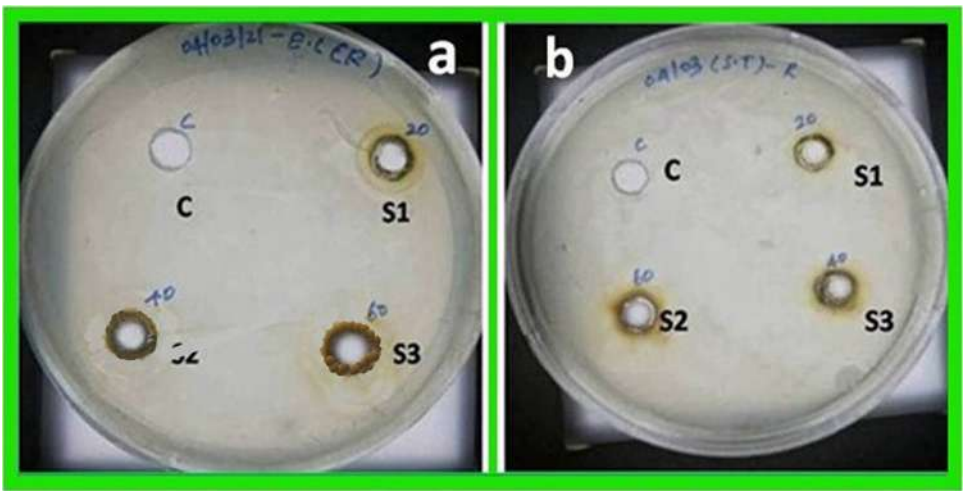

Fig. 8 The Antibacterial efficacy of Ag: NPs against *E. coli* and *S. typhi*

come into contact with bacteria, they permeate the cell membrane after reacting with functional groups in the cell membrane that include −COOH, −OH, and –SH [49]. Bacterial death is triggered by the deactivation of its genetic material and cell protein. Following the presence of reactive oxygen species (ROS) & the dispersal of Ag ions, Ag: NPs have an efficient antibacterial assay. Enhanced surface area, smaller particles, oxygen voids, and reactive molecular mobility are all related to greater ROS. The hydroxyl (−OH) & superoxide (O_2^-) radicals present in ROS have the ability to damage DNA and membranes of cells. The Ag: NPs and bacteria link together due to electrostatic attraction. Bacteria cannot grow in such a setting, and the resulting ROS kills the organism's cells [50].

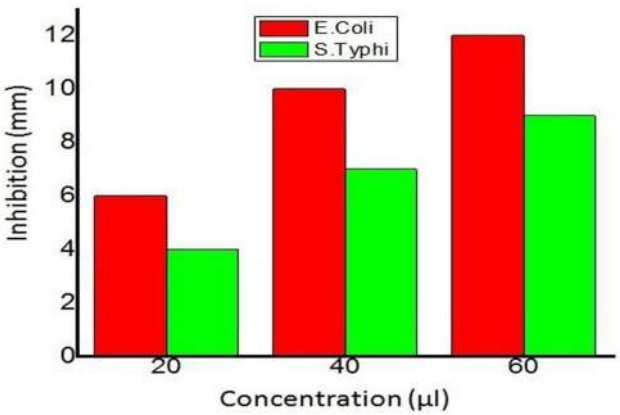

Fig. 9 Inhibition zone of Ag: NPs against *E. coli* and *S. typhi*

Conclusions

The biosynthesis method of nanoparticles is substantially safer and more environmentally friendly than chemical procedures. In this study, we presented a bio-compatible method of synthesizing Ag: NPs by employing leaf extract of *Artocarpus heterophyllus*. Experimental analyses such as P-XRD, FT-IR, UV–Vis, photoluminescence, FE-SEM, and antibacterial efficacy were conducted for the characterization of Ag: NPs. The XRD diffraction study confirms the FCC formation of Ag: NPs. The typical particle size of the biosynthesized Ag: NPs was found to be 23 nm. FT-IR spectroscopy was applied to study the availability of functional groups in the Ag: NPs. The absorbance and transmittance spectra of the UV–Vis study have shown substantial transparency and less absorbance for the Ag: NPs in the entire visible region. The bandgap of the Ag: NPs was found to be 3.25 eV using the Tauc relation. In PL investigation, the samples were found to be photoluminescent with an emission peak at 472 nm. Confirmation of the surface-wide aggregate of nanostructural homogeneities was provided by the FE-SEM micrographs. The micrographs indicate that Ag: NPs are poly-disperse clusters of smaller spheres with high uniformity. Antibacterial activity was reported in the plate treated with Ag: NPs. Clear inhibition zones were observed in *E. coli* and *S. typhi* plates at the concentrations of 20ul, 40ul, and 60ul, respectively. In particular, *E. coli* is more responsive to Ag: NPs than *S. typhi*. According to the experimental findings, the biosynthesized silver nanoparticles limit the growth of both normal and harmful bacteria and hence could be utilized to coat surgical tools for performing aseptic procedures in the healthcare industry.

Author Contributions **Helen Merina Albert:** Conception and design, Material preparation, Data collection and analysis Writing- original draft preparation, Formal analysis and Investigation, Figures, Writing-review and Editing. **Kishore Mendam:** Conception and design, Material preparation, Data collection and analysis, Figures, Formal analysis and Investigation, Writing- review and Editing. **Prafulla Gendaji Bansod:** Conception and design, Writing- original draft preparation, Formal analysis and Investigation, Writing- review and Editing. **M. S. Srinivasa Rao:** Conception and design, Writing- original draft preparation, Formal analysis and Investigation, Writing- review and Editing. **Archana Asatkar:** Conception and design, Writing- original draft preparation, Formal analysis and Investigation, Writing- review and Editing. **M. Kalyan Chakravarthi:** Conception and design, Figures, Formal analysis and Investigation, Writing- review and Editing. **M. P. Mallesh:** Conception and design, Material preparation, Data collection and analysis, Formal analysis and Investigation, Software, Writing-review and Editing.

Data Availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval This article does not contain any studies with human participants or animals performed by any of the authors.

Competing Interests The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

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Effect of selected mordants on the application of eco-friendly natural dye from *Spinacia oleracea* L. Leaves

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Abstract
Coloration of fabric is a major process in the production of textile material. In the present study, natural dye was extracted from Spinach leaves by using ethanol as solvent system for extraction. The overall process was carried out by mordanting the fabrics through pre-mordanting and post-mordanting system. It was done by using the natural mordant i.e. pomegranate rind as well as synthetic mordant i.e. stannous chloride and copper sulphate either by individually or in combination in the ratio of 9:1, 7:3 and 5:5 for each fiber and method of mordanting. The Different tone and shades were obtained on wool fibers in control and in combination of mordants such as pomegranate + stannous chloride and pomegranate + copper sulphate. Depending upon the mordants used the colour obtained on textile from Spinach extract may give different shades. The shades generated in natural mordant as well as synthetic mordants were all unique and different than control. The dyes produced were dyed on wool fabric and tested for their color fastness to washing properties.

Keywords: Dyes, wool fiber, Spinach leaves, natural & synthetic mordants

Introduction
The use of non-toxic and eco-friendly natural dyes on textiles has become a matter of significant importance because of the increased environmental awareness in order to avoid some hazardous synthetic dyes [1]. Recently, a number of commercial dyes and small textile export houses have started looking at the possibilities of using natural dyes for regular basis for dyeing and printing of textiles to overcome environmental pollution caused by the synthetic dyes [2]. For successful commercial use of natural dyes, the appropriate and standardized dyeing techniques need to be adopted without scarifying required quality of dyed textiles materials [3]. The extraction of colorant is the first stage in the natural dyeing process [4]. Extraction is the separation of the desired colour component by breaking the cell wall using physical or chemical techniques from the plant into a solvent medium under employment conditions [4-6]. Use of natural unconventional sources for dyeing of textiles can make the dyeing process cheaper and eco-friendly. The main idea of extracting dyes from plant (natural) sources is to avoid the environmental pollution. Present days with global concern over the use of eco-friendly and biodegradable materials, considerable research work is being undertaken around the world on the application of natural dyes in textile industry.
Spinach (*Spinacia oleracea*) is a green leafy vegetable (Family Amaranthaceae), low in calories is considered as a good source of vitamins (ascorbic acid, riboflavin, niacin and folic acid) minerals (iron and calcium) and dietary fibers. Spinach leaf extract used as the natural dyes for a dye-sensitized solar cell (DSSC) [7]. As the Spinach leaf extract have not been explored and undocumented with respects to dyeing in textile industry, the present work was a small step in utilizing the value of Spinach leaves as a source of natural dye for wool fabrics and to understand the process of dying during wool cloth coloration using different natural as well as synthetic mordants.

Materials and Methods
Source: A dark variety of spinach leaves were collected from the Amravati Market. The fresh spinach was used for the extraction and dyeing process.
Substrate: Wool fabric was selected for the study and collected from local market of Amravati and cut in a proper weight is 250 mg. Wool fabrics were used for the work.
Chemicals: 2% Stannous chloride, 2% Copper sulphate are used as chemical mordants and 2% pomegranate rind was used as a natural mordant.

The mordants were used individually as well as in a combination of natural and chemical mordants in the ratio of 9:1, 7:3 and 5:5 by employing pre-mordanting and post-mordanting method.

Methodology

For dyeing both natural (*Pomegranate rind*) and synthetic mordants (Stannous Chloride and Copper Sulphate) were used. The dying of wool fibers was done by using mordant individually as well as mordants in combinations. The dying of wool fibers was carried out in following steps.

- Extraction of dye.
- Mordanting.
- Dyeing.
- Fastness test.

Extraction of dye

50 gm of fresh spinach leaves were boiled in 100 ml ethanol. Extraction was carried out by boiling at 800 C gradually increasing the temperature up to 1000 C for 1 hour with regular stirring. After that the extract was filtered using muslin cloth. Dark green coloured filtrate was obtained from the fresh spinach leaves.

Extraction of a natural mordant (Pomegranate rind)

The outer surface of pomegranate (rind) was peeled off, washed thoroughly, dried in shade and powdered by the mechanical process. The stock solution of each mordant was prepared by dissolving 2 gm of powder in 100ml of ethanol.

Mordanting

Mordanting was achieved by pre-mordanting (before dyeing) and post mordanting (after dyeing) system. For mordanting, accurately weighed wool samples were rinse with ethanol and then treated with chemical mordants *viz*. copper sulphate (2%) and stannous chloride (2%) as well as natural mordants viz. Pomegranate rind (2%). The stock solution of each mordant was prepared by dissolving 2gm of powder in 100ml of ethanol. The mordant combinations viz. pomegranate rind: copper sulphate and pomegranate rind: stannous chloride was used in the ratio of 9:3, 7:3 and 5:5. The wool fabrics were treated with different metallic salts and natural mordants by following two steps.

Dyeing

Pre-mordanting method

For each of the selected mordant, the textile material is first immersed into the mordant solution (stannous chloride and copper sulphate individually as well as in combinations) and then brought to heating at 100 °C for 30 min with material-to-liquor ratio of 1:40. The dried pre-mordanted fabrics were then placed in a 100 ml of dyebath, gradually raising the temperature to 100 °C and allowed to simmer for 50 minutes. The dyed fabrics were removed and cool washed in a 2g/l detergent solution.

Post-mordanting method

The dried scoured wool fabrics were placed in a 100 ml of spinach dye bath, gradually raising the temperature to 100 °C and allowed to simmer for 50 minutes. The dyeing process was carried out in the dye bath without mordant. The dyeing was carried out for one hour at 50 °C. The dyed fabric was dried and the wool fiber was mordanted in the solution at 100 °C for 50 minutes.

Fastness Test

The dyed material was tested for light, wash and rub fastness. Light fastness was analyzed by exposing the dyed material to direct sun light for 1 day [8]. The wash fastness was carried out by washing the dyed fibber with soft detergent. The rub fastness of the dyed fibber wash carried out by rubbing the fibber and checking for fading of colour [9-11].

Results and Discussion

The detailed results of extraction of natural dye from spinach leaves by using ethanol as a solvent system and its application to wool fabric samples (photographs of dyed fabrics) using various mordants and mordanting techniques are presented in the Table 1. Natural dye mostly requires a mordant to be fixed on to the fibre. Common mordants like alum, copper sulphate, potassium dichromate, iron salt and stannous chloride have an affinity for the dye and the fibre, they form an insoluble precipitate with the dye in the fibre [12]. In the present study, the wool fabrics generally used in textile was selected for dyeing and ethanol used as solvent. The overall process was carried out by mordanting the fabrics through pre- mordanting and post-mordanting system. Mordant plays a very important role in imparting colour to the fabrics, mordanting was done by using the natural mordants i.e. pomegranate rind as well as synthetic mordant i.e. stannous chloride and copper sulphate either by individually or in combination in the ratio of 9:1, 7:3 and 5:5 for each fiber and method of mordanting. Depending upon the mordants used, the colours obtained on textile fibre from Spinach extract exhibited different green shades. The shades generated in natural mordant as well as synthetic mordant were all unique and different than control.

Effect of mordants and mordanting methods on Colour fastness

Natural dye mostly requires a mordant to be fixed on to the fibre. In the present study, the colour of extract (dye) was green and the wool fabrics were dyed with dye without application of any mordant was considered as a control to determine colour fastness. The dyed wool fabrics were tested for light fastness, wash fastness and rub fastness. The colour fastness is usually rated either by loss of depth of colour in original sample or is expressed by staining scale [12]. Wash fastness was carried out by washing the dyed fibre with non-ionic detergent (1 g/lit). Light fastness was analyzed by exposing the dyed material to direct sunlight for 24 hours. The rub fastness of the dyed fibre was carried out by rubbing the fibre and checking for fading of colour [10]. Below the tables revealed the fastness properties of spinach leaves extract dyed with wool fabrics. When wool fabric was tested for light, wash and rub fastness, it was found to exhibit moderate which rated 3, good rated by 4 and poor results which rated by 2 for the colour change, 5 rated for colour stained (Table No 1 & Figure 1).

Table 1: Colour properties of dyed wool fabrics with ethanol

Mordant with solvent	Method of Mordanting	Light Fastness		Wash Fastness		Rub Fastness	
		CC	CS	CC	CS	CC	CS
PR + Ethanol	Pre –M	4	5	3	5	2	5
CuSO4+ Ethanol		4	5	3	5	3	5
SnCl2+ Ethanol		4	5	2	5	2	5
PR + Ethanol	Post – M	3	5	2	5	2	5
CuSO4+ Ethanol		4	5	2	5	2	5
SnCl2+ Ethanol		4	5	3	5	2	5

PR: Pomegranate Rind, Pre-M: Premordanting, Post-M: Post mordanting; CC - Colour Change, CS 0 - Colour Stained

Table 2: Colour fastness of dyed wool fabrics with spinach leaves dye using selected mordents and mordanting methods with Ethanol (Solvent)

Mordant	Method of Mordanting	Mordant Proportions	Light Fastness		Wash Fastness		Rub Fastness	
			CC	CS	CC	CS	CC	CS
CuSO4 + PR	Pre-Mordanting	9:1	4	5	3	5	2	5
		7:3	4	5	3	5	2	5
		5:5	3	5	2	5	2	5
	Post-Mordanting	9:1	3	5	2	5	2	5
		7:3	3	5	3	5	2	5
		5:5	4	5	2	5	2	5
SnCl2 + PR	Pre-Mordanting	9:1	4	5	3	5	3	5
		7:3	4	5	3	5	2	5
		5:5	4	5	2	5	2	5
	Post-Mordanting	9:1	4	5	3	5	2	5
		7:3	4	5	3	5	2	5
		5:5	4	5	3	5	2	5

PR-Pomegranate Rind, CC - Colour Change, CS - Colour Stained

Copper Sulphate: Pomegranate rinds

When wool fabric treated with copper sulphate: Pomegranate rinds in combination with different proportion (9:3, 7:3 and 5:5) and was tested for light, wash and rub fastness, it exhibited moderate which rated 3, good rated by 4 and poor results which rated by 2 for the colour change, 5 rated for colour stained. The results are tabulated in Table 2 & Fig 1.

Stannous chloride: Pomegranate rind

The wool fabric was treated with Stannous chloride: Pomegranate rinds combinations with different proportions (9:3, 7:3 and 5:5) with ethanol and evaluated for colour fastness to light, washing and rubbing, the results showed good to poor results (Table 2 and Figure 1).

Results indicated that intensity of colours on dyed samples was changed after washing, exposing to sunlight and subjected to rubbing. During washing the sample, there is a little change in the colour. This is may be due to several factors, such as the dye itself decomposes, thus converting to colorless or a differentially coloured compound. Since most of the natural dyes have hydroxyl groups, which ionize under alkaline conditions, some of the samples dyed in acidic conditions faded when washed with alkaline soaps. The use of mild non-ionic soaps is recommended for use with these dyes [13]. Direct sunlight was used for determination of light fastness of the dyed samples for tenure of 24 hours [14]. Good light fastness by using copper sulphate as a mordants due to strong co- ordination tendency, enhances the interactions between the fiber and the dye, resulting in high dye uptake as well as protects the chromophore from photolytic degradation [12, 15]. Natural dyes have better biodegradability and generally have higher compatibility with the environment. They are non-toxic, non-allergic to skin, non-carcinogenic, easily available and renewable [13].

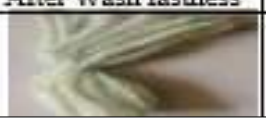
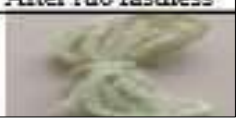
				
	Stannous Chloride ($SnCl_2$)	After light fastness	After Wash fastness	After rub fastness
				
Premordanting (In-combination)	Premordanting Cu +PR 9:1	After light fastness	After Wash fastness	After rub fastness
				
				
	Premordanting Cu +PR 7:3	After light fastness	After Wash fastness	After rub fastness
				
	Premordanting Cu +PR 5:5	After light fastness	After Wash fastness	After rub fastness
				
	Premordanting Sn +PR 9:1	After light fastness	After Wash fastness	After rub fastness
				
	Pre mordanting Sn +PR 7:3	After light fastness	After Wash fastness	After rub fastness
				
	Pre mordanting Sn +PR 5:5	After light fastness	After Wash fastness	After rub fastness
Post-mordanting (Individual)				
	Pomegranate rind	After light fastness	After Wash fastness	After rub fastness
				

Fig 1: Effect of Fastness properties on colour consistencies of treated wool fibres

Conclusion

The present investigation revealed that the ethanol extract of fresh spinach leaves has the dyeing potential as a source for wool dyeing. The whole process of extraction and dyeing is ecologically safe. The shade generated in natural mordant as well as synthetic mordants were all unique and different than control. The results revealed that the potential of colour retention on wool was good and gave brilliant colour and even absorption when mordant used in combination as compared to individual mordant. The fastness properties obtained are found to be good for wool. The present study was a small step in utilizing the value of natural Spinach leaves by extracting the natural dye and understands the process of dyeing during wool fabrics coloration using different natural. Future research can be conducted by testing the application of the Spinach leaves. Dye on other fabrics with different mordant and the mordanting techniques.

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Transparent Supply Chains with Blockchain

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Abstract - **Supply chain operation (SCM) is a core commercial exertion responsible for moving goods and services from one point to another through colorful stakeholders. The traditional SCM is grounded on a centralized approach managed at the central headquarter, and all other sub-offices get instructions from the main office. Some major issues with present SCM systems are security, transactional translucency, traceability, stakeholder involvement, product counterfeiting, fresh detainments, fraud, and precariousness. The traditional SCM is grounded on a centralized approach. A single business headquarters and a single storehouse full of departmental directors in different areas like logistics, distribution, and procurement, and these directors are responsible for overseeing their specific position during the complete force chain. They keep track of the information in a centralized database stored hard. When the data on the record isn't salutary to the company's growth, it may be misrepresented intimately. As a result, distrust between a ventures has precipitously conspicuous, performing in advanced communication charges. Also, there's no pricing translucency in the force chain because of the mediators. Likewise, because of the high threat of data manipulation inside the adventure, the data across force chain realities is inharmonious; as a result, the product tracing procedure has been delayed. In moment's force chain, there's no translated medium to store consumers' private information. Cyber-attacks will be suitable to pierce this data, revealing important public and particular information.**

Another crucial issue is that goods only travel in one direction in moment's force chain operation. As a result, if a product is defective, the client is responsible for the consequences. SCM is a core commercial exertion responsible for moving goods and services from one point to another through a variety of stakeholders. Different groups, coffers, actions, and associations are concerned with converting raw accoutrements into completed products and satisfying consumer orders, which are appertained to as force chains. It's an connected network of pots, individualities, conditioning, information, and coffers that are included in fabricating and transferring a product or service from the dealer to the customer via a planned inflow of information, physical dispersion, and payment. It starts with the delivery of raw accoutrements to a manufacturer and stops with the delivery of the completed product or service to the consumer. Control of the sluice of products and services to maintain the quality of sensitive goods throughout the payload, exclude gratuitous charges, and more satisfy client prospects is known as force chain operation.

Keywords: Transparent, Supply Chains, Blockchain, SCM.

1. Introduction

Transparency is viewed as a supporting pillar of supply chain management (SCM). A lack of transparency involving supply chain partners and practices can contribute to corporate and government scandals. As a result, improving supply chain transparency offers potential benefits to firms across the supply chain network. Globalization of supply chains, moreover, increases the complexity of these networks and thereby also increases the need for transparency to better manage processes, product flows, financial transactions, and information exchange. Maintaining secure supply chain information networks is another key feature of supply chain strategy. The critical purpose of information security is to protect user data from being modified or compromised. Yet, transparency requires disclosing potentially sensitive information to other participants in the supply chain. This raises the issue as to whether both transparency and security can be achieved simultaneously in SCM. Blockchain applications are currently evolving from pilot trials to real world applications. According to the International Data Corporation (IDC), worldwide spending on blockchain solutions will reach $11.7 billion in 2022. This is particularly relevant to SCM, as supply chain blockchains represent one of the most promising opportunities for the implementation of the distributed ledger technology.

2. Supply chain transparency

Supply Chain Transparency and Security Transparency involve sharing information among different participants across the supply chain network. As more partners engage within that network, information availability increases resulting in greater transparency, which boosts both traceability and visibility. Traceability in a supply chain is generally the ability of the system to identify and verify

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individual components including the historical state of activities. This involves tracking a product's flow and its attributes throughout the entire supply network. Traceability applies not only to the physical movement of a product but also to the information related to product quality and safety.

3. Blockchain in supply managements

Blockchain in Supply Chain The creation of blockchains has been called one of the most revolutionary innovations to emerge in recent years. Several studies reported that blockchain SCM integration is still in its infancy. Researchers typically suggest that blockchains can bring specific benefits to SCM.

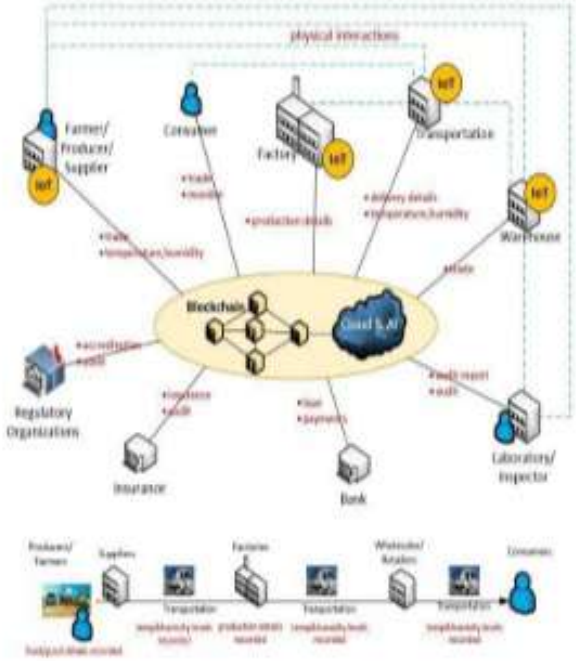

Figure 1: Participants and their roles in a typical blockchain integrated supply chain flow

4. Blockchain technology background

Original idea and building blocks of blockchain technology are coming from crypto money and date back to 1980s. Most recently, in 2008 December the article by an author nicknamed Satoshi Nakamoto titled as ''Bitcoin: A Peer-topeer Electronic Cash System'' popularized the blockchain technology. The blockchain concept consists of a combination of mathematics, crypto, computer and monetary science.

Blockchain technology, in fact, is a type of parallel and distributed computing architecture. It allows to eliminate central servers or trusted authority in digital interactions of partners. Thus it is classified as a disruptive technology which has potential to transform radically most of the processes in our daily life. Simply, copies of the data, called ledger, are stored on thousands of computers working together, and all changes to the data are provided by consensus of partners. The parties of [illegible] other. The factors tha[illegible]ers of the system are [illegible]y be made according [illegible] kept in a ledger whe[illegible], protected by crypto[illegible] chain is available to [illegible] digital data to change ownership like assets in the physical world.

The main consensus protocols used to ensure trust are Proof of Work (PoW), Byzantine Fault Tolerance (BFT), Proof of Stake (PoS) and Proof of Elapsed Time (PoET). The main purpose of the consensus mechanism is to ensure that proposed change requests are compatible with existing status of data and rules. Blockchain computers, called nodes, perform these validations. Cryptography is mainly used to ensure the authenticity of change requests on data and the immutability of data in the ledger by organizing modification history as blocks cryptographically connected each other. Privacy is another important issue in blockchain. Crypto is also used to ensure the privacy of the participant. High availability of the ledger is provided by keeping the entire ledger at the nodes, not at the center.

There are mainly two types of blockchain platform namely, public and private. In public blockchain anyone can send change requests to the network and can operate a node. In private blockchain, also called permissioned blockchain, both sending requests to the network and having a node is restricted to a set of actors.

5. Problems of Supply Chain and Opportunities with Blockchain

The main objectives of the supply chain are listed as cost, quality, speed, dependability, risk reduction, sustainability, and flexibility (Kshetri, 2018). Manufacturing has been globalized, leads well defined supply chain management more crucial and valuable. In today's supply chain systems, it is difficult for customers to know exactly the value of a product due to lack of transparency. In addition, investigating supply chains mostly is not feasible in case of suspicion of illegal or unethical activities.

Heavy paperwork, process costs, and slow processes are other main challenges of the supply chain. A literature survey on the research focuses on blockchain for supply chain domain shows that the supply chain domain already benefits from blockchain technology because of its four main features.

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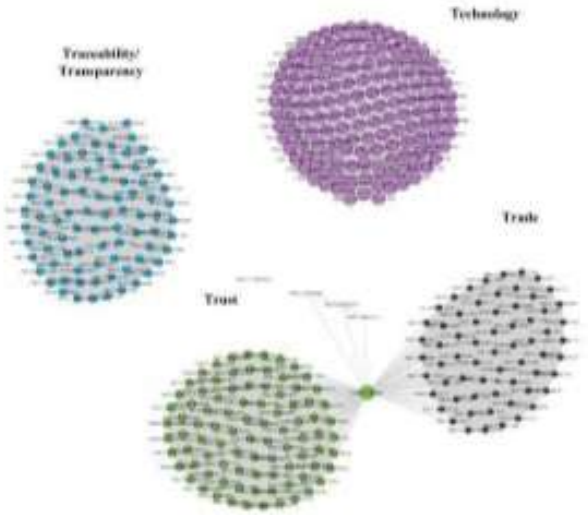

Figure 2: Research focuses in literature for deployment of blockchain for supply chain

Supply chain participants	Current limitations	Blockchain impact
Producer	Lack of ability to prove the origin and quality metrics of products transparently	Benefits from increased trust of keep track of the production raw material and value chain from producer to consumer
Manufacturer	Limited ability to monitor the product to the final destination. Limited capabilities of checking quality measured from raw material.	Added value from shared information system with raw material suppliers and distribution networks
Distributor	Custom tracking systems with poor collaboration capabilities. Limited certification ability and trust issues.	Ability to have proof-of-location and conditions certifications registered in the ledger.
Wholesaler	Lack of trust and certification of the products' path.	Ability to check the origin of the goods and the transformation /transportation conditions.
Retailer	Lack of trust and certification of the products' path. Tracking of products between consumers and wholesalers.	Ability to handle effectively the return of malfunctioning products.
Consumer	Lack of trust regarding the compliance of the product with respect to origin, quality and compliance of the product to the specified standards and origin.	Full and transparent view on the product origin and its whole journey from raw material to final, purchased product.

Table 1: How blockchain can improve the existing limitations of supply chains

In order to give an idea how blockchain might impact the needs of supply chain actors, we quoted Table 1 from literature. It presents Litke (2019)'s summary on how blockchain responds to the limitations that the actors of supply chains encounter today. other application areas. Employing blockchain in supply chain processes provides transparent, decentralized, secure, faster and low cost transactions. By eliminating unnecessary third parties and covering more daily life processes in digital systems minimizes paperwork. Blockchain establishes trust among trading partners. Making more detailed data available in blockchain, improves supply chain monitoring ability and safety. This reduces insurance risks. Smart contracts and automated payments are game changer. They add efficiency and remove bureaucracy especially in insurance, and traceability. They also allow escrowed payment by keeping money until terms of the deal are met and agreed, and then releasing automatically. Blockchain technology, in fact, provides missing infrastructure the cutting edge technologies need. Thus, increasing focus on providing integration and cooperation with technologies such as Artificial Intelligence, Big Data Analytic, Cloud Computing and IoT will help to realize advanced supply chain systems.

Now, there has been a considerable increase in the need for SC's fairness, security, and efficiency. The stakeholders have begun to demand a more transparent SCM process. End users want to know the complete information on the provenance of the items. To address such a problem, a tamper resistant tracking method must be created. Infrastructure decentralization and the development of a trust layer for business logic may be revolutionized using BC technology. BC is an immutable, permanent record system created by covering encrypted information in chronological order. Decentralization, traceability, tamper-proofing, and cryptographic security are all important elements of the BC system. Besides, smart contracts can be created, permitting transactions to be done safely between commonly un-trusted parties. Smart contracts are a type of digital contract or agreement. When a certain goal is fulfilled, a smart contract can be configured to do a task without the participation of a third party. BC can also support automatic payments, quality control, and stakeholder trust, among other things. Real-time data handling with monitoring and regulating data in a virtual environment, less paperwork, increased efficiency with faster response times, increased supply chain visibility, and reduced geographic limits are several advantages of adopting BC in supply chains. It also reduces the risk of SCM attacks.

6. Comparisons with the Existing Surveys

Several industries outside of finance, such as the supply chain, are among the most extensively discussed BC applications. BC technology is ideal for addressing supply chain concerns. The possibility of adopting BC technology in SCM has been a topic of investigation, and several reviews have been published so far that gives an overview of the current situation and a research path forward. Motivated by these facts, we have reviewed various supply chains in the proposed survey. This section compares state-of-the-art works that focus on the BC and SCM and their integration.

1) Conclusions

Blockchain is widely regarded as one of the important technology in many industries. It improves trust, transparency, traceability and security in the supply chain. The purpose of this literature is to focus on the usage of the blockchain in the supply chain.

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2) Contributions

This paper investigates the current status of BC technology implementation in various supply chain network areas. We comprehensively surveyed the application of BC in Food and Health supply chain networks. This study makes several significant contributions, including theoretical advances related to the adoption of BC in the supply chain.

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Impact of Machine Learning in Natural Language Processing (NLP)

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Abstract **- Natural Language Processing (NLP) has witnessed unprecedented growth and innovation in recent years, largely propelled by advancements in machine learning techniques. This research paper provides a detailed exploration of the pivotal role that machine learning plays in the field of NLP, highlighting its profound impact on various aspects of language understanding, generation, and analysis. The paper begins by tracing the historical evolution of NLP, from rule-based approaches to the current era dominated by data-driven machine-learning methods. It elucidates how machine learning, with its ability to extract patterns and meaning from vast amounts of textual data, has revolutionized the NLP landscape. Furthermore, the paper delves into the core components of NLP where machine learning has made significant contributions. It discusses the pivotal role of supervised learning in tasks such as sentiment analysis, text classification, and named entity recognition. Additionally, It explores the emergence of unsupervised learning and its applications in topics like word embeddings, topic modeling, and document clustering.**

Keywords: Natural Language Processing, Machine Learning, Deep Learning, Sentiment Analysis, Neural Networks, pre-trained Language Models, Ethical Considerations, Multimodal learning.

I. Introduction

Machine Learning and Natural Language Processing are super important subfields of Artificial Intelligence that have gained prominence in recent times. The goal of NLP is to build systems that can make sense of the text and automatically perform tasks like translation, spell check, or topic classification.

Machine Learning and Natural Language Processing play an awfully important part in making a synthetic agent into an artificial 'intelligent' agent. An Artificial Intelligence system can accept better information from the environment and might act on the environment in a user-friendly manner because of the advancement of Language Processing.

Similarly, artificial intelligent systems can process information and make more accurate forecasts for their actions. It's like they've become supercharged with intelligence.

Example Traditional algorithms follow a predefined set of instructions and struggle to handle unknown problems with multiple variables. However, machine learning algorithms excel in such situations by leveraging past examples and adapting to new challenges. Machine learning algorithms can learn from data and make informed predictions, making them much more effective when dealing with unknown variables in real-world problems.

Deep learning, which encompasses the use of artificial neural networks, is a specialized branch of machine learning. Lately, deep learning techniques have gained significant popularity and have achieved remarkable results. One key reason behind their success is the flexibility they offer in designing the network architecture. This adaptability has proven crucial in various applications, including natural language processing research. Deep learning techniques have truly revolutionized the field of machine learning and continue to push boundaries Natural language processing empowers machines to understand and process human languages. Natural Language Processing gave the system the ability to understand English or the Hind language.

Natural language processing has gained widespread adoption due to its incredible user-friendliness. It allows us to do so much with just our voice, from selecting music to controlling various electronic appliances like air conditioners, ovens, and even ceiling fans and light bulbs. This technology has truly transformed these devices into smart gadgets that respond to our commands. All this is possible because of Natural Language Processing.

II. Impact of Machine Learning in Natural Language Processing

Processing natural language involves multiple steps to enable machines to understand and interpret human language. These steps include Morphological Analysis, Semantic Analysis, Semantic Analysis, Discourse Analysis, and pragmatic Analysis, generally, these analysis tasks are applied

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serially. Machine learning plays a crucial role in enhancing various natural language processing processes. It adds value by enabling systems to learn patterns and make predictions based on vast amounts of data.

1. Morphological Analysis:

It is the study of word structure and forms in NLP. It helps understand word meaning and grammar.

2. Syntactic Analysis:

It is study of sentence structure and grammar in NLP. It helps understand how words are combined to form meaningful sentences.

3. Semantic Analysis:

It is the study of meaning in NLP. It helps understand the interpretation and representation of words and sentences.

4. Discourse Analysis:

It is the study of how language is used in communication and conversation. It helps understand the structure, coherence, and meaning of extended texts or conversations.

5. Pragmatic Analysis:

It is the study of how language is used in context to convey meaning beyond the literal interpretation of words. It helps understand the intentions, implicatures, and social aspects of communication.

III. Role of Machine Learning In The Application Of Natural Language Processing

NLP applications heavily rely on natural language machine learning and deep learning algorithms to process tasks. These algorithms play a crucial role across a wide range of NLP applications, making them an integral part of the field.

Various deep learning techniques, such as Deep Neural Networks, Autoencoders, Restricted Boltzmann Machines, Recurrent Neural Networks, and Convolutional Neural Networks, have been extensively explored and implemented in different applications of natural language processing

Recurrent Neural Networks (RNNs) and their variants, such as Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU), along with Convolutional Neural Networks (CNNs) and their variants like Recurrent Convolutional Neural Networks (RCNN) and Regional Convolutional Neural Networks (R-CNN), have been extensively studied and applied in natural language processing applications.

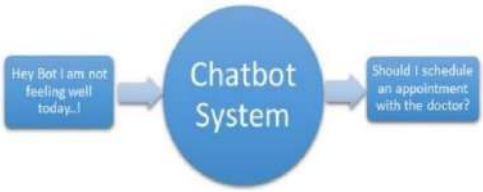
1. Sentiment Analysis:

Sentiment analysis plays a crucial role in understanding user opinions and sentiments towards a particular product or service. It has become increasingly important in customer relationship management, as even a single negative opinion can have a significant impact on the product's reputation. In recent times, deep learning techniques have gained popularity and have been extensively utilized in sentiment analysis.

2. Chatbot Systems:

Chatbot systems are conversational agents or dialog systems that try to engage the user in conversation. Conversation can be continued through voice or text. Personal assistants like Amazon's Alexa and Google Assistant have made the chatbot system more popular and have shown the convenience they offer. However, developing a fully capable chatbot that can replace a human agent is indeed a challenging task, which requires Natural Language Understanding and Natural Language Generation.

Recent frameworks like Google's, IBM's Watson AI, and Amazon's Alexa AI provide an easy way of developing a chatbot system. And, all these frameworks employ complex and proprietary deep-learning architectures.



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3. Question and Answering Systems:

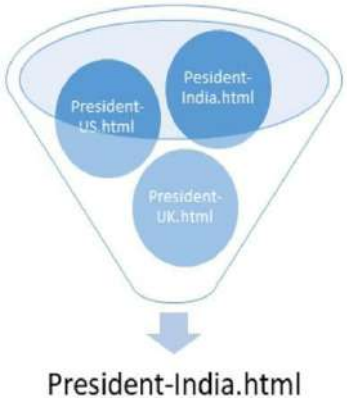
Nowadays, there is a blurring line between dialogue systems and question-answering systems. Chatbot systems often perform question-answering tasks, and vice versa. So, research efforts focused on developing a chatbot system will likely involve developing a question-answering system as well.

A question-answering system consists of three key components: question processing, information retrieval, and answer processing. Machine learning and deep learning techniques have been instrumental in advancing all three components.

Question processing, in particular, has received significant research attention. The goal is to understand the question to improve answer retrieval effectively. Researchers have approached question processing as a classification problem and explored various deep-learning techniques for better question classification.

4. Information Retrieval Systems:

Information Retrieval is another important application of NLP that tries to retrieve relevant information. Information retrieval systems act as the backbone of systems like chatbot systems and question-answering systems. The basic way to retrieve information is by analyzing keyword frequency. However, advanced systems process a vast amount of data to extract only the relevant information. This alternative method allows for more efficient and accurate retrieval of data. This process is carried out using deep learning techniques.



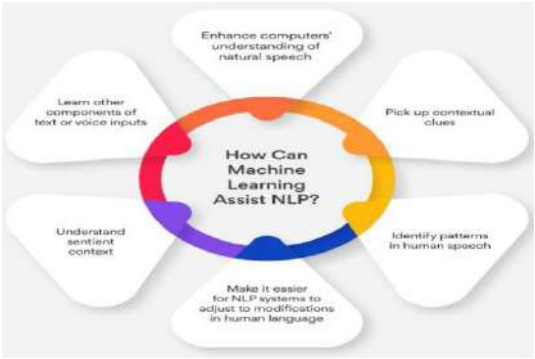
5. Machine Translation

A machine translation system aims to translate a text from one language to another with minimal or no human intervention. Applications like Google Translate are prime examples of machine translation systems. Simply translating word-for-word is not sufficient, as sentence structure can vary across languages. Machine translation systems use advanced algorithms and artificial intelligence to analyze and understand the structural and linguistic differences between languages.

IV. The Relationship between Machine Learning and Natural Language Processing

Machine learning and natural language processing are closely related. Machine Learning techniques, such as deep learning and neural networks, are used in natural language processing to train models that can understand, interpret, and generate human language. These models learn from large amounts of text data to recognize patterns, extract meaning, and make predictions. Machine learning empowers natural language processing systems to perform tasks like sentiment analysis, text classification, machine translation, and more. It's an exciting field that continues to advance our ability to interact with computers using human language.

1. Supervised Machine Learning for NLP:



In supervised learning, models are trained using labeled data to find the mapping function between input variable X and output variable Y. Y=f(X) Supervised learning needs supervision to train the model, which is similar to how a student learns things in the presence of a teacher. Supervised learning can be applied to regression problems (predicting

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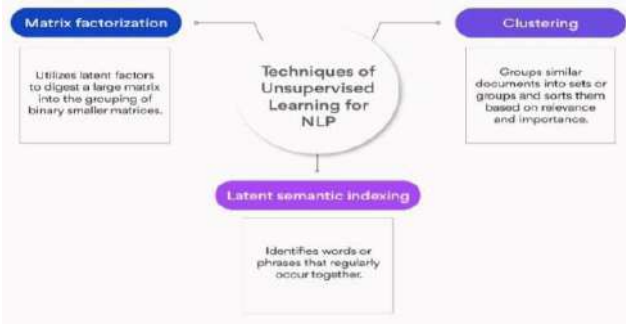
continuous values) and classification problems (predicting categorical values). In this form of NLP machine learning, statistical models are employed to enhance its understanding and performance. It becomes precise over time and data scientists can broaden the textual data the machine interprets as it continually learns.

2. Unsupervised Machine learning for NLP:

Unsupervised learning is a different type of machine learning where patterns are discovered in unlabeled data. It aims to find hidden structures and patterns without any guidance or supervision. Instead, the algorithm learns on its own by analyzing the data.



V. Conclusion

In conclusion, the research paper underscores the pivotal role that machine learning plays in advancing the capabilities of natural language processing, it emphasizes the need for ongoing research to address challenges and maximize the potential of these technologies in revolutionizing communication understanding, and interaction with human language.

In conclusion, we can say using machine learning makes our life easy for example if we are searching for something it helps to make it easy by machine learning keep learning from history so it helps us in it. All our grammatical mistakes it automatically corrected and gives us accurate results of our search. Through this research paper, we can easily understand the processes of processing. How it converts our language to computer language make it easy and by using natural language processing computer can easily understand our language. Machines make it easy to use computers in our comfort zone and without any problem of understanding.

Throughout the paper, it becomes evident that the utilization of machine learning methods significantly enhances the performance of NLP applications. The accuracy and efficiency of tasks like language translation, sentiment analysis, and speech recognition have improved due to the power of machine learning algorithms.

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Methods in Cryptography

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Abstract - Cryptography, the science and art of secure communication, has evolved into a cornerstone of the digital age. This abstract delves into the core principles, historical development, and contemporary significance of cryptography in the context of data protection, privacy, and cybersecurity.

Historical Foundations: It was initially used for military and diplomatic purposes. From rudimentary ciphers to complex code-breaking machines during World War II, the historical progression of cryptography reflects humanity's quest for secure communication.

Fundamental Principles: Modern cryptography relies on mathematical and computational principles. It encompasses symmetric and asymmetric encryption. Symmetric encryption employs a shared secret key for both encryption and decryption, while asymmetric encryption uses a public-private key pair. Algorithms such as AES and RSA exemplify the robust mathematical foundations of cryptography.

Applications in the Digital Era: In the contemporary digital landscape, cryptography plays a pivotal role in safeguarding sensitive data. It enables secure online transactions, protects information during transmission, and ensures the integrity of data. Beyond communication security, cryptography is vital in diverse fields like blockchain technology, digital signatures, and privacy-preserving protocols.

Keywords: Cryptography, Information Security, Encryption, Decryption, Digital Privacy, Digital Signatures, Blockchain, Quantum Computing, Cybersecurity.

1. Introduction

Cryptography, the science and art of secure communication, has evolved into a cornerstone of the digital age. This abstract delves into the core principles, historical development, and contemporary significance of cryptography in the context of data protection, privacy, and cybersecurity. It was initially used for military and diplomatic purposes. From rudimentary ciphers to complex code-breaking machines during World War II, the historical progression of cryptography reflects humanity's quest for secure communication. Modern cryptography relies on mathematical and computational principles. It encompasses symmetric and asymmetric encryption. Symmetric encryption employs a shared secret key for both encryption and decryption, while asymmetric encryption uses a public-private key pair. Algorithms such as AES and RSA exemplify the robust mathematical foundations of cryptography. In the contemporary digital landscape, cryptography plays a pivotal role in safeguarding sensitive data. It enables secure online transactions, protects information during transmission, and ensures the integrity of data. Beyond communication security, cryptography is vital in diverse fields like blockchain technology, digital signatures, and privacy-preserving protocols.

Cryptography faces ongoing challenges, including the looming threat of quantum computing, which could compromise current encryption standards. Researchers are actively developing post-quantum cryptographic solutions. Additionally, the pursuit of privacy has given rise to advanced techniques like homomorphic encryption and zero-knowledge proofs.

2. Methods of Cryptography

Symmetric-key cryptography:

Symmetric-key cryptography, also known as secret-key cryptography or private-key cryptography, is a fundamental branch of cryptography that involves using the same secret key for both the encryption and decryption of data. In this cryptographic system, the security of the communication relies on keeping the key itself secret, as anyone with access to the key can both encrypt and decrypt the data. Symmetric-key cryptography is characterized by the following key principles:

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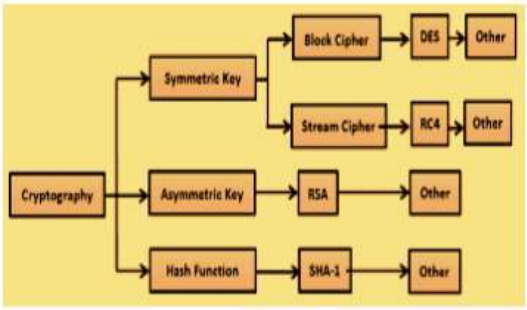


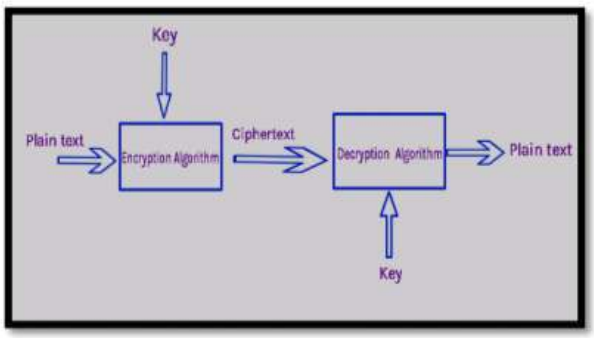
Single Key: Both the sender and the recipient use a single shared secret key for encryption and decryption. This key is typically a random string of bits, and the security of the system relies on the secrecy and strength of this key.

Efficiency: Symmetric-key algorithms are typically much faster than their asymmetric (public-key) counterparts. This makes them ideal for encrypting large amounts of data, such as data storage and streaming media.

Examples: Common symmetric-key encryption algorithms include the Advanced Encryption Standard (AES), Data Encryption Standard (DES), and Triple DES. These algorithms employ mathematical operations and the secret key to transform plaintext into ciphertext and vice versa.

Key Distribution: A major challenge with symmetric-key cryptography is key distribution. To securely share the secret key between the sender and receiver, secure key exchange protocols are often used. This can be a vulnerable point if not handled carefully.

Security: The security of symmetric-key systems is dependent on the key length and the quality of the encryption algorithm. Modern symmetric-key algorithms, such as AES, are considered highly secure when used with sufficiently long keys.



Asymmetric-key cryptography

Asymmetric-key cryptography, also known as public-key cryptography, is a fundamental branch of cryptography that employs a pair of distinct keys for secure communication and data protection. In this system, each participant has both a public key and a private key, and they perform different functions in the encryption and decryption processes. Asymmetric-key cryptography provides several key advantages, and its applications extend to various aspects of digital security and authentication. Here is an overview of asymmetric-key cryptography:

Key Concepts:

1. Public Key: This key is widely distributed and known to anyone who wants to communicate with the key's owner. It is used for encrypting data that only the owner of the corresponding private key can decrypt.

2. Private Key: This key is kept secret and is only known to the owner.

3. Encryption: To send an encrypted message to someone, you use their public key to encrypt the message.

4. Digital Signatures: Asymmetric cryptography is used to create digital signatures. The private key is used to sign a message, and the recipient can verify the signature using the sender's public key. This ensures the message's authenticity and integrity.

5. Key Pairs: A user or entity generates a pair of keys, typically using mathematical algorithms.

3. Applications

- Secure Communication Asymmetric cryptography is often used in secure email communication, securing data transmission over the internet, and protecting sensitive information. Protocols like SSL/TLS are used to secure web traffic by employing asymmetric encryption for key exchange.
- Digital Signatures: It is essential in verifying the authenticity and integrity of documents, messages, and software updates. Digital signatures are commonly used in e-commerce, legal contracts, and software distribution.
- Public Key Infrastructure (PKI): PKI systems are built on asymmetric cryptography to manage digital certificates, which are used to verify the identity of individuals and entities in online interactions.
- Cryptocurrency: Blockchain technology, which underlies cryptocurrencies like Bitcoin, uses asymmetric cryptography to secure transactions and control the transfer of digital assets.
- Secure Authentication: Asymmetric keys are often used in secure authentication protocols, providing secure access to networks, systems, and data.

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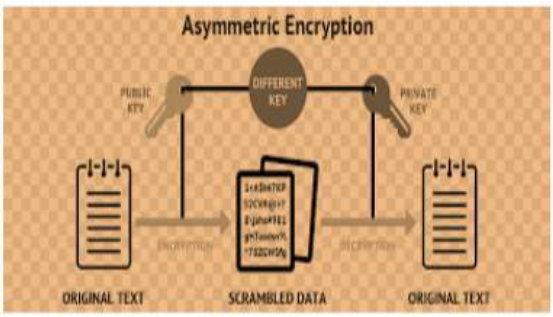
4. Advantages

1. Key Distribution: Asymmetric cryptography eliminates the need for secure key distribution because public keys can be openly shared, while private keys remain secret.

2. Non-Repudiation: The use of digital signatures provides non-repudiation, making it difficult for parties to deny their involvement in a transaction or the authenticity of a document.

3. Scalability: Asymmetric cryptography can be used in scenarios involving multiple parties without the need for shared secret keys for each pair of participants.

4. Security: When properly implemented, asymmetric cryptography offers a high level of security, particularly against brute-force attacks.



5. Algorithms

Cryptography relies on various algorithms to provide secure encryption, decryption, and other cryptographic operations. These algorithms are designed to protect sensitive information from unauthorized access and ensure the confidentiality, integrity, and authenticity of data. Here are some of the most commonly used cryptographic algorithms:

1. Symmetric Key Algorithms:

Advanced Encryption Standard (AES): AES is one of the most widely used symmetric encryption algorithms. It supports key lengths of 128, 192, and 256 bits and is known for its speed and security.

Data Encryption Standard (DES): Although DES is now considered outdated and insecure for many applications, it was one of the first widely adopted symmetric encryption algorithms.

Triple Data Encryption Standard (3DES): 3DES is a more secure variant of DES that applies the DES algorithm three times with different keys.

Blowfish: Blowfish is a symmetric block cipher known for its speed and simplicity.

Twofish: Twofish is a symmetric key block cipher designed as an alternative to AES.

2. Asymmetric (Public Key) Algorithms:

Rivest-Shamir-Adleman (RSA): RSA is a widely used asymmetric algorithm for secure key exchange, digital signatures, and encryption. It is based on the mathematical properties of large prime numbers.

Elliptic Curve Cryptography (ECC): ECC is a type of asymmetric cryptography that uses the algebraic structure of elliptic curves to provide strong security with shorter key lengths, making it efficient for resource-constrained devices.

Diffie-Hellman (DH): Diffie-Hellman is a key exchange algorithm used to securely exchange keys over an untrusted network.

Digital Signature Algorithm (DSA): DSA is an asymmetric algorithm designed for creating digital signatures.

Elliptic Curve Digital Signature Algorithm (ECDSA): ECDSA is an elliptic curve-based digital signature algorithm used for cryptographic authentication and data integrity.

3. Asymmetric key algorithms:

Common asymmetric encryption algorithms include:

RSA (Rivest–Shamir–Adleman): One of the oldest and widely used asymmetric encryption algorithms, it's used for encryption, digital signatures, and key exchange.

DSA (Digital Signature Algorithm): Primarily used for digital signatures, DSA is part of the Digital Signature Standard (DSS).

ECC (Elliptic Curve Cryptography): ECC provides strong security with shorter key lengths compared to RSA, making it more efficient for many applications.

Common asymmetric key exchange protocols include:

Diffie-Hellman (DH): Used to securely exchange keys over an untrusted network.

ECDH (Elliptic Curve Diffie-Hellman): A variant of Diffie-Hellman that uses elliptic curve cryptography for key exchange.

Asymmetric cryptography is essential for securing communications, data, and digital transactions in various applications, including secure web browsing (HTTPS), email encryption, secure chat applications, and more. It offers a way

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to protect data confidentiality, integrity, and authenticity in a public and interconnected world.

4. Hash Functions:

SHA-2 (Secure Hash Algorithm 2):SHA-2 includes several hash functions, such as SHA-256 and SHA-512, and is widely used for data integrity and digital signatures.

SHA-3: SHA-3 is the latest member of the Secure Hash Algorithm family, designed for improved security and performance.

MD5 (Message Digest Algorithm 5): MD5 was widely used in the past for data integrity and checksums but is now considered weak and unsuitable for security-critical applications.

SHA-1 (Secure Hash Algorithm 1): SHA-1 was commonly used for data integrity but is now considered insecure due to vulnerabilities.

5. Key Exchange Algorithms:

Diffie-Hellman Key Exchange (DHE): This algorithm allows two parties to securely exchange encryption keys over an untrusted network.

Elliptic Curve Diffie-Hellman (ECDH): ECDH is a variant of Diffie-Hellman that uses elliptic curve cryptography for key exchange.

RSA Key Exchange: RSA can also be used for key exchange, though it is typically slower than the aforementioned methods.

These are just a few examples of cryptographic algorithms used in the field of cryptography. The choice of which algorithm to use depends on the specific requirements of the cryptographic application, including factors such as security, performance, and compatibility with existing systems. Cryptographers and security experts continually evaluate and update these algorithms to address emerging threats and vulnerabilities.

6. Homomorphic Encryption:

Partially Homomorphic Encryption Schemes:

These schemes support one type of homomorphic operation, either addition (homomorphic under addition) or multiplication (homomorphic under multiplication), but not both.

Paillier Cryptosystem: A partially homomorphic encryption scheme that is homomorphic under addition. It's used for secure aggregation of data without revealing individual values.

Fully Homomorphic Encryption (FHE) Schemes: These schemes support both addition and multiplication operations on encrypted data, making them more versatile but also more complex.

RSA-based Fully Homomorphic Encryption: Builds on the RSA cryptosystem to achieve fully homomorphic encryption. It's computationally intensive and typically used for proof-of-concept rather than practical applications due to its inefficiency.

Gentry's Fully Homomorphic Encryption: Proposed by Craig Gentry, this was the first practical FHE scheme. It uses lattice-based cryptography and has since evolved to become more efficient and secure. Some popular implementations include the BFV (Brakerski-Vaikuntanathan) and CKKS (Cheon-Kim-Kim-Song) schemes.

LWE-based Fully Homomorphic Encryption: Several modern FHE schemes are based on the Learning with Errors (LWE) problem, a hard mathematical problem. These schemes are known for their security and efficiency.

Ring-LWE-based Fully Homomorphic Encryption: This is an extension of LWE-based schemes that leverages the Ring-LWE problem. It offers certain advantages in terms of efficiency and security.

6. Conclusion

Cryptography is a continuously evolving field, with new algorithms and methods being developed to address emerging security challenges. The choice of cryptographic method depends on the specific use case, security requirements, and the threat model. It's essential to stay updated with the latest developments and best practices in cryptography to ensure the security of digital information and communications.

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Challenges of Digital Forensic in Cloud Computing

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***Abstract* - Cloud services are becoming the most promising technology of recent days. It provides scalable, flexible services to many users at the same time and it helps to quickly access resources from the cloud service provider. Digital forensics is part of the computer forensic science. Various cloud issues block the cloud forensics process, so there is no standard framework for cloud forensics can be drawn. This article summarizes the challenges, various challenges are also discussed in this article at each stage of cloud forensics in cloud computing.**

Keywords: Cloud Computing System, Cloud Forensics, Digital Forensics Process.

1. Introduction

Cloud technology enables convenient use when needed use of computing resources with minimal management work and communication with the service provider. Virtualization and the nature of multithreading the cloud offers better utilization of resources and exists basic cloud computing functions, but they do the main problems of the cloud. But with any new technology, security comes into play about whether the technology in question has good protection and privacy The implementation of this technique is very simple, but some techniques such as cloud computing, digital forensics and the cloud forensics is more useful in today's world, but less so it takes a lot of time to implement the security of these technologies. Digital forensics is a part of computer forensics. The identification, collection, analysis and presentation digital evidence called digital forensics. In this paper we discuss the challenges of each stage for digital forensics in a cloud computing environment.

2. Challenges of Cloud Forensics

This section presents the challenges in every phase of cloud forensics.

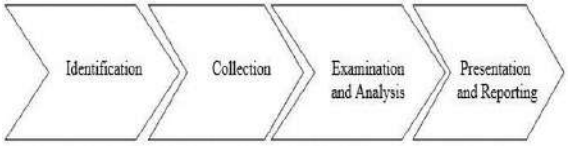

Figure 1: Cloud forensic process flow

1) Identification

The identification phase mainly defines the goal and the research process. Crime detection is an initial step in the digital research process model. Detecting malicious activity is easy the recognition phase. The most important thing here is how we say it is it a crime traditionally in digital forensics investigators detect crime in the following ways:

- If someone has made a complaint.
- Due to anomalies detected by the intrusion detection system.
- During the computer system audit.

Challenges:

i) Using evidence in logs:

Decentralized nature the cloud makes it difficult to identify the data. Availability of log files depends on maintenance cloud model. In SaaS, there is more to identify PaaS difficult due to limited access, detection is better in IaaS but not full access.

ii) Persistent data:

Cloud is essentially volatile, volatile data means that when the device is turned off, all data will be lost deleted in the same way in the cloud when the VM is completely powered off data is lost if it is not saved somewhere. RAM may contain valuable evidence such as username, passwords and encryption keys. Because RAM capacity increases and RAM memory increases use of data encryption.

iii) Lack of cloud management:

This is a subscription network connection to a common set of resources and resources are virtual in nature, namely physical no cloud ever knows the location of the resource user.

iv) Lack of customer awareness:

Everything is down in the cloud there is little control over the CSP and cloud user interaction with CSP is sometimes absent. CSP lack of transparency and little international regulation leads to the loss of important terms in relation to forensic investigations at the service level agreement (SLA). This problem affects all three service models.

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2) Collection and preservation of evidence

Evidence gathering collects evidence of what has been identified sources of evidence. The evidence collected must be maintained Data Retention is the maintenance of data integrity raw data should not be changed until the study is completed. In the traditional system, the research process starts by grabbing and taking the system hard drive a bit clever copy to keep the same integrity system but, in the cloud, it is practically impossible because evidence is intrinsically intact and changeable.

Challenges:

i) Data Integrity:

Researchers must maintain integrity of evidence maintains integrity raw data is very difficult for a cloud researcher. Data integrity is a complex part of the entire cloud process forensic data, as there is no need to change the original data the evidence is presented to the law.

ii) Cloud Situation isolation:

When a criminal incident occurs in the cloud, in the cloud case, and in collected evidence the cloud instance must be isolated for digital research. Isolation prevents possible corruption and contamination of collected evidence. Isolated cloud the example helps maintain the integrity of the evidence collected from the cloud case.

iii) Digital provenance:

This is an important feature of forensic science digital history descriptive studies object A secure origin system was proposed which performs reliable evidence of digital forensics in a cloud environment. This formula proves this cloud the evidence is admissible in court.

iv) Chain of Custody:

In the traditional research process scientists must create and preserve supply chain. The chain of descent is documentation from the testimonies collected, as who collects evidence, when and how evidence is preserved and by whom. Researcher required maintaining a proper chain of custody beforehand it documents.

3) Examination and Analysis

Once in a digital imaging process (DIP) model. Information is collected and stored using various research techniques and there are several software tools to help researchers FTK (Forensic Toolkit). All these tools are available to filter and search for pattern matching content or files or file types. Using these tools, one deleted or modified data can be restored. During the analysis stage, the evidence must be evaluated. The evidence obtained in the analysis phase is confirmed compare with alternative evidence confirm that evidence has not been changed. Research and the analysis phase of cloud expertise is similar digital forensics phase of investigation and analysis.

Challenges:

i) Lack of cloud forensics tools:

Cloud Forensics is cloud driven, Currently, there are mostly no cloud forensics tools cloud researchers use digital forensics and the web forensic tools in one cloud, but they are not adequate cloud expertise differs from digital and online in criminology never study these tools in the cloud is not enough. Many cloud researchers beginning to explore cloud-based forensics technology and some tools are already in place use, but we need better tools.

ii) Correlation of evidence from multiple sources:

In the cloud one resource is shared between cloud users. Evidence also comes from several sources that bring various problems to researchers.

Presentation:

The gathered evidence in the digital investigation process is needed to be submitted in the court of law to prove the crime. At the end of investigation, the investigator needs to present a report and it must be useful for cross- examination. The result report should be used by an organization to improve their security policy and must be documented for future investigation.

3. Research Methodology

Cloud Forensics is the process of analysing and gathering evidence from cloud-based systems and infrastructure for a legal investigation or security breach. As the use of cloud technology increases, so does the need for cloud-based forensic tools and techniques.

It is a complex and challenging field due to the dynamic and distributed nature of cloud computing. By developing new techniques, researchers can help investigators collect and analyse evidence from cloud environments more effectively.

It is important to note that cloud forensics investigation process can vary depending on the specific investigation.

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4. Conclusion

In this paper, we discussed the technical challenges of implementation digital forensics in the cloud environment and presented requirements for forensic data from the cloud. There are many things that can be done to improve cloud computing for digital forensics. The collection is reliable proving the cloud is difficult because we have very little control clouds compared to traditional computer systems. This paper presents different challenges of digital forensic in cloud computing with the help of cloud forensic process flow. With each phase it describes the challenges in cloud. Digital forensic refers to investigations that are focused on challenges that occur primarily involving in cloud.

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Advancements in 5G and Beyond Networks: Enabling the Fourth and Sixth Industrial Revolutions

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***Abstract* - This paper explores the evolution from 5G to 6G cellular communication technologies and their integration into the Fourth Industrial Revolution (Industry 4.0). It assesses 5G transmission techniques and anticipates advancements like NOMA with SC-FDE for spectral efficiency. Key 5G features include mm-wave, microwave, and m-MIMO. 5G enables IoT, V2V communication, and transformative technologies like autonomous driving and smart cities. The study offers insights into 6G, highlighting VR, AR, holography, advanced IoT, AI applications, wireless BCI, and high-speed mobility. It emphasizes 5G and 6G integration in Industry 4.0, shaping future industries and economies. The paper also examines post-5G trends, indicating reliance on new MIMO techniques and terahertz bands for emerging applications.**

Keywords: 5G; 6G; NOMA; Industry 4.0; massive MIMO; mm-wave; IoT.

1. Introduction

The advent of the Fourth Industrial Revolution signifies a profound era marked by the fusion of human capabilities with machine integration and advanced AI development. This transformative epoch extends well beyond the realms of robotics and AI, encompassing a complex network of technological dimensions. A pivotal aspect of this paradigm shift is the need for efficient machine communication and perception, facilitated by cutting-edge sensor technologies and robust communication protocols. At its core lies the Internet of Things (IoT), an expansive network interconnecting devices across the Internet Protocol (IP) spectrum, generating copious amounts of data, often referred to as "big data." Artificial intelligence processes this data, transforming it into actionable knowledge, valuable for human decision-making and the autonomous decision-making of machines.

These innovations, with far-reaching implications, extend beyond industry and commerce, shaping society and disrupting traditional employment landscapes. They manifest as more efficient mobility solutions, including autonomous vehicles, smart cities, home automation, intelligent industrial processes, precision agriculture, streamlined logistics, AI-driven medical and legal services, and the proliferation of intelligent drones. The future of mobility, particularly autonomous driving, hinges on the interactions between robotic entities and their environment, generating vast amounts of data processed by AI for informed decision-making. Fifth-generation (5G) communications play a pivotal role, offering ultra-reliable low-latency communications (URLLC), vital for services like remote surgery and autonomous vehicle operations.

This is comprehensively explores the evolution of 5G, delving into current transmission techniques, with a particular focus on non-orthogonal multiple access (NOMA) technology for its potential to enhance spectral efficiency. It also looks ahead to the sixth generation (6G) of communications and contextualizes both 5G and 6G within the overarching framework of the Fourth Industrial Revolution. The following sections provide in-depth analysis of 5G, NOMA technology, potential 6G trajectories, and conclude by summarizing key insights.

2. Varied Applications in 5G Communications

5G technology brings a plethora of use cases:

Enhanced Mobile Broadband (eMBB): This ushers in an era of high-speed connectivity, promising significantly higher peak data rates, enabling applications like virtual reality (VR) to thrive.

Massive Machine-Type Communications (mMTC): 5G is designed to support a large number of connected devices, essential for the Internet of Things (IoT).

Ultra-Reliable Low-Latency Communications (URLLC): URLLC facilitates large-scale sensor networks with minimal human intervention and ultra-low latency demands, necessitating flexible multiple access methods.

3. 5G Standardization and Progression

The road to 5G standards started with the appearance of the first study item related to 5G in 3GPP Release 14. However, formal standardization began after 3GPP Release 15. This process involved two phases, one focusing on

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broadband wireless cellular services and the other addressing specific 5G use cases such as mMTC and URLLC.

4. Scalable Subcarrier Spacing and Numerology

5G NR introduces scalable subcarrier spacing, a departure from the fixed subcarrier spacing in 4G. The subcarrier frequency in 5G is adaptable, spanning a range from $\mu = 0$ to $\mu = 5$, allowing adjustments of transmitted waveforms based on channel conditions. This adaptability, referred to as 5G numerology, is vital given the diverse carrier frequencies in 5G, ranging from microwave to mm-wave spectrums.

The capability to tailor subcarrier spacing accommodates varying channel conditions, such as multipath environments and phase noise common in mm-wave communications. This adaptability supports applications with stringent latency requirements, such as URLLC, by adjusting the duration of OFDMA symbols.

5. Enhancing Spectral Efficiency with NOMA

As 5G advances, the pursuit of improved spectral efficiencies is paramount. One avenue to achieve this objective is through the adoption of Non-Orthogonal Multiple Access (NOMA). NOMA is a promising multiple access technique in 5G and beyond. It utilizes power allocation strategies to serve multiple users simultaneously on the same time and frequency resources, significantly enhancing spectral efficiency. NOMA can be categorized into conventional and cooperative NOMA, with the latter offering superior performance in mitigating the near-far problem.

6. Non-Orthogonal Multiple Access (NOMA)

Non-Orthogonal Multiple Access, or NOMA, is a pivotal advancement in multiple access techniques within the realm of 5G and beyond. It leverages power allocation strategies to serve multiple users simultaneously on the same time and frequency resources, offering enhanced spectral efficiency compared to conventional Orthogonal Frequency Division Multiple Access (OFDMA). NOMA is often integrated with multiple-input multiple-output (MIMO) systems, particularly massive MIMO.

6.1 Enhanced Spectral Efficiency

NOMA's primary advantage is its capacity to serve a larger number of users without requiring a spectrum expansion. This results in a substantial increase in channel capacity, especially valuable in scenarios with a high density of mobile devices, such as massive Machine-Type Communications (mMTC) or Ultra-Reliable Low-Latency Communications (URLLC) in 5G.

6.2 Addressing the Near-Far Problem

NOMA addresses a significant challenge known as the near-far problem, caused by varying transmission power levels among users. To mitigate this, NOMA employs Successive Interference Cancellation (SIC), enabling the receiver to detect user signals in descending order of received power. This approach cancels users with higher power levels first, enabling interference-free detection of weaker signals.

6.3 Two Types of NOMA

NOMA can be categorized into two primary categories: conventional NOMA and cooperative NOMA. In the conventional NOMA scenario, the SIC receiver of a reference user cancels signals with powers exceeding that of the reference user. However, signals from users closer to the base station, which have lower power levels due to power control, are not canceled, potentially causing interference.

Cooperative NOMA provides a solution to this challenge by enabling the cancellation of all interfering users' signals, introducing diversity. This approach allows users closer to the base station to detect and subtract signals from more powerful, distant users. Users closer to the base station can also transmit copies of signals from more distant users, resulting in interference-free detection and improved performance, especially for users farther from the base station.

6.4 Performance Comparison

Performance simulations demonstrate the effectiveness of cooperative NOMA over conventional NOMA. Cooperative NOMA shows significant improvements, closely approaching the Matched Filter Bound (MFB) performance. These simulations consider various factors such as channel modeling, signal power levels, and the use of efficient algorithms.

7. Evolution toward 6G: Meeting Emerging Needs

The landscape of cellular communications is in a constant state of evolution to meet the expanding demands of modern society and emerging technologies. As we look toward the digital society of 2030 and beyond, it's clear that the trajectory of progress will only intensify. The proliferation of connected devices, including the Internet of Things (IoT), sensors, vehicles, drones, and data-driven applications, necessitates a paradigm shift in our communication networks.

7.1 Enhanced Services for 6G

The forthcoming 6G networks are expected to usher in a new era of connectivity, unlocking capabilities that transcend the boundaries of previous generations, such as:

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- Augmented Reality (AR) and Extended Reality (XR): AR and XR applications, infused with immersive experiences, will rely on the lightning-fast data transmission and ultra-low latencies of 6G networks to deliver seamless interactions with the virtual world.
- Artificial Intelligence (AI)-Infused Applications: 6G will be the breeding ground for AI-driven innovations, enabling applications that harness the power of machine learning and deep learning in real-time.
- Wireless Brain-Computer Interactions (BCI): The convergence of wireless communication and neuroscience will open up possibilities for direct interactions between the human brain and digital interfaces.
- Holographic Services: Holography, once confined to science fiction, will become a reality in 6G, revolutionizing telepresence and communication.
- Integration with Localization, Mapping, and Remote Control: 6G will bridge the gap between communication and spatial awareness, facilitating precise localization, mapping, and remote control of devices and assets.
- Emerging eHealth Applications: Healthcare will witness a transformation, with 6G supporting advanced eHealth applications, remote diagnostics, and telemedicine.
- Improved Autonomous Vehicles: The automotive industry will experience a leap forward with enhanced communication capabilities that ensure the reliability and safety of autonomous vehicles.
- Efficient Support for IoT: Smart cities and smart homes will become even smarter, accommodating a vast array of low-power IoT devices efficiently.
- Support for Flying Vehicles and High Mobility: The advent of flying vehicles and the need for ultra-high mobility support will require a three-dimensional network architecture with widespread 3D coverage.

8. Literature Review

Sr. No.	Model	Author	Techniques	Conference/Journal and Year	Conclusion
1.	Network Slicing and Service Differentiation	Andrews et al	Network Slicing	IEEE Communications Magazinen 2014	Network slicing, introduced by Andrews et al., has revolutionized 5G by enabling dedicated network segments for distinct applications. This approach, encompassing enhanced mobile broadband (eMBB), massive machine-type communications (mMTC), and ultra-reliable low-latency communications (URLLC), provides unparalleled flexibility, allowing 5G to cater to a wide array of services and requirements.
2.	mmWave Technology	Rappaport et al.	Millimeter-Wave Technology Small Cells, Advanced Beamforming	IEEE Transactions on Wireless Communications 2013	The pioneering work of Rappaport and team on millimeter-wave (mmWave) technology has been instrumental in unleashing the potential of 5G. Operating at higher frequencies, mmWave technology has paved the way for higher data rates and increased network capacity. Through the utilization of small cells and advanced beamforming techniques, it has transformed wireless communication, redefining our expectations for speed and efficiency..
3.	Small Cells in 5G Networks	S. M. Alam et al.	Small cell deployment, HetNets, Network capacity.	IEEE Access 2017	Small cell deployment in heterogeneous networks (HetNets) is vital for increasing network capacity, improving coverage, and managing the data explosion in 5G networks
4.	Network Security in 5G	R. Roman et al.	5G security, Threats, Security mechanisms	IEEE Communications Magazine 2018	Ensuring robust network security is paramount in 5G due to increased vulnerabilities. Effective security mechanisms are crucial to protect against emerging threats in 5G networks
5.	Massive MIMO	Larsson et	Massive	IEEE Journal on	Larsson and colleagues' work on massive

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		al.	multiple-Input, Multiple-Output (MIMO)	Selected Areas in Communications 2014	multiple-input, multiple-output (MIMO) technology has established it as a cornerstone of 5G networks. By harnessing a multitude of antennas, this technology has significantly enhanced spectral efficiency and network coverage. The result is improved network performance, which is crucial in meeting the ever-growing demand for wireless connectivity and data.
6.	Infrastructure Requirements	Andrews et al.	Small Cells, Fiber-Optic ackhaul, Edge Computing	IEEE Communications Magazine 2014	The deployment of 5G networks, as discussed by Andrews et al., demands a substantial investment in infrastructure. This encompasses the deployment of small cells, the establishment of robust fiber-optic backhaul networks, and the construction of edge computing facilities. While these requirements are essential for realizing the full potential of 5G, they present both cost and logistical challenges.
7.	Spectrum Allocation	Al-Turjman	Spectrum Allocation Regulatory Coordination	IEEE Wireless Communications 2019	Spectrum allocation, as explored by Al-Turjman in 2019, remains a substantial challenge in 5G deployment. It necessitates coordinated efforts from regulatory bodies and network operators to ensure the allocation of sufficient spectrum in desirable frequency bands, including the critical mmWave frequencies. Overcoming this challenge is vital for 5G to deliver on its promises.
8.	Terahertz (THz) Communication	Jornet et al.	Terahertz (THz) Frequencies High Data Rates, Propagation Challenges	IEEE Transactions on Terahertz Science and Technology 2018	The concept of terahertz (THz) communication, introduced by Jornet and collaborators in 2018, holds tremendous promise for beyond-5G and 6G networks. THz frequencies offer vast bandwidth and the potential for exceptionally high data rates. However, the propagation challenges associated with THz frequencies must be addressed to fully exploit their potential. THz communication is poised to transform the landscape of future wireless communication.
9.	Quantum Communication	Diamanti et al.	Quantum Key Distribution (QKD).	Nature Photonics 2016	Quantum communication, as explored by Diamanti and team, represents a futuristic and highly secure approach to data transmission for beyond-5G and 6G networks. Quantum key distribution (QKD) promises unbreakable encryption, ensuring the utmost security for sensitive data. This technology holds the potential to redefine the standards for secure communication in an increasingly interconnected digital world.
10.	AI-Enabled Networking	Zhao et al.	Artificial Intelligence (AI)	IEEE Network Magazine 2021	Zhao et al.'s work underscores the pivotal role of artificial intelligence (AI) in optimizing and managing beyond-5G and 6G networks. AI-driven network orchestration, predictive maintenance, and resource allocation are poised to significantly enhance network performance and efficiency. These advancements will render future networks more adaptive and intelligent, meeting the

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					evolving demands of a highly interconnected world.
11.	Software-Defined Networking (SDN)	N. M. Khan et al.	SDN, Network management, Virtualization	IEEE Communications Magazine 2015	SDN enhances network management and agility in 5G networks, enabling dynamic resource allocation and efficient virtualization.
12.	mobile Edge Computing (MEC)	K. Zhang et al.	Mobile Edge Computing, Low latency, Edge services.	IEEE Transactions on Wireless Communications 2018	MEC, offering low-latency processing at the network edge, plays a pivotal role in supporting real-time applications in 5G networks, improving user experiences.
13.	AI-Enabled Networking	M. Aazam et al.	Fog computing, IoT, Edge analytics.	IEEE Access 2018	Fog computing, acting as an intermediary between the cloud and IoT devices, enhances 5G network performance by enabling low-latency, localized data processing and analytics.
14.	Massive Machine- Type Communications (mMTC)	M. Bennis et al.	mMTC, IoT, Low-power devices.	IEEE Communications Magazine 2018	mMTC in 5G is vital for connecting massive low-power IoT devices, enabling applications in smart cities, agriculture, and healthcare.
15.	Cloud RAN (C-RAN)	G. Wu et al.	Cloud RAN, Centralized processing, Network capacity.	IEEE Network 2015	C-RAN centralizes processing to improve network capacity and efficiency, reducing costs and enhancing the performance of 5G networks.

9. Conclusion

The review paper concludes by summarizing the key findings and underscoring the significance of the transition from 5G to B6G networks, setting the stage for unprecedented advancements in wireless communications.

By providing a structured and precise summary of the research paper, readers can easily grasp the key insights and advancements in cellular communication technologies, from 5G to the anticipated B6G networks, and their implications for various applications and services.

10. Future scope

The future scope in 5G and beyond networks research encompasses several critical domains. It includes autonomous network management through AI, sustainable practices for reduced environmental impact, dynamic spectrum optimization, and integration of edge computing and security enhancements. Heterogeneous network integration, cross-layer optimization, and user-centric services aim to enhance user experiences. Research in developing regions is essential for inclusive deployment. Furthermore, exploration of network slicing in various industries, quantum communication for security, and the advent of 6G networks are key focus areas.

Ethical considerations related to data privacy, surveillance, and digital equity also feature prominently. These research directions promise to drive innovation and address emerging challenges.

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AI in Healthcare

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***Abstract* - Artificial intelligence (AI) is a technology that helps to make tasks easier for humans, especially in healthcare. This transformation is driven by the increasing availability of healthcare data and the rapid advancements in analytical techniques. In this article, we aim to provide an overview of the current status of AI applications in healthcare and explore its potential future uses, considering it as one of the most revolutionary technologies of the 21st century. Healthcare is identified as an early candidate for a significant transformation through AI technologies, and our goal is to contribute to the discussion on how AI can enhance decision-making capabilities in this sector. Our aim will assess whether the current structures are adequately equipped to handle the challenges posed by AI in healthcare. Artificial intelligence, machine learning, and deep learning have the potential to greatly assist in proactive patient care, mitigate future health risks, and streamline healthcare workflows. The future of healthcare, driven by AI, holds promise for more efficient and effective healthcare delivery.**

Keywords: Artificial intelligence, Machine learning, Clinical decision support, Healthcare.

1. Introduction

Artificial intelligence (AI) technology is quite distinct from traditional healthcare methods because it can gather information, process it, and provide clear results to users. AI achieves this through machine learning algorithms. In healthcare, AI is used to tackle complex problems by analyzing intricate medical data. It enables computer algorithms to make conclusions without direct human input, recognizing patterns and creating logical pathways. However, to minimize errors, AI outputs need to be repeatedly tested.

Unlike humans, AI algorithms are quite literal; they can't adapt or understand context beyond what's explicitly provided. Understanding the future of healthcare requires a good grasp of AI's role. Although AI research began in 1956, it had a limited impact on medical practice for many years. However, the recent hype surrounding machine learning is becoming a reality.

AI is particularly well-suited for healthcare delivery, and its use in clinical settings has grown exponentially. Modern medicine faces the challenge of managing vast amounts of structured and unstructured data to treat and manage diseases. AI systems, with their data-mining and pattern- recognition abilities, come to the rescue. Medical AI is helpful for the prediction, diagnosis, and treatment of diseases. It uses symbolic models of diseases and analyzes their connections with patient signs and symptoms. Diagnostic AI applications collect and synthesize clinical data, compare it with predefined disease categories, and aid in diagnosis and treatment. Furthermore, AI is involved in developing treatment protocols, drug research, and patient monitoring.

2. Technologies of Artificial Intelligence

Many technologies are directly concerned with healthcare, each supporting particular mechanisms and tasks. A few important AI technologies in healthcare are detailed as follows:

1) Machine learning

Machine learning is a specific area within the broader field of artificial intelligence (AI). It relies on algorithm models to implement AI concepts. What sets machine learning apart is its ability to adapt and improve over time when exposed to new data. It's as if the machines are actually learning as they process information. Neural Networks and Deep Learning One of the biggest prevailing types of AI is machine learning which is a statistical method. For the healthcare industry, machine learning plays an important role because it can help us to make sense of the large amount of healthcare data that is generated every day within electronic health records. The use of machine learning in healthcare is automating medical billing, clinical decision support, and the development of clinical practice guidelines within health systems. Machine learning algorithms can help us to find patterns and insights in medical data that would be impossible to find manually. The neural network is an intricate technology that became feasible after the 1960s. It is used to find out whether a patient will develop a specific disease. It works similarly to a neuron's function in processing signals but it is not as functional when compared to the brain’s functions. Deep learning is progressively utilized for speech

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recognition and fundamentally is a type of natural language processing (NLP).

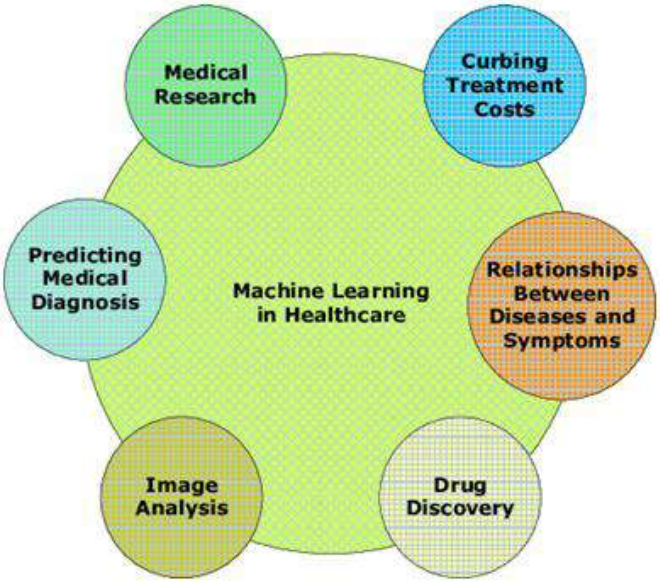

Figure 1: Application of Machine Learning

2) Natural Language Processing (NLP)

In the medical dataset, data is categorized as structured and unstructured. NLP techniques are used to extract insights from unstructured clinical text, such as doctor's notes and patient records. This helps in identifying patterns, trends, and important information within textual data. NLP is utilized for converting data into a usable and analyzable form. Doctors can use speech-to-text conversion tools with built-in NLP capabilities to transcribe their notes and enter them into the corresponding patents in Electronic Health Record (EHR) fields and also medical staff can use the NLP tools to extract relevant data from EHRs.

3) Artificial neural networks

Artificial neural networks (ANNs) are a fundamental component of AI and machine learning in healthcare. Artificial neural networks are data processing models inspired by the structure and functioning of the human brain, consisting of interconnected nodes (neurons) that process and transmit data and make predictions or decisions based on that learning. The main objectives of artificial neural networks are to reflect the activities of human brain nerve cells utilizing neural networks of algorithms and maintaining information. In healthcare, artificial neural networks are used for a wide range of applications, leveraging their ability to learn.

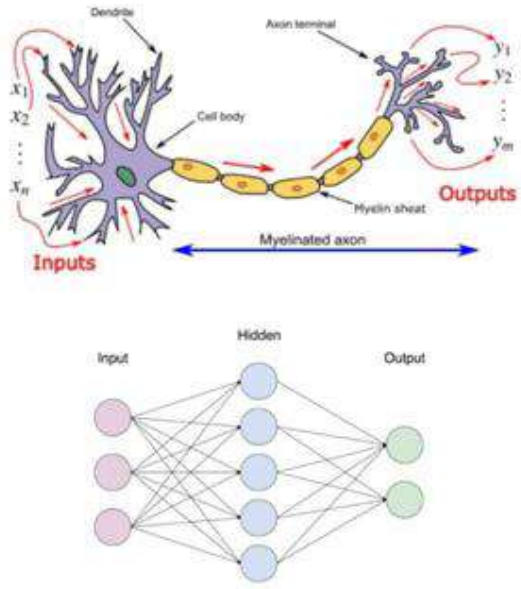

Figure 2: Process of Artificial neural networks

4) Robotic Process Automation

Robotic Process Automation (RPA) is a technology that uses software robots to automate repetitive, rule-based tasks in various industries, including healthcare. While RPA is not a form of artificial intelligence, it is often used with AI to improve process efficiency and accuracy. Robotic Process Automation helps many areas in healthcare, including appointment scheduling, billing, and claims processing, reducing operational costs and human errors. Robotic surgery, also known as robot- assisted surgery, revolutionizes the field of medicine by empowering surgeons to perform various types of surgical procedures with unmatched precision and flexibility. Some benefits of RAS are increased accessibility and better decision-making, less tissue damage, and faster recovery.

During the recent COVID-19 crisis, healthcare facilities harnessed the potential of robots in the operating room and clinical settings to address pressing challenges. Robots were employed to reduce the risk of pathogen exposure and provide vital support to healthcare workers, thereby helping to ensure the safety of both patients and medical professionals.

Figure 3: Robotic surgery

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3. Advantages of AI in Healthcare

Ability to analyze data and improve diagnosis:

AI technology is great at quickly and accurately viewing medical records and data. It's faster and more precise than humans, helping doctors make quicker and better diagnoses, which means patients get better care.

Better patient care:

When AI is used well in healthcare, it makes patient care better. It makes medical research faster, helps doctors make better decisions, and reduces mistakes in treatment plans.

Reduced cost of care:

AI can help save money in healthcare. It can do tasks like paperwork faster and with fewer mistakes than people. This saves money and helps us use resources better.

Quick and Accurate data:

In medicine, it's important to have information that is both quick and right. AI gives real-time data that helps doctors make decisions faster and can prevent problems from getting worse.

Reduced staffs stress:

Jobs in healthcare can be very stressful, and there aren't always enough people to do the work. AI can help by doing some tasks, making it easier on the staff, and making sure that patients get good care even when things are busy.

Support with administrative tasks:

AI can do things like keeping records, analyzing scans, and entering data. This means doctors and nurses have more time to take care of patients and do other important parts of their jobs.

4. Future Scope

The future scope of AI in healthcare research is highly hopeful. Future studies can explore the integration of AI into remote patient monitoring, enhancing healthcare accessibility and reducing geographical barriers. Additionally, there is potential to develop AI algorithms for predicting disease outbreaks and optimizing resource allocation during health crises. As AI continues to evolve, research can focus on creating user-friendly AI interfaces for healthcare professionals and patients, facilitating seamless adoption. The future of AI in healthcare research is assured to revolutionize healthcare delivery, diagnostics, and patient outcomes.

5. Conclusion

Artificial intelligence technology is rapidly advancing and holds tremendous potential to improve various aspects of healthcare, ultimately leading to better and quicker patient outcomes. Healthcare organizations must be agile in adapting to these evolving technologies, changing regulations, and the expectations of consumers. Artificial intelligence, along with machine learning and deep learning, plays a vital role in enabling proactive patient care, reducing future health risks, and streamlining healthcare processes. It has proven particularly valuable in robot-assisted surgeries and early disease diagnosis, such as detecting cancer in its initial stages. Another advantage of AI is its capacity to handle data storage, apply advanced data analysis, and perform complex tasks at high speeds and low costs. AI is also employed in roles like virtual nursing assistants, clinical judgment or diagnosis support, image analysis, as well as managing workflows and administrative tasks.

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Biometric Authentication & It's Security Purposes

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***Abstract* - Trusted user authentication is becoming an increasingly important function in a web-enabled world. The effect of an unsecure authentication system in a corporate or enterprise environment can be prosperous and can include dropping of confidential information, rejection of service, and compromise of data integrity. The value of trusted user authentication is not limited to computer or network access. Many other applications in daily life also require user authentication, such as banking, e-commerce, and can benefit from physical access control and enhanced security to computer resources.**

Keywords: Biometric, Pattern, Iris, Authentication, Security, Sensors.

1. Introduction

Password less authentication plays an important role in improving this situation. By leveraging the unique physical characteristics of individuals to establish their identity, it provides unparalleled security. It locks sensitive, critical information behind the scenes of your fingerprints, iris patterns, facial features, voice patterns, and behavioral patterns like keystroke dynamics. Biometric systems can be deployed in applications ranging from physical authorization and time attendance systems to mobile devices and online transactions. This compatibility enables organizations to apply tighter security measures across multiple touch points, protecting sensitive data and assets.

2. Applications of Biometric Authentication

A) Lawful Applications

Justice and Law Enforcement: Biometric technology and law enforcement have a long history, and many important variations in identity management have arrives from this beneficial relationship. Biometrics implemented by the police force today is truly multimodal. Fingerprint, face and voice recognition play a unique role in improving public safety and tracking the people we are looking for.

B) Government Applications

Border Control and Airports: A major area of application for biometric technology is at the boundary. Biometric technology helps automate the boundary crossing process. Reliable and automated passenger screening initiatives and automated SAS help simplify the international passenger travel experience while improving the efficiency of government agencies and keeping borders more secure than ever.

C) Health Care Applications

In the healthcare sector, biometrics presents an enhanced model. Medical records are one of the most valuable personal documents; Doctors need to access them quickly and accurately. Lack of privacy and good computing can make the difference between timely and error free detection and health fraud.

D) Commercial Applications

Privacy:

As connectivity spreads across the globe, it's clear that old security methods aren't strong enough to protect what matters most. Fortunately, biometric technology is more accessible than ever, poised to provide added security and convenience for everything from car doors to phone PINs that need to be protected.

Finance:

Biometric technology is widely used in finance to enhance security and convenience. By using unique biometric characteristics like fingerprints, iris, voice, and face, customers can securely access their financial data. These biometric modalities, used alone or in combination, help protect against fraud and ensure that the person accessing the account is the authorized user.

Eyes Movement Applications:

Eye movement tracking applications have various uses in different industries. In the automotive industry, tracking a driver's eye movements can help measure sleepiness or drowsiness. Screen navigation applications use eye tracking to assist people with disabilities in scrolling web pages or performing actions on computers or mobile devices. In aviation, eye and head movement tracking in flight simulators can analyze pilot behavior and serve as a training tool for new pilots.

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E) Screen Navigation

Screen navigation applications that track eye movements are indeed crucial for people with disabilities. By using cameras, these applications enable individuals to scroll web pages, write text, and perform actions on computers or mobile devices simply by clicking on buttons. This technology has been gaining significant attention due to the rapid development and the increasing demand for new methods of screen navigation, particularly on mobile devices platforms. It's exciting to see how this innovation is improving accessibility for individuals with disabilities.

F) Aviation

Flight simulators track the pilot's eye and head movement to analyze their behavior in realistic scenarios. This helps evaluate their performance based on eye movements and other information. It's also a valuable training tool for new pilots, encouraging them to regularly monitor airplane indicators on the primary flight display (PFD). It's fascinating how technology aids in pilot training and enhances aviation safety.

3. Security Needs for Biometric Authentication

According to research papers, security is crucial for biometric authentication due to the following reasons: Non-repudiation: Biometric authentication provides a unique and personal identifier for individuals, making it difficult to deny their actions or presence. Difficult to replicate: Biometric traits, such as fingerprints or iris patterns, are difficult to replicate, making it challenging for unauthorized individuals to gain access. Enhanced protection: Biometric data is stored in encrypted form, adding an extra layer of protection against unauthorized access. Reduced reliance on passwords: Biometric authentication reduces the reliance on traditional passwords, which can be easily forgotten, guessed, or stole.

Continuous authentication: Biometric authentication can provide continuous authentication, ensuring that the authorized user remains present throughout the session. Overall, research emphasizes the importance of security in biometric authentication to protect sensitive data and ensure the integrity of the authentication process.

4. Simple Biometric System Architecture

A) Sensor

The sensor is the first block of the biometric system which gathered all the crucial data for biometrics. It is the interface between the system and the natural world. Basically, it is an image acquisition system, but it also depends on the peculiarity or characteristics required that it has to be restore or not.

B) Pre-Processing

The second block in a biometric system performs pre-processing tasks. Its function is to increase the input and cancel artifacts from the sensor, background noise, etc. It also performs some kind of normalization to prepare the data for further analysis. It is the second block that executes all the pre-rectifying. Its function is to increase the input and to cancel artifacts from the sensor, background noise, etc. It performs some kind of normalization.

C) Feature Extractor

The third step in a biometric system is indeed the most important one. It involves extracting features to identify them later on. The goal of a characteristic extractor is to characterize an object using calculation for recognition.

D) Template Generation

The template generator plays a crucial role in the biometric system. It generates templates using the extracted features for authentication. These templates can be in the form of a vector of numbers or an image with distinct characteristics. They are stored in the database for differentiates and serve as input for similar.

E) Matcher

The matching phase involves using a matcher to compare the acquired template with the stored templates. Various algorithms like Hamming distance are used for this comparison. Once the inputs are matched, the results are generated.

F) Application Device

An application device is a device that utilizes the results of a biometric system. Examples of such devices include the Iris recognition system and facial recognition system. They make use of biometric data for identification and authentication purposes.

5. Research

In biometric authentication, research methodology involves conducting studies to understand and improve the accuracy and reliability of biometric systems. Researchers start by selecting a specific biometric modality, such as fingerprint, iris, or face recognition. They collect a large dataset of biometric samples from individuals to create a training set. Next, researchers develop algorithms and models to extract unique features from the biometric samples. These features are then used to create templates or reference points

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for each individual. The templates are stored securely in a database.

A) Data overload & accuracy

Data overload and accuracy are important considerations in biometric authentication. When it comes to data overload, it refers to the situation where a large amount of biometric data is collected and processed. This can pose challenges in terms of storage, processing power, and efficiency. It's crucial to strike a balance between collecting enough data for accurate identification and authentication, while also considering the limitations of the system.

In terms of accuracy, biometric authentication systems strive to achieve high levels of precision and reliability. However, it's important to note that no system is perfect and there can be instances of false positives or false negatives. Factors such as environmental conditions, variations in biometric traits, and quality of sensors can impact accuracy. Continuous research and advancements in algorithms and technologies aim to improve the accuracy of biometric authentication systems.

B) How Biometric authentication help in Security purposes

- Biometric authentication enhances security by using unique physical or behavioral traits for identification.
- These traits, such as fingerprints, iris patterns, or facial features, are difficult to replicate, making it harder for unauthorized individuals to gain access.
- Biometric data is more secure than traditional methods like passwords, as it is inherently tied to the individual and cannot be easily forgotten or stolen.

C) Biometric System Architecture

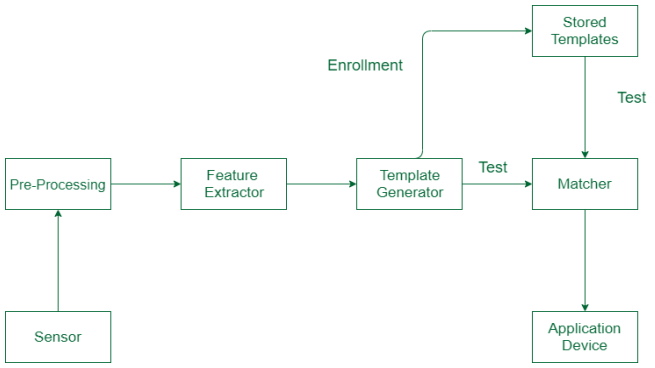

Figure 1: Biometric System Architecture

D) Research Methodology

In biometric authentication, researchers follow a systematic research methodology. They start by selecting a specific biometric modality, like fingerprint or face recognition. Then, they collect a dataset of biometric samples and develop algorithms to extract unique features. These features are used to create templates for each individual. Researchers evaluate the system's performance using testing protocols and metrics like False Acceptance Rate and False Rejection Rate. Statistical analysis is done to analyze the results and improve the system.

E) Discussion

Biometric authentication is a fascinating field that offers secure and convenient ways to verify one's identity. It utilizes unique physical or behavioral characteristics, such as fingerprints, iris patterns, or facial features, to authenticate individuals. This technology has numerous applications, from unlocking smartphones to accessing secure facilities. It provides a higher level of security compared to traditional methods like passwords or PINs, as biometric traits are difficult to forge or replicate. However, it's important to address privacy concerns and ensure that biometric data is securely stored and used ethically. Overall, biometric authentication is an exciting field with promising advancements in enhancing security and user experience.

F) Future Scope

The future scope of biometric authentication looks promising. Advancements in technology will likely lead to more accurate and reliable biometric systems. We can expect improvements in areas such as multi-modal biometrics, where multiple biometric traits are combined for enhanced security. Additionally, research and development will focus on addressing challenges like spoofing attacks and ensuring the privacy and security of biometric data. Biometric authentication will continue to find applications in various industries, such as banking, healthcare, and travel, providing convenient and secure ways to verify identity it's an exciting field with ongoing innovation and potential for widespread adoption.

6. Result

Biometric authentication provides secure and convenient identity verification using unique physical or behavioral characteristics. It offers a higher level of security differentiated to traditional methods like passwords. Advancements in technology continue to improve biometric systems, making them more accurate and reliable. It has various applications in industries such as banking, healthcare, and travel. Overall, biometric authentication has proven to be a successful and effective method of ensuring secure access.

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7. Conclusion

Biometric authentication is a secure and convenient method of verifying one's identity using unique physical or behavioral characteristics. It offers a higher level of security differentiated to traditional methods like passwords. Advancements in technology continue to improve biometric systems, making them more accurate and reliable. Biometric authentication has found applications in various industries, providing secure access to sensitive information and facilities. It is a promising field with ongoing innovation and potential for widespread adoption.

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Comparative Analysis of Robotic Operating Systems

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***Abstract* - The Robot Operating System (ROS) comprises a collection of software libraries and tools utilized for constructing robotic systems, distinguished by its distributed and modular design. Within the context of ROS, task planning pertains to the arrangement of actions into a structured sequence aimed at achieving predefined objectives, all while striving to minimize associated costs, whether in terms of time or energy consumption. Task planning assumes critical importance when guiding the actions of a robotic agent, particularly in scenarios where a causal sequence could potentially lead the agent into a deadlock situation. Furthermore, task planning finds utility in less restrictive environments, contributing to the delivery of more intelligent and adaptive robotic behavior. This paper introduces the ROSPLAN framework, an architectural solution designed to seamlessly integrate task planning into ROS-based systems. It presents a comprehensive overview of this framework.**

Keywords: Robotic Operating Systems (ROS), Simulation, Unity3D, SLAM, Real-time Robotics Operating Systems, Robotics Development Platforms.

1. Introduction

Developing software for robots is a complex task due to the varying hardware of different robots and the overwhelming amount of code required. Robotics software architectures must facilitate large-scale software integration efforts. The integration of task planning and robotics presents several challenges, including generating an initial state that aligns with current environmental conditions, transforming actions planned by task planners into concrete actions, and developing and executing plans with a strategic approach that accommodates action failures, plan failures resulting from uncertainty or dynamic environmental changes, and evolving mission requirements.

This paper presents a framework that establishes a connection between generic task planning and an execution interface seamlessly provided by the Robot Operating System (ROS). This approach bridges two established standards: PDDL2.1, the planning domain description language encompassing temporal and numeric aspects, and the Robot Operating System (ROS). The primary objective is to create a modular architecture that readily accommodates various temporal planners, ensuring the effectiveness of plan execution frameworks like T-REX.

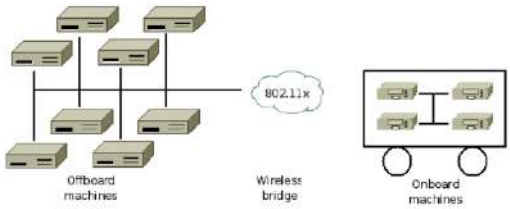

Figure 1: A typical ROS network configuration

ROS 1:

ROS 1 is a collection of libraries used to build various types of robots, including tools for monitoring processes, inspecting communications, and receiving time-series transformations. It has a thriving ecosystem of sensor, control, and algorithmic packages, enabling even small teams to build sophisticated robotics applications. However, ROS 1 struggles to deliver data consistently over lossy connections, has a single point of failure and lacks built-in security features. ROS 2 has been developed to address these issues but has faced numerous challenges due to architectural and engineering limitations. For example, the SROS project was introduced to enhance ROS 1's security but required consistent maintenance and further development to keep up with security trends.

Category	ROS 1	ROS 2
Network Transport	Bespoke protocol built on TCP/UDP	Existing standard (DDS), with abstraction supporting addition of others
Network Architecture	Central name server (`roscore`)	Peer-to-peer discovery
Platform Support	Linux	Linux, Windows, macOS
Client Libraries	Written independently in each language	Sharing a common underlying C library (`rcl`)
Node vs. Process	Single node per process	Multiple nodes per process
Threading Model	Callback queues and handlers	Swappable executor
Node State Management	None	Lifecycle nodes
Embedded Systems	Minimal experimental support (`rosserial`)	Commercially supported implementation (micro-ROS)
Parameter Access	Auxilliary protocol built on XMLRPC	Implemented using service calls
Parameter Types	Type inferred when assigned	Type declared and enforced

Figure 2: Summary of ROS 2 features compared to ROS 1

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ROS 2:

ROS 2 is an open software platform that allows the development of robotic applications. Also known as Robotics Software Development Kit (SDK). ROS 2 is distributed under the Apache 2.0 License, which allows users to modify, implement, and redistribute the software without obligation to return it. ROS 2 is built on a government ecosystem that encourages partners to develop and publish their own software. Most plugin packages also use the Apache 2.0 license or a similar license. ROS 2 aims to increase mass adoption by making the code freely available, allowing users to use and distribute their applications without restrictions. 1. Middleware: This is also called ROS 2's pipeline. It manages communication between different components of the platform, from the network API to the language parser. 2. Algorithms: ROS 2 provides many algorithms frequently used in robotic applications. These include perception, SLAM, planning, etc. takes place. 3. Developer tools: ROS 2 has a command line and graphical tools that developers can use to configure, initialize, understand, visualize, debug, simulate, and log. There are also many tools for site management, design processes, and deployment.

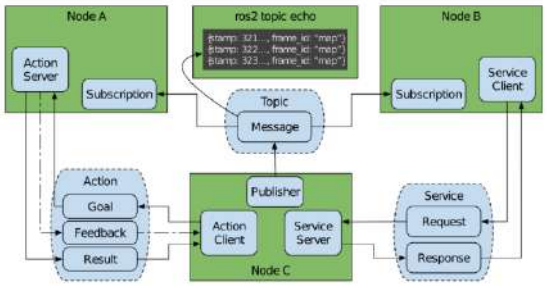

Figure 3: ROS 2 node interfaces: topics, services, and actions

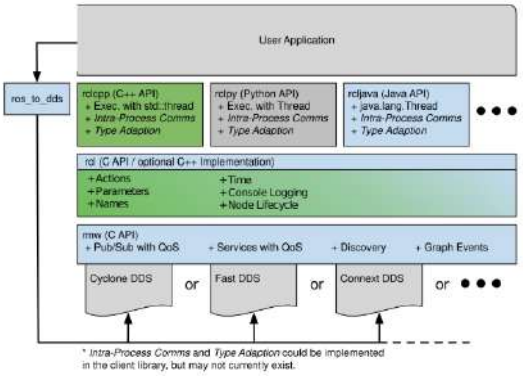

Figure 4: ROS 2 Client Library API Stack

2. Case studies

Five case studies were conducted to showcase the material acceleration provided by ROS 2. Each study presents a qualitative analysis of the impact of ROS 2 on the respective organization, based on interviews, customer experiences, and codebases analyzed during the study. The various use cases and scales demonstrate the significance of ROS 2 across the robotics sector.

A) Land: Ghost Robotics

Ghost Robotics, a Philadelphia-based company, specializes in quadruped robots for defense, enterprise, and research. These robots can navigate difficult environments like caves, mines, forests, and deserts. They have partnerships with the US military for base security and experimental applications. Ghost uses ROS 2 on its main computing platform, a Nvidia Jetson Xavier, for mission execution, high-level gait planning, terrain mapping, and localization. Their software architecture is heavily integrated with ROS 2, allowing for parallel development without disrupting other teams.

Figure 4: Case-study robot systems deployed on land, air, and sea

B) Sea: Mission Robotics

Mission Robotics, a San Francisco-based company, specializes in building marine robots for tasks such as structure inspection, environmental survey, salvage, and security. Their robots are designed to be flexible, allowing customers to customize their platform for their specific application. Mission's robots are equipped with sensors that gather data about the surface and underwater environment, allowing for more frequent, longer, and less risky underwater tasks. The mission uses ROS 2 as a common data bus to facilitate data streams and enable seamless integration of new hardware. The company's on-robot software is built on Cyclone and Connext DDS, which are more flexible and easier to customize. Mission Robotics uses ROS 2 as a common interface, allowing customers to create their own extensions and share a common infrastructure. For example, Mission collaborated with Aqua link to add depth sensing to an autonomous surface vessel using a Zed stereo camera, creating a starting point for developing new computer vision and autonomy capabilities for marine applications.

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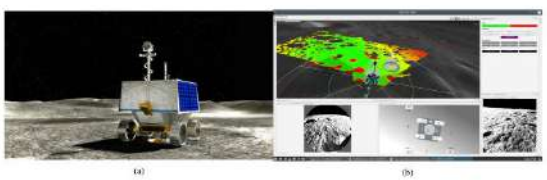
C) Large Scale: OTTO Motors

OTTO Motors, a Canadian company, offers autonomous robots for material handling services in warehouses and factories, replacing manually controlled equipment at scale. With thousands of robots deployed worldwide, OTTO operates fleets of over 100 robots in a single facility. Customers like Toyota and General Electric have adopted OTTO's technology. Initially developed on ROS 1, OTTO found it could not test more than 25 robots on the same shared network due to a custom multi-master system. To address this, they decided to use DDS, a flexible and efficient data exchange protocol widely used in robotics. As an early adopter of ROS 2, OTTO could scale up to 100+ robots in customer facilities, thanks to ROS 2's fine-grained network topology management and better support for bandwidth management through QoS on shared network links.

D) Air: Auterion Systems

Auterion, a Swiss aerial drone startup, aims to develop commercial autopilots based on the open-source PX4 Autopilot project. The company supports various types of airframes and aims to extend drone operations into unstructured spaces with hazards while enhancing autonomy. Auterion uses ROS 2 to integrate higher-level functionality into its drone systems, focusing on logging and introspection capabilities. ROS 2's logging capabilities collect runtime events, metadata, and raw data streams from all layers of the system, making it crucial for effective development, debugging, and validation processes. Auterion also uses rviz2, a 3-dimensional renderer, to visualize drones and sensor data in an interactive environment. These capabilities enable Auterion to focus on core flight control capabilities and customer requirements, allowing them to focus on building foundational tooling instead of building foundational tools. The company's focus on open standards and open standards has led to improved efficiency in its development process.



(a) VIPER on Lunar Surface (rendering), (b) Command and Operations Software

E) Space: NASA VIPER

NASA's Volatiles Investigating Polar Exploration Rover (VIPER) mission is set to launch in November 2023 to explore the southern polar region of the Moon. The rover will spend 100 days searching for water ice and other resources using various instruments. It will communicate with Earth using the X-band link to the Deep Space Network and use Earth-based computer resources to map terrain and compute stereo solutions. Earth-based operation tools, compute modules and high-fidelity simulations are based on ROS 2 and Gazebo.

The VIPER team is focused on producing highly reliable software and is extensively utilizing Gazebo for high-fidelity testing of all their components and systems. The project developed new plugins to model mission-specifics, such as camera lens flare, lunar lighting conditions, gravity, and terrain on the lunar surface. The VIPER team used Gazebo to test and validate almost all of their rover's software prior to launch.

VIPER reused 284,500 significant lines of code (SLOC) without modification from Gazebo, modifying <1% to pass validation. This code reuse accelerated development, allowing them to produce a simulation in just 266 work months focused on VIPER-specific elements. A combination of Gazebo and ROS 2 is used to train the rover's operators.

3. Research Methodology

"Comparative Analysis of Robotic Operating Systems" would require a structured methodology to systematically compare different robotic operating systems (ROS) and provide meaningful insights. To conduct a comparison of robotic operating systems, it is important to first define the research problem. Which is followed by an explanation of the significance and relevance of the study. The research then states its objectives and hypotheses. A brief overview of robotic operating systems is provided, including their history and evolution. Some existing literature on ROS is reviewed to identify gaps and areas of comparison. The key features, characteristics, and components of ROS that are relevant for comparison have been discussed. A set of ROS packages is compared and identified, based on relevance, popularity, and diversity. Data sources and collection methods are described, and information about each ROS package is gathered, including documentation, user feedback, technical specifications, and community support. Criteria and parameters for comparison are defined, such as hardware compatibility, real-time capabilities, middleware architecture, community support and ecosystem, security features, scalability, and performance metrics. Each ROS package is evaluated based on the defined criteria, using quantitative and qualitative analysis methods, such as surveys, interviews, or experimental data, depending on the criteria. The results are presented in tables, charts, and visual aids, with explanations and interpretations for each comparison point. Later the strengths and weaknesses of each ROS package are highlighted, and the results' implications are discussed. The

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findings are compared with the literature and existing knowledge, and potential future research directions in the field of ROS are suggested. Finally, the key findings are summarized, and the significance of the study is done.

4. Future Scope

The future scope of research papers in comparative analysis of Robotics operating systems (ROS) is vast and exciting. ROS is a middleware platform that provides a set of tools and libraries for developing robotic applications. It has become the de facto standard for ROS development and is used by researchers and developers all over the world.

One area of future research is in the development of new ROS-based applications for a variety of industries, such as healthcare, manufacturing, and logistics. For example, ROS could be used to develop new surgical robots, autonomous assembly line robots, and self-driving delivery trucks.

Another area of future research is developing new ROS-based tools and libraries to make it easier and more efficient to develop robotic applications. For example, researchers could develop new ROS-based tools for planning, navigation, and control.

Finally, researchers could also focus on improving the performance and reliability of ROS. For example, they could develop new ROS-based tools for real-time task scheduling and fault tolerance.

5. Conclusion

ROS 2 has been completely redesigned to meet the challenges of modern robotics. It was created with a thoughtful set of principles and modern robotics requirements in mind, allowing for extensive customization. Built on top of DDS, ROS 2 is a reliable and high-quality robotics framework that can support a wide range of applications. It continues to accelerate the deployment of robots and drive the next wave of the robotics revolution.

Through a series of case studies, we have shown that ROS 2 is significantly accelerating companies and institutions toward useful deployment in various environments and scales. ROS 2 is an enabler, equalizer, and accelerator. Standardization around ROS 2 in multiple industries is creating opportunities for new collaborations, faster development, and propelling newly developed technologies forward. This trend is expected to continue to manifest in the coming years as ROS 2 reaches peak maturity.

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Chat GPT Curse or Blessings

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Abstract - **Chat GPT is an AI language model developed by open AI that can understand and generate human-like text. It can be used for a variety of use cases such as language generation, question, question answering, text summarization, chat bot development, language translation. Chat GPT is a large language model that uses queues and millions of data points to mimic human responses. This form of mimicry is why Chat GPT will answer questions even when it doesn't output the correct answer. So, make sure you're not using any information from Chat GPT without fact-checking it.**

Keywords: Chat GPT: Chat GPT Curse; Chat GPT Blessings; Chatbot; OpenAI; AI.

1. Introduction

Chat GPT is an artificial intelligence (AI) chatbot that uses natural language processing to create humanlike conversational dialogue. The language model can respond to questions and compose various written content, including articles, social media posts, essays, code and emails. The journey began with the introduction of the GPT-1 model in 2018.GPT-1 was a groundbreaking language. It was pre-trained on a massive corpus of text from the internet.

2. History of Chat GPT

Chat GPT was developed by OpenAI, an artificial intelligence research lab founded in December 2015. The team behind OpenAI consisted of prominent individuals such as Elon Musk, Sam Altman, Greg Brockman, Ilya Sutskever, Wojciech Zaremba, and John Schulman. Chat GPT was launched on November 30, 2022, by San Francisco- based open AI (the creator of the initial GPT series of large language models; DALL.E2, a diffusion model used to generate images; and whisper, a speech transcription model).

Figure 1: History of Chat GPT

Description of Chat GPT- ChatGPT, which stands for chat generative pre-trained Transformer, is a large language model-based chat bot developed by Open AI and launched on November 30, 2022, which enables users to refine and steer a conversation towards a desired length, format, style, level of detail, and language. Chat GPT is an AI-powered language model developed by OpenAI. It's designed to engage in natural language conversations with users like you. It uses a deep learning architecture called GPT-3.5 to generate text-based responses. Chat GPT can provide information, assist with tasks, and have discussions on a wide range of topics. It's trained on a diverse dataset, but its knowledge is up to date only until September 2021.

Figure 2: What is Chat GPT?

3. Chat GPT Curse and Blessings

Chat GPT can be both blessings and curse, depending on how they are used. While they are offering numerous benefits, such as quick access to information and automation of repetitive tasks, they also have the potential to spread misinformation and perpetuate harmful biases. In the researching and writing that students will learn, and there is a real very danger that Chat GPT will be detrimental to their education simply because it is so good at what it does. I imagine in the not too distant future there will be software written to detect whether a piece of writing has been composed by a human, or Chat GPT – but all this doing id pitting one form of AI against another, and Chat GPT most likely only ever produce inconclusive results.

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Figure 3: Chat GPT Curse or Blessings

4. Chat GPT architecture

Chat GPT is built upon either GPT-3.5 or GPT-4 - members of open-AI's proprietary series of generative pre-trained transformer (GPT) models based on the transformer architecture developed by Google and is fine tuned for conversational applications using a combination of supervised and reinforcement learning techniques. There is the main part of transformer, Transformer Model, Layer Stacking, Attention Mechanism, Parameter Size, Pre-training, Fine-tuning, Decoding Strategies, Context Windows, Prompt Engineering, API Integration. It's very important to implementation of version.

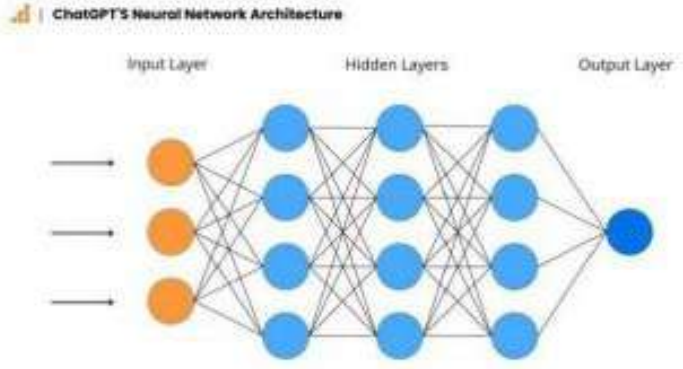

Figure 4: Chat GPT Neural Network Architecture

5. Application of Chat GPT

Chat GPT is an artificial intelligence program that generates dialogue. Created by Open AI, this high capable chat bot uses machine learning algorithms to process and analyze large amounts of data to generate responses to user inquiries. Some applications of Chat GPT, Customer Support and Service, Content Generation, Virtual Assistants, Language Translation, Education and Tutoring, Healthcare, Information Retrieval, E-commerce, Legal and Financial Services, Entertainment, Language Learning, Creative Writing and Storytelling, Accessibility, Market Research and Surveys, etc.

Figure 5: Application of Chat GPT

6. Chat-GPT Design Model

Table 1: Chat-GPT Design Model

Model name	Technical name	Max Tokens
GPT-3.5 16K	gpt-3.5 turbo16k	16384
GPT-3.5	gpt-3.5-turbo	4084
Davinci	text-davinci-003	4096
Curie	text-curie-001	2049

7. Conclusion

Chat GPT is a powerful language model that can generate human-like text in a variety of scenarios. Its potential applications are vast and can revolutionize many industries. Chat GPT can be employed in customer support, content generation, virtual assistance education, healthcare, and many other domains. Its extensive pre-training on large text corpora, coupled with fine-tuning for specific tasks, allows it to provide contextually relevant and coherent responses to user queries. As technology continues to advance, Chat GPT and similar models hold significant potential for improving user experiences, automating tasks, and enhancing communication in various industries and applications.

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Cloud Computing & It's Security

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***Abstract* – It is particularly relevant to Hong Kong because of the tremendous amounts of data that are being processed here daily in various sectors, research. There cent establishment of a major cloud R&D center in Hong Kong by Lenovo (January 2015) attests to this fact. The results will also benefit Hong Kong as the reliance on cloud computing services is rapidly increasing.**

Keywords: Scalability, flexibility, data storage, software development, website hosting, bigdata analytics, virtual desktops, and Internet of Things (IoT).

1. Introduction

With cloud computing, you can store your data on remote servers and access it anytime, anywhere. It's super convenient and saves you from worrying about hardware or software maintenance. Plus, it's scalable, so you can easily adjust your storage and computing needs.

Cloud computing is like having your own virtual storage and computing power. You can access your files and software from anywhere, anytime. It's super convenient and saves you from worrying about hardware or software maintenance. Plus, it's scalable, so you can easily adjust your storage and computing needs.

Another cool thing about cloud computing is that it allows for easy collaboration. Multiple users can work on the same files and projects in real-time, regardless of their physical location. It's like having a virtual team working together seamlessly. Plus, cloud computing also enhances data security by providing backup and disaster recovery options.

Did you know that cloud computing also offers cost savings? Instead of investing in expensive hardware and infrastructure, you can pay for cloud services on a subscription basis. This means you only pay for what you use, which can be more cost-effective for businesses and individuals. Plus, cloud providers handle the maintenance and updates, saving you time and resources. It's a win-win situation!

Example, Let's say you have a bunch of photos on your phone, but you're running out of storage. With cloud computing, you can upload those photos to a cloud storage service like Google Drive or iCloud. Once they're in the cloud, you can access them from any device with an internet connection. It's like having your own personal photo album in the virtual sky!

Cloud computing offers different types of services? There's Infrastructure as a Service (IaaS), where you can rent virtualized hardware resources. Then there's Platform as a Service (PaaS), which provides a platform for developing and deploying applications. Lastly, there's Software as a Service (SaaS), where you can access software applications over the internet.

2. Roles of Cloud Computing

Cloud computing has various roles, It serves as a platform for storing and accessing data, hosting applications, and providing computing resources on-demand. It also enables collaboration, data backup, and disaster recovery. In simpler terms, cloud computing plays the role of a flexible and convenient technology partner that helps you with storage, computing.

And it doesn't stop there; Cloud computing also plays a crucial role in enabling scalability, cost-efficiency, and global accessibility. It allows businesses to easily scale their resources up or down based on demand, saving costs on hardware and infrastructure. Additionally, it provides users with the ability to access their data and applications from anywhere in the world, as long as they have an internet connection. It's like having a virtual powerhouse at your service!

The diagram for cloud computing includes four main components:

1. Cloud Storage: This is where you can store your data virtually, like files, documents, and media. It provides a secure and accessible space for your information.

2. Cloud Computing: This component offers on-demand computing resources, like servers and processing power, that can be accessed remotely. It allows you to run applications and perform tasks without needing to have physical hardware or software installed on your own device.

3. Cloud Security: This aspect focuses on keeping your data safe and protected in the cloud. It includes measures like

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encryption, access controls, and regular backups to ensure the confidentiality and integrity of your information.

4. Cloud Accessibility: With cloud computing, you can access your data and applications from anywhere with an internet connection. This means you're not limited to a specific device or location, giving you more flexibility and convenience.

3. The Applications of Cloud Computing

Cloud computing has a wide range of applications; It can be used for data storage, software development, website hosting, big data analytics, and even running virtual machines. The flexibility and scalability of cloud computing make it suitable for various industries and purposes. Let me know if you'd like more details about any specific application!

Cloud computing has a wide range of applications; It can be used for data storage, software development, website hosting, big data analytics, and even running virtual machines. The flexibility and scalability of cloud computing make it suitable for various industries and purposes.

And the applications of cloud computing are vast, some common examples include:

1. Data Storage and Backup: Cloud storage services like Google Drive and Dropbox allow you to store and access your files from anywhere with an internet connection.

2. Software Development and Testing: Cloud platforms like AWS and Microsoft Azure provide developers with the infrastructure and tools to build, test, and deploy applications without the need for physical servers.

3. Website Hosting: Cloud hosting services like Amazon Web Services (AWS) and Google Cloud Platform (GCP) offer scalable and reliable hosting solutions for websites and web applications.

4. Big Data Analytics: Cloud-based platforms like Google BigQuery and Amazon Redshift enable businesses to process and analyze large volumes of data quickly and cost-effectively.

5. Virtual Desktops: Cloud-based virtual desktop infrastructure (VDI) solutions like Amazon WorkSpaces and Microsoft Azure Virtual Desktop allow users to access their desktop environments from any device.

6. Internet of Things (IoT): Cloud computing provides the necessary infrastructure to collect, store, and analyze data from IoT devices, enabling smart and connected solutions.

These are just a few examples, but cloud computing has applications in various industries and sectors.

4. Cloud Computing Model

There are three main models of cloud computing:

1. Infrastructure as a Service (IaaS): In this model, cloud providers offer virtualized computing resources such as virtual machines, storage, and networks.

2. Platform as a Service (PaaS): PaaS provides a platform for users to develop, test, and deploy applications without worrying about underlying infrastructure. Cloud providers manage the infrastructure, and users focus on building and running their applications.

3. Software as a Service (SaaS): SaaS allows users to access and use software applications over the internet. Each model offers different levels of control and management, catering to different user needs.

Data Security in Cloud Computing

When it comes to data security in cloud computing, it's important to choose a reputable cloud provider that prioritizes security measures. Cloud providers implement various security measures like encryption, access controls, and regular security audits to protect data from unauthorized access. Additionally, users can also take steps to enhance data security by implementing strong passwords, using multi-factor authentication, and regularly backing up data. It's always a good idea to stay informed about the security practices of your chosen cloud provider and take necessary precautions to ensure the safety of your data.

• Data in Rest

When data is at rest in cloud computing, it is securely stored in encrypted form on the cloud provider's servers. This helps protect the data from unauthorized access and ensures its confidentiality and integrity. Cloud providers implement robust security measures to safeguard data, giving users peace of mind about the security of their information.

• Data in Transit

When data is in transit in cloud computing, it is encrypted and securely transmitted over the internet. This ensures that the data remains protected from interception and unauthorized access during its journey from the user's device to the cloud provider's servers. Cloud providers use encryption protocols

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and secure communication channels to maintain the confidentiality and integrity of the data in transit.

5. Conclusion

In conclusion, the research paper underscores the pivotal role that Sure thing! Let's dive a bit deeper into the benefits of cloud computing. One of the key advantages is the ability to access your files and software from anywhere, anytime. Whether you're on your phone, tablet, or computer, as long as you have an internet connection, you can easily retrieve and work on your data.

Another great aspect is the scalability of cloud computing. You can easily adjust your storage and computing needs based on your requirements. If you need more storage space or computing power, you can easily upgrade your plan without having to invest in additional hardware.

Collaboration is another major perk. With cloud computing, multiple users can work on the same files and projects simultaneously, regardless of their physical location. This makes it incredibly convenient for teams to collaborate in real-time, increasing productivity and efficiency.

Data security is also a top priority with cloud computing. Cloud providers offer backup and disaster recovery options, ensuring that your data is protected and can be easily restored in case of any unforeseen events. This gives you peace of mind knowing that your important files are safe and secure.

Lastly, let's not forget about the cost savings. Instead of investing in expensive hardware and infrastructure, you can pay for cloud services on a subscription basis. This means you only pay for what you use, making it a more cost-effective option for businesses and individuals alike. Plus, cloud providers handle the maintenance and updates, saving you time and resources.

Overall, cloud computing offers a wide range of benefits, from convenience and scalability to collaboration and cost savings. It's definitely worth considering if you're looking for a flexible and efficient way to store and manage your data.

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Exploitation of Nano-Crystalline Cupric Cxide (CuO) Doped Zinc Oxide (ZnO) Multilayer Thick Film as a CO_2 Gas Sensor

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ABSTRACT

Cupric oxide and Zinc oxide nano-crystalline powder were synthesized via liquid-phase method. The samples are prepared in the form of multilayer thick films. The XRD pattern of (CuO-ZnO) 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 CO_2 gas. The response time is faster than recovery time. The sample C3 sensor (15CuO:85ZnO) offers high sensitivity, rapid response and recovery to CO_2 gas.

Keywords: *Nanoparticles; CuO-ZnO; multilayer thick films; CO_2 Gas Sensors*

INTRODUCTION

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. [1-3]. Quentin Simon et al. 2012 [4] synthesized CuO/ZnO nanocomposites on Al2O3 substrates by a hybrid plasma-assisted approach. Various oxidizing and reducing gases such as O_3, CH_3CH_2OH, and H_2 are studied for gas sensing properties of CuO/ZnO nanocomposites. Yalu Chen et al.2013 [5] prepared CuO-ZnO nanostructured p-n junction composite via the hydrothermal method. The gas sensing performance of pure ZnO and CuO-ZnO composite toward n butanol was studied. They show that porous structure allows the target gas molecules diffuse rapidly making chemisorption and the chemical reactions on the p-n junctions more easily. At 220 °C 2.7 times higher sensitivity was obtained for CuO-ZnO composite than that of pure ZnO. Ryan Dula Corpuza and Jason Rayala Albiab 2014 [6] fabricated ZnO and ZnO-CuO composites on a graphite electrode via electrophoretic deposition. Greater surface area, smaller particle sizes and thicker deposits exhibit high gas sensitivity. The addition of CuO in the deposition gives compact and dense surface structure resulted to decrease in sensitivity. The expected increase in sensitivity in the presence of CuO was not attained. Madhavrao K. Deore et al. 2016 [7] prepared CuO-doped ZnO thick films by the screen printing technique. These films were studied for different gases such as CO, Cl_2, NH_3, Ethanol, H_2S and LPG and observed that CuO doped films were more selective to H_2S gas against the other test gases showing rapid response and recovery time. The main purpose of this work was to develop CuO doped ZnO, nano-crystalline composites sensors which operate at relatively low temperature and sensitive in low possible detection limit with better sensitivity.

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EXPERIMENTAL

In the present work of thesis, we have used liquid phase synthesis method for the synthesis of pristine nano-particles of CuO, ZnO and Al_2O_3 [8-10]. 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.

Fabrication of Sensors : Multilayer preparation

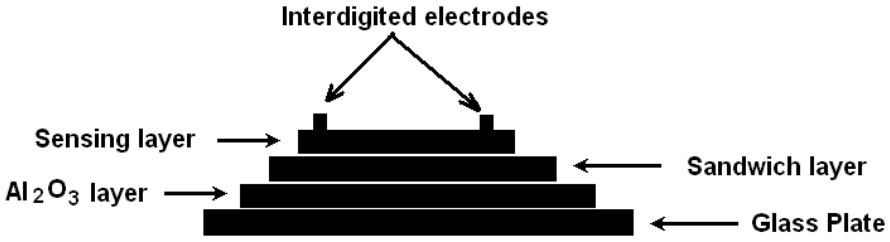

Fig.1 Design of multilayer Sensor

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, Inter-digited electrodes were fabricated using conducting silver paste and design of multilayer sensor is shown in Fig. 1.

Preparation of Samples of Series: CuO: ZnO / Al_2O_3/GP

The obtained product of fine nanopowder of CuO and ZnO 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 ZnO (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 : ZnO system was further calcinated at temperature 800°C for 5hrs. in the auto-controlled muffle furnace (*Gayatri Scientific, Mumbai, India*.) After, the calcinations again uniformly mixed the powder using the grinder.

Table 1 Thickness of Multi-layers for Series: CuO: ZnO / Al_2O_3/GP Gas Sensors.

Sample Code	Composition Layers:---- Upper /Al_2O_3/Glass plate (GP)	Thickness (x 10^{-4} cm)		
		Upper Layer(1)	Al_2O_3 Layer(2)	Total (1+2)
C1	05CuO:95ZnO/ Al_2O_3/GP	2.8	27.1	29.9
C2	10CuO:90 ZnO / Al_2O_3/GP	3.4	28.7	32.1
C3	15CuO:85 ZnO / Al_2O_3/GP	2.2	29.4	31.6
C4	20CuO:80 ZnO / Al_2O_3/GP	3.9	28.8	32.7
C5	25CuO:75 ZnO / Al_2O_3/GP	2.8	28.9	31.7
C6	30CuO:70 ZnO / Al_2O_3/GP	2.9	30.2	33.1

RESULTS AND DISCUSSION

XRD of CuO & ZnO Nanomaterial and their dopings

The average crystallite size was calculated by Debye-Scherer's equation with the help of XRD patterns as shown in figure 4. 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-Scherer'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 2, the XRD pattern peak for CuO doped ZnO exhibits hexagonal and monoclinic crystalline phases at 2θ values of 8.25º, 26.56º, 38.45º, 44.21º, 53.56º, 62.55º, 73.12º and 82.67º (JCPDS Card No.5-3242), with the corresponding planes of (1 0 0), (1 1 0), (1 1 1), (2 2 0), (1 0 2), (2 0 2), (1 0 3), and (1 0 2), respectively. As shown in table 2, Sample Code C3 i.e. (15CuO:85ZnO) sample shows small crystalline size. The average crystalline size was found to be smaller in case of C3 sample and hence its active surface is more [11].

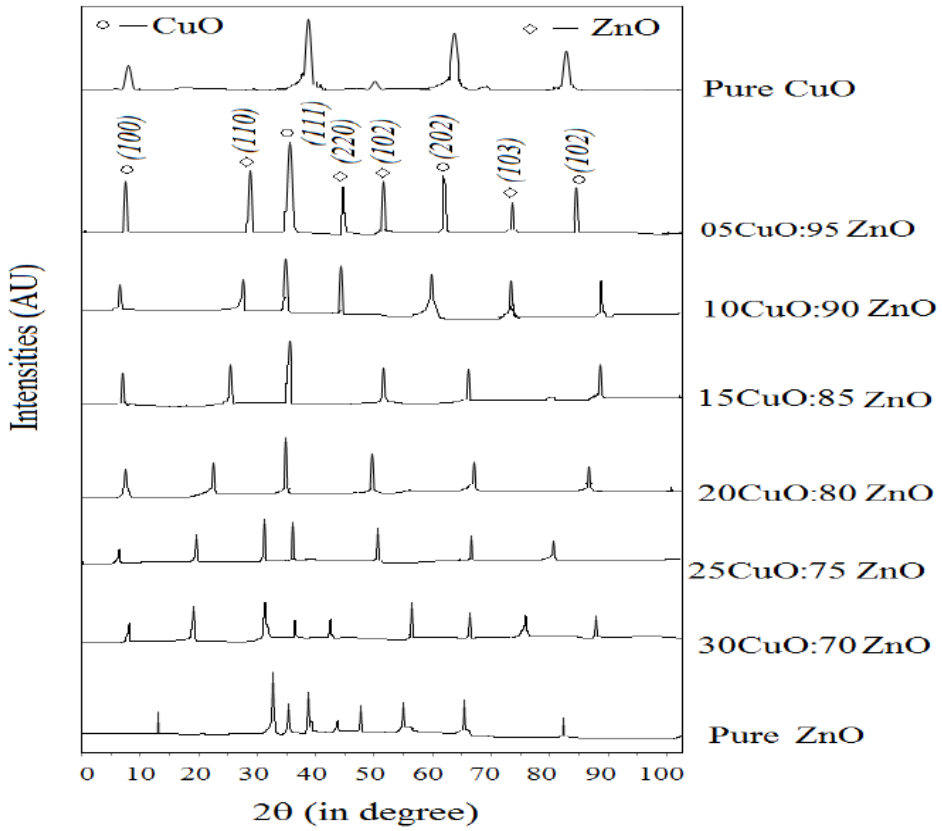

Fig.2. XRD spectra of Pure CuO, Pure ZnO and CuO doped with ZnO Nanomaterial

Table 2 Average crystallite size of ZnO and CuO doped ZnO

Sample Code	Chemical Composition of CuO:ZnO (mole %)	Maximum Intensity Peak Position (2θ) degree	FWHM (2θ) degree	Average Crystallite Size (D) in nm
PC	Pure CuO	43.32	0.1865	162.22
C1	05CuO:95 ZnO	26.45	0.1786	102.33
C2	10CuO:90 ZnO	28.44	0.1862	98.22
C3	**15CuO:85 ZnO**	**29.34**	**0.1372**	**78.33**
C4	20CuO:80 ZnO	32.45	0.1672	93.23
C5	25CuO:75 ZnO	38.33	0.1932	105.22
C6	30CuO:70 ZnO	48.34	0.2122	112.44
PZ	Pure ZnO	57.33	0.2344	117.87

Scanning electron microscopy (SEM) Analysis

From SEM picture (figure 3 (a) to (d)), it is observed that all the samples viz. Al_2O_3, CuO, ZnO and Sample Code C3 i.e. (15CuO:85ZnO) (optimize sample shown only) are porous in nature. Porosity varies with sample to sample and among these material, Sample Code C3 i.e. (15CuO:85ZnO) showed more porosity (small size ~ 60 to 80 nm). Due to small pores size, its surface area is more [12-14] 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.

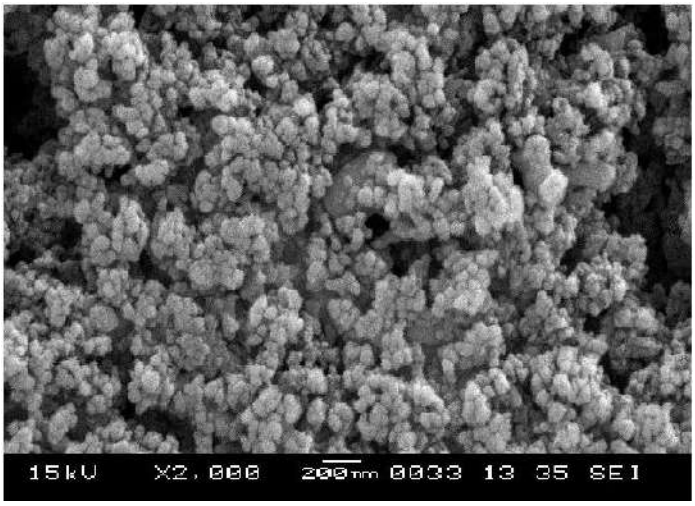

Fig. 3 (a) *SEM picture of Al_2O_3*

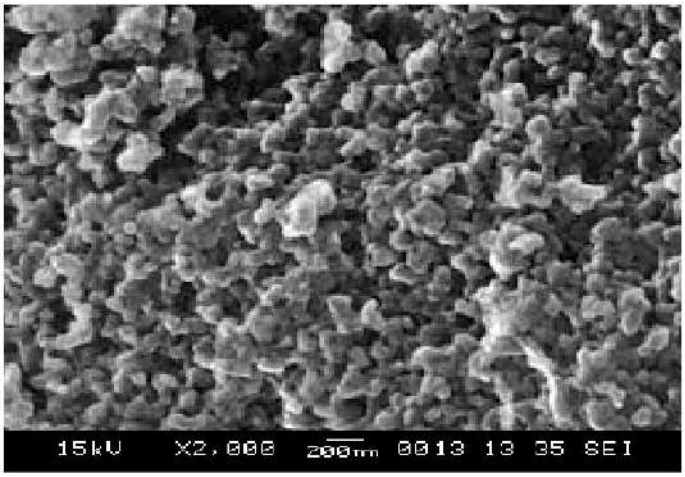

Fig. 3 (b) *SEM picture of CuO*

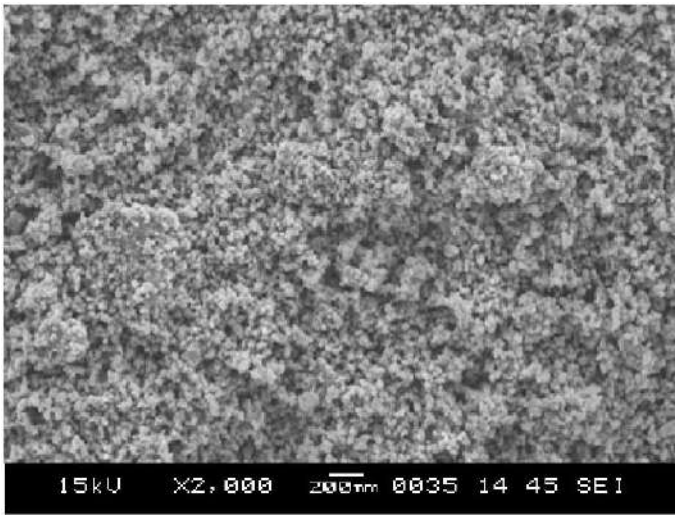

Fig. 3(c) SEM picture of ZnO

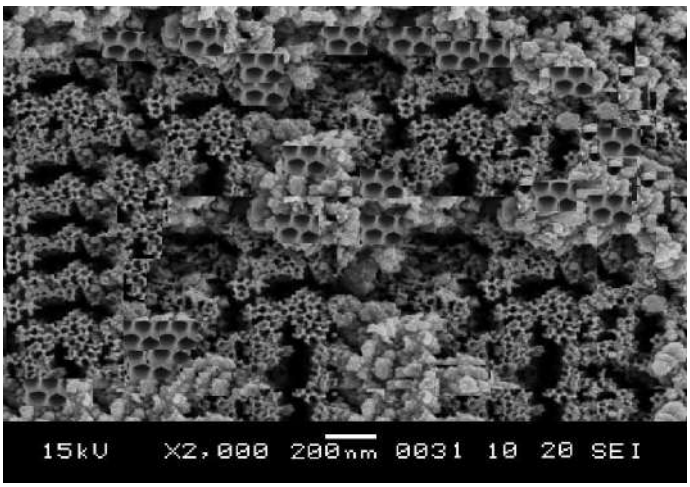

Fig. 3 (d) SEM picture of 15CuO:85ZnO

Table 3. shows the average diameter and number of pores per inch of of pure Al_2O_3, CuO, and ZnO and their dopings.

Table 3. 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_2O_3	95	154
PC	CuO	80	172
PZ	ZnO	87	160
C1	05CuO:95ZnO	79	165
C2	10CuO:90ZnO	81	161
C3	**15CuO:85ZnO**	**45**	**245**
C4	20CuO:80ZnO	67	187
C5	25CuO:75ZnO	74	176
C6	30CuO:70 ZnO	69	183

From the SEM pictures (table 3), it is observed that Sample Code C3 i.e. (15CuO:85ZnO), 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 [14-15]. It is also found that average diameter of pore in case of (15CuO:85ZnO) are small as compared to other doping. This also tends to exhibit large surface area and exhibited high response of the samples.

Detection of CO_2 gas: Gas Sensing Properties

CO_2 acts as an oxidizing agent in some chemical reactions, such as the production of carbonates. It can also participate in redox reactions, where it can accept electrons and become reduced and hence its resistance increases with increase of CO_2 gas concentration [16]. The sensitivity of the sensor is given by,

$$S = \left(\frac{R_{gas} - R_{air}}{R_{air}} \right) = \left(\frac{\Delta R}{R_{air}} \right)$$

Where, R_{gas} = resistance of the sensor in presence of gas and
R_{air} = resistance of the sensor in air

The variations of sensitivities and sensors with concentration of CO_2 gas at room temperature are shown below.

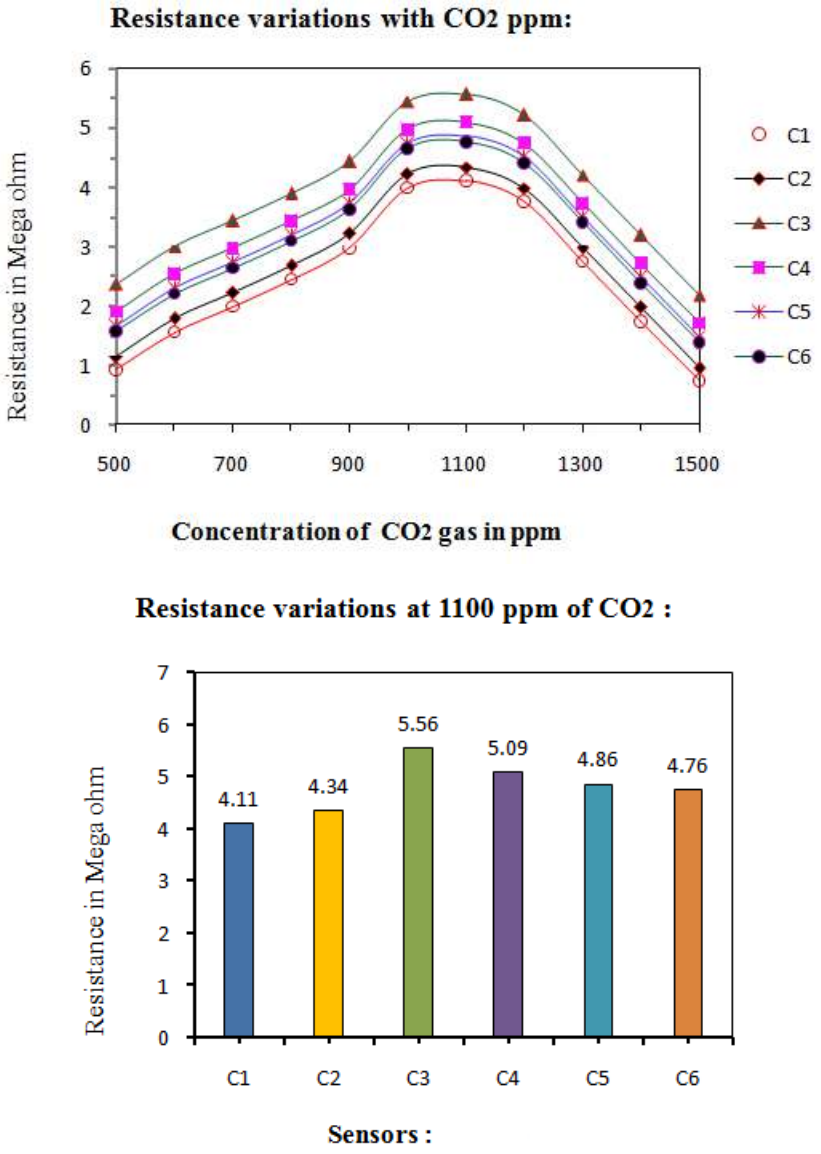

Fig. 4 : variations of resistance with CO_2 gas concentration

For CO_2 gas concentration variation from 500 ppm to 1500 ppm, variation of resistance for C1 to C6 sensors is shown in Fig. 4. As carbon-dioxide concentration increases, Cu ions interact with Zn ions by absorbing CO_2 gas and resistance increases. It is exhibited that, initially resistance increases with increases of concentration of gas, becomes maximum at 1100 ppm and then with further increase of gas concentration, it decreases. It is recorded maximum resistance for C3 sensor (15CuO:85ZnO) to be 5.56 MΩ at 1100 ppm CO_2 gas concentration [17-19].

Static Responses of sensors:

Static responses [20-21] of samples Fig. 5. of ($CuO:ZnO/Al_2O_3$/GP) were studied at 700, 900 and 1100 ppm of CO_2 gas concentration as a function of time and from the manifested variations, response and recovery times were calculated.

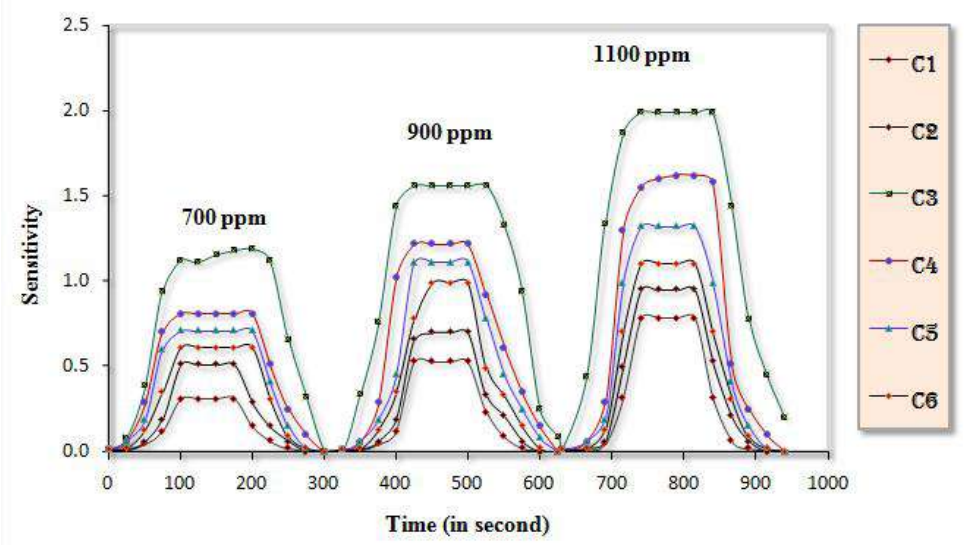

Fig. 5: Static response (response and recovery times)

Table 4. *Response and Recovery times of Samples*

Sr. No.	Sample Compositions	Sensor	Response time (s) for 1100 ppm	Recovery time (s) for 1100 ppm
1	05CuO:95 ZnO /Al_2O_3/GP	C1	93	95
2	10CuO:90 ZnO /Al_2O_3/GP	C2	87	89
3	15CuO:85 ZnO /Al_2O_3/GP	C3	56	61
4	20CuO:80 ZnO /Al_2O_3/GP	C4	69	76
5	25CuO:75 ZnO /Al_2O_3/GP	C5	72	79
6	30CuO:70 ZnO /Al_2O_3/GP	C6	82	91

At 100 ppm CO_2 gas concentration, from table 4, sensor C3 manifested fast response (response time 56 s and recovery time 61 s) among the fabricated sensors. Also, it is observed that response time less than that of recovery time.

CONCLUSIONS

The XRD pattern of (CuO-ZnO) system samples shows 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 CO_2 gas. The response time is faster than recovery time therefore the Sample C3 i.e. (15CuO:85ZnO) is found to optimized sensor for CO_2 gas.

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Sol-Gel Synthesis and Characterization of SnO_2- PPy Multilayer Thick Films[1]

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ABSTRACT

The aim of this study is focused on preparation of tin oxide doped with polyporrole multilayer thick film by using base as a alumina substrates. The structural and morphological properties reported, XRD patterns show nanocrystalline form with desired peaks of composites and SEM 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 and found (92SnO_2:8 PPy) sensor multilayer thick film as optimised sensors

Keywords: *Tin oxide; polyporrole; multilayer thick films; XRD; SEM*

INTRODUCTION

Tin oxide (SnO_2) is the most used sensing material in commercially sensor devices for toxic gases detection [1]. It is well known that the sensing properties of SnO_2-based material depend on its chemical and physical characteristics, which are strongly dependent on the preparation conditions, dopant and grain size. This implies that the synthesis of the sensing material is a key step in the preparation of high-performance MOS gas sensors. SnO_2 powders and films can be prepared by a variety of synthesis methods [2-5]. This paper focused on synthesis of pristine nano-particles of SnO_2, ppy and Al_2O_3 and also (SnO_2- ppy) multilayer thick films with Al_2O_3, as base material.

EXPERIMENTAL: PREPARATION OF MATERIALS

The methods of synthesis of nano-particles can be broadly classified in the three categories namely, liquid phase synthesis, gas-phase synthesis and vapour-phase synthesis . In the present work, we have used sol-gel method for the synthesis of pristine nano-particles of SnO_2, Al_2O_3 and PPy [6].

Preparation of Tin Oxide (SnO_2)

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. Stannous chloride dehydrates ($SnCl_2.2H_2O$), Ammonia solution and deionized water were used during reaction. The conducting silver paint (Sigma Aldrich Chemical, USA) is used to form electrodes.

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In preparation of SnO_2, 2g (0.1 M) of stannous chloride dehydrate ($SnCl_2.2H_2O$) is dissolved in 100 ml water. After complete dissolution, about 4 ml ammonia solution is added to above aqueous solution with magnetic stirring. Stirring is continued for 20 minutes. White gel precipitate is immediately formed. It is allowed to settle for 12 hrs. Then it is filtered and washed with water 2-3 times by using deionized water. The obtain precipitate were mixed with 0.27 g carbon black powder (charcoal activated). The obtained mixer is kept in vacuum oven at 70 ºC for 24 hours so that the mixer gets completely in to dried powder. Then this dry product was crushed into a find powder by grinder. Now obtained product of fine nanopowder of SnO_2 was calcinated at 700^0C up to 6 hours in the auto controlled muffle furnace (GAYATRI Scientific, Mumbai, India.) so that the impurities from product will be completely removed.

Preparation of Polypyrrole (PPy)

The method used for the preparation of polypyrrole is chemical polymerization. Powder polypyrrole was prepared with 4.290 (high) weight ratio of pyrrole (Py) monomer/oxidant ($FeCl_3$). During the synthesis, concentration of $FeCl_3$ was kept constant and methanol was used as a solvent.

The Py monomer, anhydrous iron (III) chloride ($FeCl_3$) and methanol were used as received for synthesis of PPy. The solution of 7 ml methanol and 1.892 g $FeCl_3$ was first prepared in round bottom flask. Then 8.4 ml Py monomer was added to ($FeCl_3$ + methanol) solution with constant stirring in absence of light. The amount of Py monomer added to the solution (1/2.33 times of $FeCl_3$) was in such a way to get maximum yield [7].

The polymerization of Py, which was suppressed in a solution, progressed rapidly due to an increase of oxidation potential caused by evaporation of solvent. In the polymerization reaction of Py, it was observed that as soon as the Py monomer was added to the solution, the colour changed to dark green/black. There was an increase in temperature of the solution during the start of reaction, which showed that it is an exothermic reaction [8]. The reaction was carried out at room temperature for 4 hrs. The final precipitated polymer was filtered by a conventional method. The polymer was washed with distilled water several times till the filtrate obtained was colourless. To remove last traces of un-reacted pyrrole and remaining ferric and ferrous chloride formed due to polymerization, it was then washed with methanol.

The polymer, obtained in powder form was dried first at room temperature for a few hours and then finally dried in an oven kept at 80^0C for 5-6 hrs. This polypyrrole is then used for active layers of Semiconductor Gas Sensors.

Preparation of Alumina (Al_2O_3)

1M alcoholic $AlCl_3$ 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.

Fabrication of Sensors

Three series of the samples prepared were SnO_2: PPy with Al_2O_3 base of multilayer sensors. The different combinations are shown in tables 1.

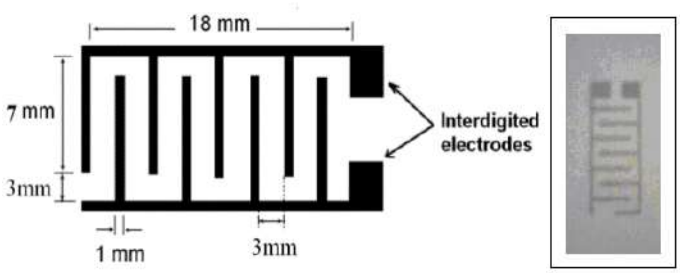
Table 1 Samples codes of series : SnO_2: PPy

Sr. No.	Sample codes	SnO_2 (mole %)	PPy (mole %)
1	F1	100	00
2	F2	98	02
3	F3	96	04
4	F4	94	06
5	F5	92	08
6	F6	90	10

Out of various methods of sensors preparation, the screen-printing (thick film technology) is most widely used. Screen-printing is the transfer of pastes though a fabric screen onto a substrate.

Multilayer preparation

Fig. 1 (a), and 1(b) show fabrication of interdigited electrodes, actual photographs of interdigited electrodes respectively.



(a) **(b)**

Fig. 1 (a) Fabrication of interdigited Electrodes (b) Actual photograph of interdigited electrodes

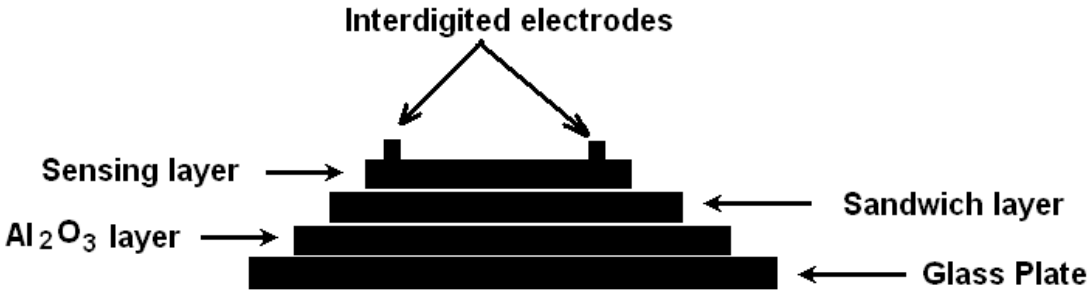


Fig.2 Design of multilayer Sensor

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, Interdigited electrodes were fabricated 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 SnO_2: PPy/Al_2O_3/GP

The obtained product of fine nano-powder of SnO_2 and PPy are used for fabrication of thick films sensors by using screen-printing technique. For this, the SnO_2 powder was mixed thoroughly with different X mole% of PPy (X = 2, 4, 6, 8,10) 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 SnO_2:PPy system was further calcinated at temperature 800°C for 5hrs. in the auto controlled muffle furnace (Gayatri Scientific, Mumbai, India.) After, the calcinations again uniformly mixed the powder using the grinder

Table 2: Length, Width and Thickness of Multi-layers in SnO_2: PPy/Al_2O_3/GP gas sensor

Sample Code	Doping mole % Layers: Upper/ /Al_2O_3/ Glass plate (GP)	Upper layer length (cm)	Upper layer width (cm)	Thickness (x 10-4 cm)		
				Upper Layer (1)	Al_2O_3Layer (2)	Total (1+2)
F1	SnO_2/ Al_2O_3/GP	3	1.5	5.1	26.4	31.5
F2	98 SnO_2:2 PPy/ Al_2O_3/GP	3	1.5	3.1	34.2	37.3
F3	96 SnO_2:4 PPy/ Al_2O_3/GP	3	1.5	2.8	35.1	37.9
F4	94 SnO_2:6 PPy/ Al_2O_3/GP	3	1.5	3.4	32.6	36.0
F5	92 SnO_2:8 PPy/ Al_2O_3/GP	3	1.5	3.0	35.5	38.5
F6	90 SnO_2:10 PPy/ Al_2O_3/GP	3	1.5	3.6	32.3	35.9
F7	PPy/ Al_2O_3/GP	3	1.5	1.9	48.4	50.3

RESULTS AND DISCUSSION

X-Ray diffraction pattern of polypyrrole [9] showed that, it is amorphous in nature. In Fig. 3 XRD pattern of polypyrrole was recorded in terms of 2θ in the range 5 to 100^0. As shown in XRD pattern broad peak occurs at 29^0 and it is characteristics of amorphous nature of polypyrrole. The broad peak occurs due to the scattering of X-rays from polymer chains at the interplaner spacing. The position of maximum intensity of amorphous halos depends on monomer to oxidant ratio. The average crystallite size of polypyrrole is about 119 nm. Abroad peak is observed at about $2\theta = 29.36$ which is characteristics peak of amorphous PPy. However, the peak obtained at 29 degree matches with the value of (3.040 A^0) $FeCl_3$. The average green size determines from XRD pattern using Scherrer formula of these material is about 119 nm for PPy.

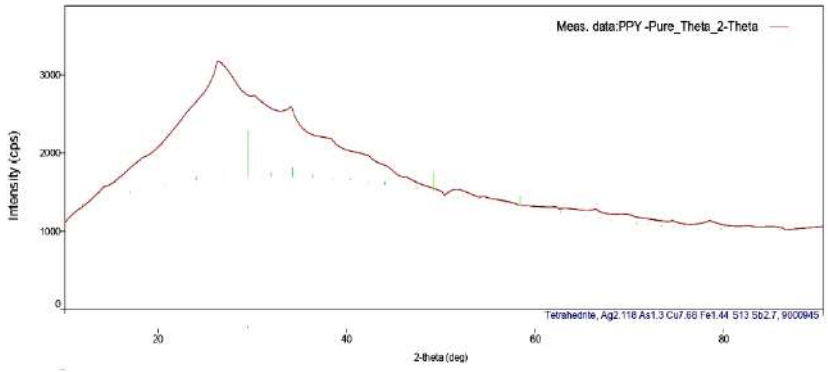


Fig. 3 XRD of Spectra of Polypyrrole

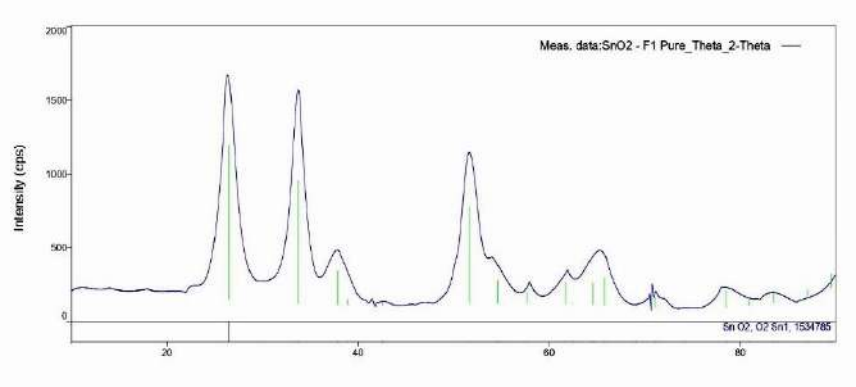


Fig. 4 XRD Pattern of SnO_2

Figure 4 shows the X-ray diffraction pattern of pure SnO_2, calcinated at 800^0C for 4-5 hours. It is recorded in terms of 2θ in the 10 to 100 ^{0}.

In case of pure SnO_2 a main pic is observed at 26.54^0. This peak corresponding to the plane (110) of SnO_2 in tetragonal structure (JCPDS card No.1534785) with 100% intensity. The other Peak of SnO_2 mainly correspondent to the planes (101), (200), (211), (220), (310), (301) and (321).

These planes correspond to the cassiterite phase of SnO_2. Tin (IV) dioxide (II) i.e. SnO_2 has only one stable phase the so called cassiterite (mineral form) or rutile (material structure). It crystalizes in the tetragonal rutile structure with space group D^{14}_{4h} (P_{42}/mnm), which correspondence to the number 136 in the standard listening with cell parameter a=b=4.7456 A0, C=3.1930 A0 and $\alpha = \beta = \gamma = 90^0$ with c/a ratio of 0.6728.

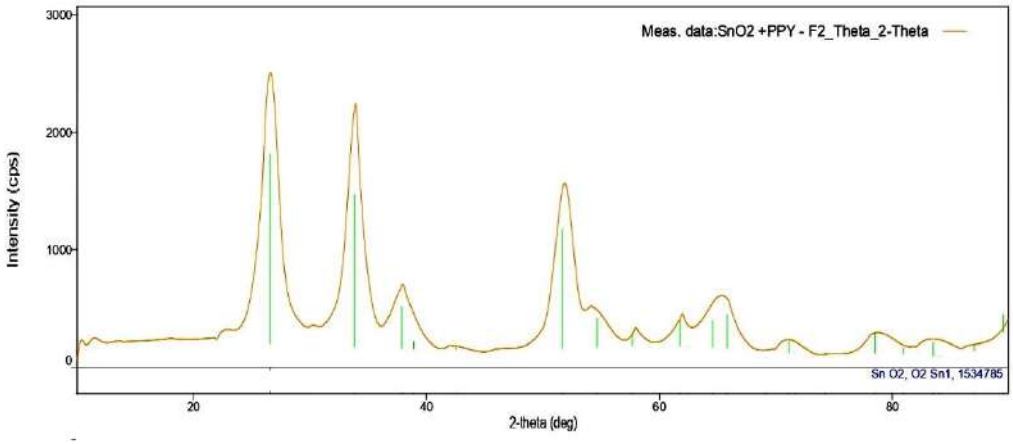


Fig. 5 XRD Pattern of $98SnO_2$:2PPy

Fig. 5. shows that the X-ray diffraction pattern of $98SnO_2$:2PPy calcinated at 800ºC for 4 to 5 hours. It is recorded in terms of 2θ in the range of 10 to 100 degree. It is observed as the doping of PPy increases, the intensity of corresponding peak increases. This peak correspondence to the plane of $96SnO_2$:4PPy (JCPDS Card no.1534785 with 100% intensity. The other peaks of $98SnO_2$:2PPy correspondence to the plane (101), (200), (211), (220), (310), (301), (321).

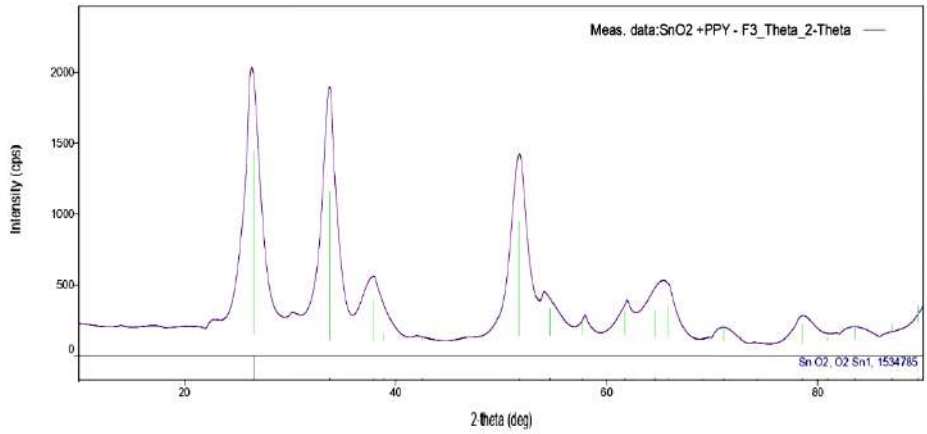


Fig. 6 XRD Pattern of $96SnO_2$:4PPy

As shown in above spectra fig.6. $96SnO_2$:4PPy main peak in case of pure SnO_2 is observe at 26.54 degree and his correspondence to the plane (110) of SnO_2 in tetragonal structure(JCPDS Card no.1534785) with 100% intensity the other pic of SnO_2 mainly correspondence to the plane (101), (200), (111) and (301).

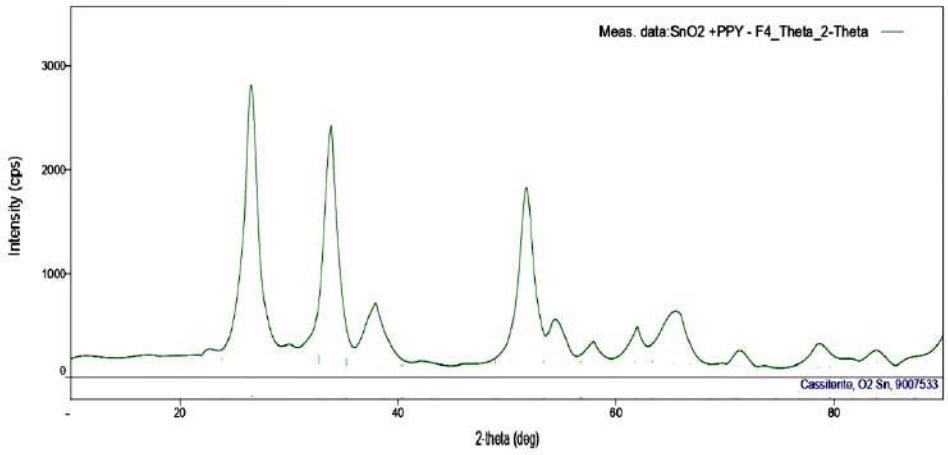


Fig. 7. XRD Pattern of $94SnO_2$:6PPy

As shown in above fig.7. $94SnO_2$:6PPy main peak [10], in case of pure SnO_2, is observed at 26.58 and this peak corresponds to the plane(110) of SnO_2 in tetragonal structure(JCPDS Card no.9007533) with 100% intensity the other peaks of SnO_2 mainly corresponds to the Planes (101), (200), (111), (211) and (301). These planes corresponds to the cassiterite phase of SnO_2.SnO_2 has only one stable phase, the so called (mineral form) or rutile (material structure) JCPDS Card no.9007533. It crystallizes in the tetragonal rutile structure with space group which corresponds to the number 136 in the standard listing with cell parameter a = b = 4.7380A, c = 3.1865A and $\gamma = \beta = \gamma = 90$ degree with c/a ratio of 0.6725.

From table 3. it is observed that average crystallite size of $94SnO_2$:6PPy doping is list as compared to the other compositions and pure materials and hence $94SnO_2$:6PPy compositions has large active surface area for sensing the gas.

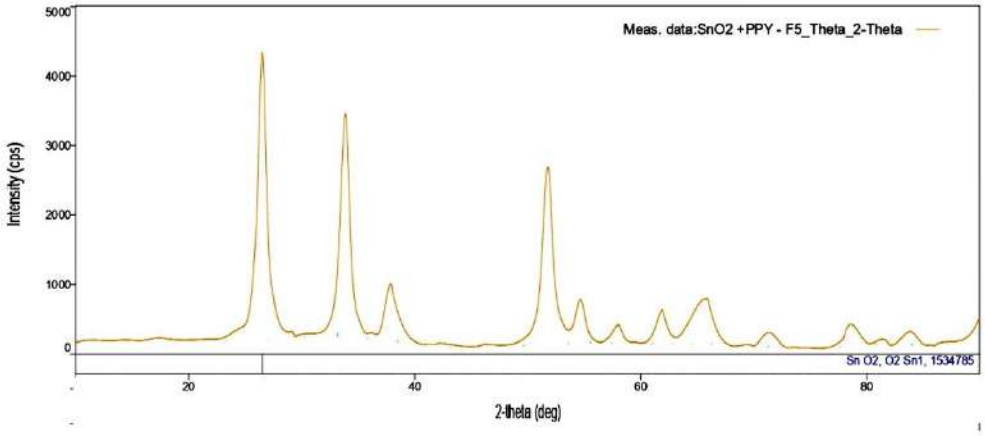


Fig. 8. XRD Pattern of $92SnO_2$:8PPy

Fig 8. $92SnO_2$:8PPy XRD spectra of doping of SnO_2:PPy, incase of pure SnO_2 is observed at 26.54 degree and this peak corresponds to the plane (110) of SnO_2 and PPy in bixbyite phase (JCPDS Card No. 1011264) with 2θ=33.16, d-value is 2.699 with 100% intensity peak of SnO_2 and PPy mainly correspond to the Planes (220), (310) and (301).

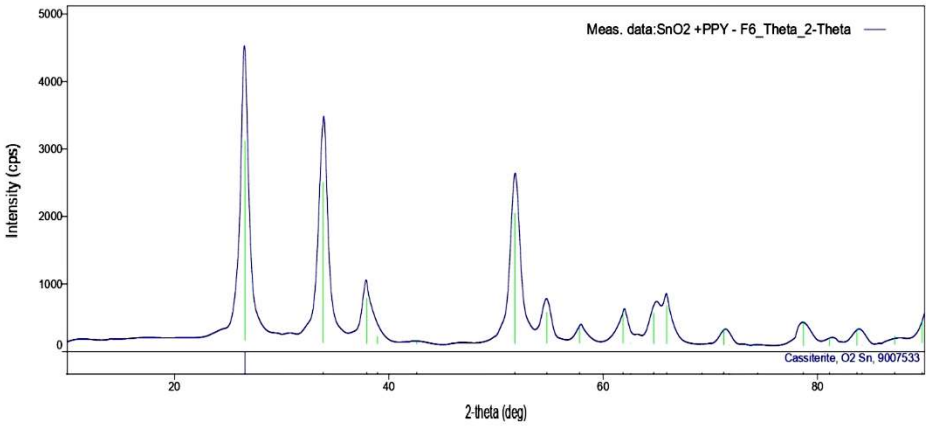


Fig. 9. XRD Pattern of $90SnO_2$:10PPy

Fig. 9. as shown in above spectra of doping of SnO_2 and PPy main peak is observed at 26.58^0 and this corresponds to the plane (110) of SnO_2 in tetragonal structure (JCPDS Caed No. 9007533) with 100% intensity. The other peak of SnO_2 and PPy Mainly correspondec to the planes (110), (101), (112) and (301). These planes correspondence to the casseterities phase of SnO_2 (JCPDS Card No. 9007533). In fig 9. it is observed that XRD pattern contains 8-10 peaks. These are prominent peak of SnO_2. The (hkl) values are obtained by using 2θ and d- values from XRD pattern.

The crystallite size (D) was calculated from Scherer's formula using FWHM and it is listed in the table 3. as below,

Table 3. Average crystallite size of SnO_2, PPy and their compositions

Sr. No.	Chemical Composition of SnO_2:TiO_2 (mole %)	Maximum Intensity Peak Position (2θ) in degree	FWHM (2θ) degree	Average Crystallite Size (D) in nm
01	Pure SnO_2	26.5414	0.1338	120.68
02	98SnO_2:2PPy/Al_2O_3/GP	26.6424	0.2165	102.62
03	96SnO_2:4 PPy/Al_2O_3/GP	26.7123	0.2168	103.68
04	94SnO_2:6 PPy/Al_2O_3/GP	26.6821	0.2178	105.24
05	92SnO_2:8 PPy/Al_2O_3/GP	26.6531	0.2175	98.23
06	90SnO_2:10PPy/Al_2O_3/GP	26.7512	0.2040	110.58
07	Pure PPy	27.8710	0.1991	146.09

SEM Analysis

The surface morphology of polypyrrole [11-13] material was studied by SEM and its picture is shown in the Fig. 10.

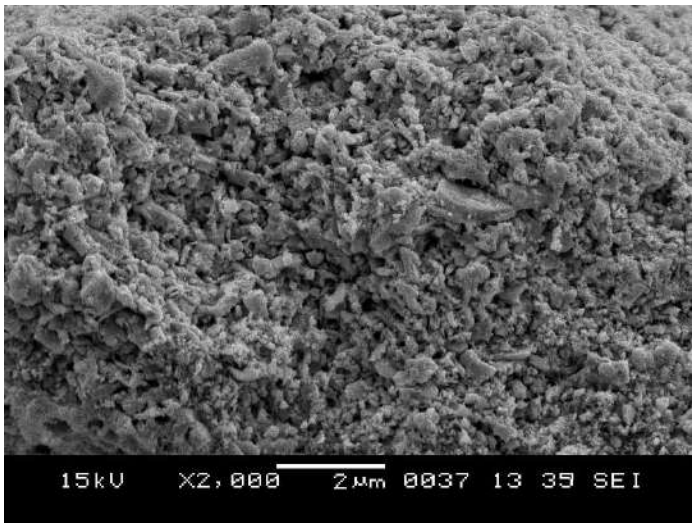


Fig. 10. SEM picture of polypyrrole

From SEM picture, it is observed that PPy is porous in nature and pore size varies from ~ 0.5 to 3 µm. Due to small pores size, its surface area is more 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.

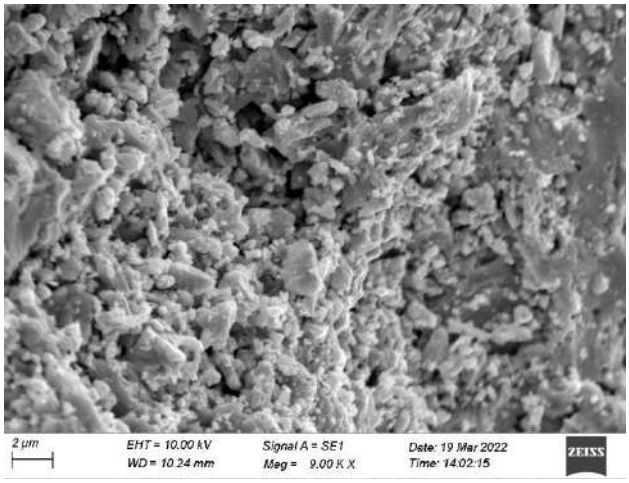
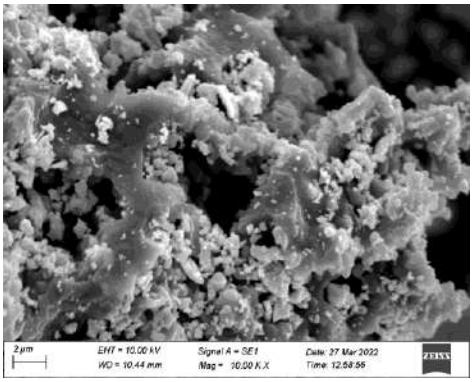
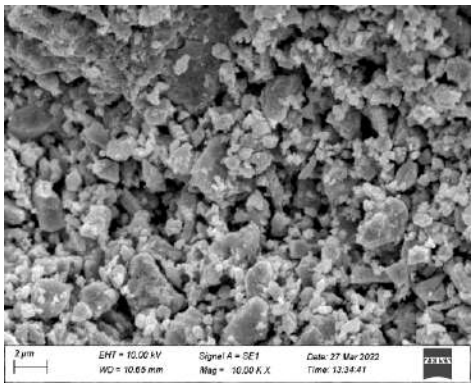


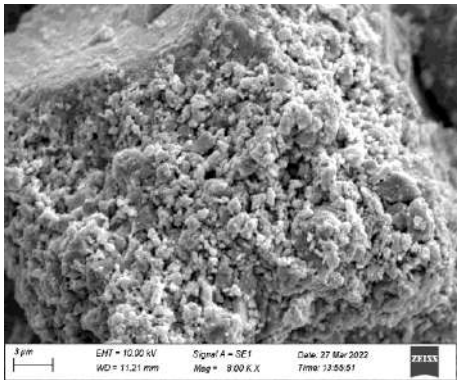
Fig. 11. SEM picture of Pure SnO_2



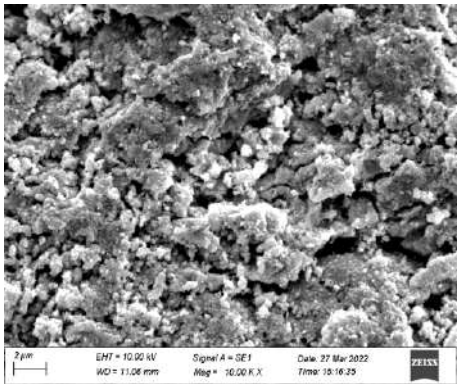
(a) SEM Picture of $98SnO_2$:2PPy



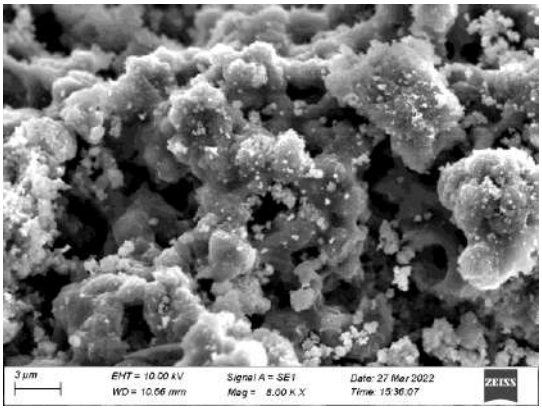
(b) SEM Picture of $96SnO_2$:4PPy



(c) SEM Picture of $94SnO_2$:6PPy



(d) SEM Picture of $92SnO_2$:8PPy



(e) SEM Picture of $90SnO_2$:10PPy

Fig. 12. SEM Picture of SnO_2:PPy Series

Table 4 Average diameters of pore and number of pores per inch of pure samples and their dopings.

Serial No.	Pure sample and their dopings (mole %)	Codes	Average diameter of pore (nm)	No. of pores per inch
1	Pure SnO_2	F1	335	93
2	$98SnO_2$:2 PPy/ Al_2O_3/GP	F2	387	83
3	$96SnO_2$:4 PPy/ Al_2O_3/GP	F3	310	112
4	$94SnO_2$:6 PPy/ Al_2O_3/GP	F4	289	134
5	$92SnO_2$:8 PPy/ Al_2O_3/GP	F5	215	154
6	$90SnO_2$:10 PPy/ Al_2O_3/GP	F6	323	95

From table 4 the SEM pictures showed that $92SnO_2$:8PPy, compositions have more pores per inch than other compositions. Thus these three compositions have more active surface areas and exhibit more sensing nature. It is also found that average diameter of pore in case of $92SnO_2$:8PPy compositions are small as compared to other compositions. This also tends to exhibit large surface area and exhibited high response of the samples [14,15].

CONCLUSIONS

All samples show nanocrystalline form and found the desired peaks of composites and also the grain size of nano-meter order and shows nano-porous structure, which leads to exhibit large surface area, stability and highest response particularly from this study ($92SnO_2$:8 PPy) sensor was found to optimized for gas sensing applications.

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Tin Oxide (SnO_2) Doped with Polypyrrole (PPy) Screen-printed Multilayer CO_2 Gas Sensor[1]

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ABSTRACT

The multilayer thick films series of sensors (SnO_2-PPy) tested for CO_2 gas sensing application in the concentration range from 200 ppm to 2000 ppm, sensitivity increases is very small upto 1200ppm but beyond 1400 ppm of CO_2 gas concentration, sensitivity becomes maximum. With further increase in CO_2 gas concentration, sensitivity decreases. Static responses of the series of (SnO_2:PPy) system also studied at 1000, 1200 and 1400 ppm of CO_2 gas concentration. sensor shows less response time and less recovery time, F5 sensor is faster in operation that other prepared sensors. F5 sensor (92SnO_2:8 PPy) offers high sensitivity, rapid response and recovery to CO_2 gas.

Keywords: *SnO_2-PPy; multilayer thick films; CO_2 Gas Sensors*

INTRODUCTION

Gas sensors consisting of metal oxides like SnO_2 , TiO_2, ZnO and others employ a variation of electrical conductance by ambient gases such as ethanol, carbon monoxide, methane, hydrogen sulfide, nitrogen oxide, and oxygen [1]. The effects of additive of various metals and metal oxides on SnO_2 , TiO_2, ZnO and others sensors are examined by Yamazoe *et al.* [2]. They found that gas sensitivity usually goes through a maximum with increasing nature. The effects of additives can be appropriately compared in terms of the temperature at the maximum of gas sensitivity. A new type of CO_2 gas sensor was developed by Masayuki *et al.* [3] using porous hydroxyapalite ceramics, both DC and AC conductivities measurement were earned out in various atmospheres including air, CO_2 and air containing different amount of CO_2. Thick films of SnO_2, ZnO, TiO_2 were prepared by screen printing technique and studied by Mude *et al.* [4] result the semiconducting metal oxide gas sensor extensively used in the gas sensing. The chemical used for the designing of gas sensor was first calcinated at 650°C for 6 hrs. Thick films of SnO_2, ZnO, TiO_2 were prepared using screen printing technique with Al_2O_3 as substrate on glass plate. Sensitivity was found to be more for SnO_2 than other metal oxides. It was observed that stability is found better in SnO_2 as compare with other metal oxides, sensitivity is also more as compare to other metal oxides. This paper focused on CO_2 gas sensing application of (SnO_2-ppy) multilayer thick films system with Al_2O_3 as base material.

EXPERIMENTAL

The methods of synthesis of nano-particles can be broadly classified in the three categories namely, liquid phase synthesis, gas-phase synthesis and vapour-phase synthesis . In the present work, we have used sol-gel method for the synthesis of pristine nano-particles of SnO_2, Al_2O_3 and PPy [5].

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Preparation of Samples of Series : SnO_2: PPy/Al_2O_3/GP

The obtained product of fine nanopowder of SnO_2 and PPy are used for fabrication of thick films sensors by using screen-printing technique. For this, the SnO_2 powder was mixed thoroughly with different X mole% of PPy (X = 2, 4, 6, 8,10) 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 1**.** The mixed powder of SnO_2:PPy system was further calcinated at temperature 800°C for 5hrs. in the auto controlled muffle furnace (Gayatri Scientific, Mumbai, India.) After, the calcinations again uniformly mixed the powder using the grinder

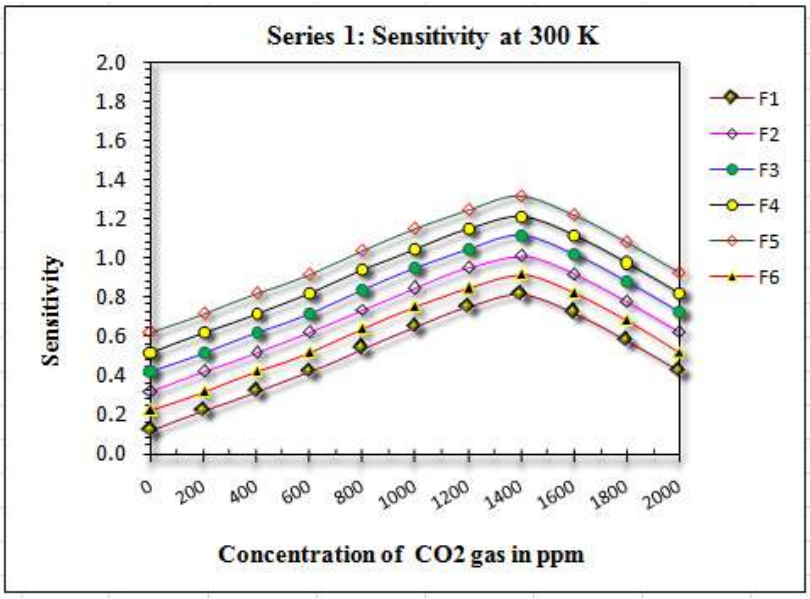
Table 1 Length, Width and Thickness of Multi-layers in SnO_2: PPy/Al_2O_3/GP gas sensor

Sample Code	Doping mole % Layers: Upper/ /Al_2O_3/ Glass plate (GP)	Upper layer length (cm)	Upper layer width (cm)	Thickness (x 10-4 cm)		
				Upper Layer (1)	Al_2O_3 Layer (2)	Total (1+2)
F1	SnO_2/Al_2O_3/GP	3	1.5	5.1	26.4	31.5
F2	98 SnO_2:2 PPy/ Al_2O_3/GP	3	1.5	3.1	34.2	37.3
F3	96 SnO_2:4 PPy/ Al_2O_3/GP	3	1.5	2.8	35.1	37.9
F4	94 SnO_2:6 PPy/ Al_2O_3/GP	3	1.5	3.4	32.6	36.0
F5	92 SnO_2:8 PPy/ Al_2O_3/GP	3	1.5	3.0	35.5	38.5
F6	90 SnO_2:10 PPy/ Al_2O_3/GP	3	1.5	3.6	32.3	35.9
F7	PPy/ Al2O3/GP	3	1.5	1.9	48.4	50.3

RESULTS AND DISCUSSION

CO_2 Gas Sensing Properties at room temperature (300 K) & at (330 K)

The variations of sensitivities and sensors with concentration of CO_2 gas at 300K and 330K temperature are shown below;



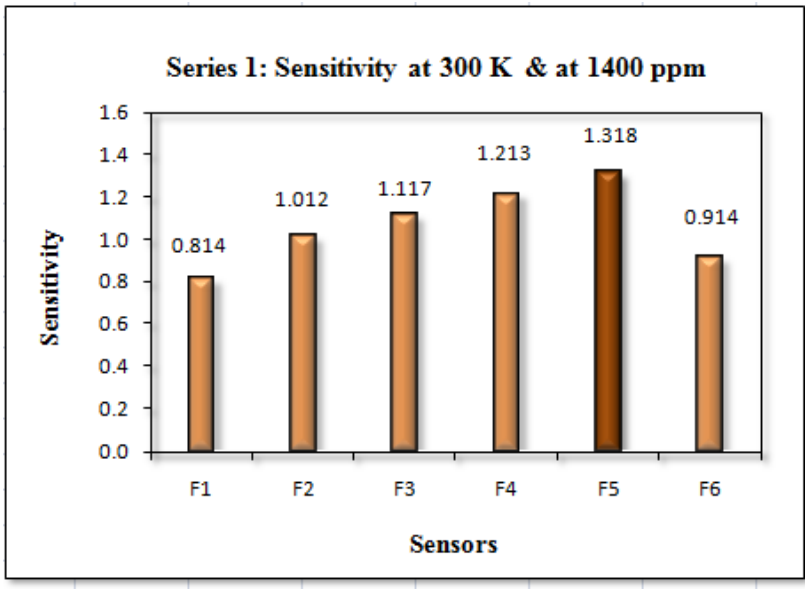
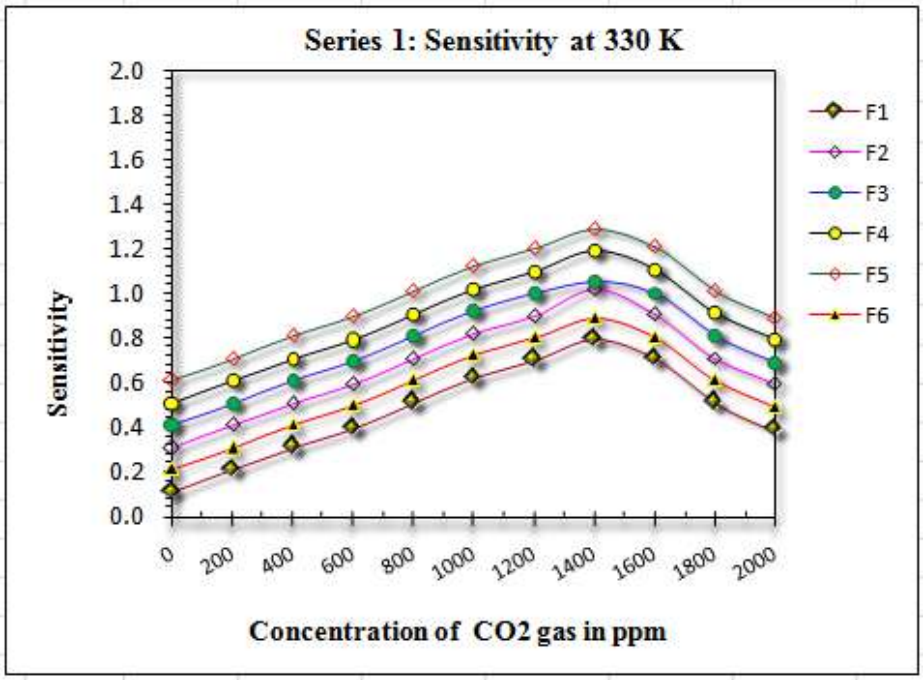


Fig. 1: variations of sensitivity with CO_2 gas concentration at 300 K



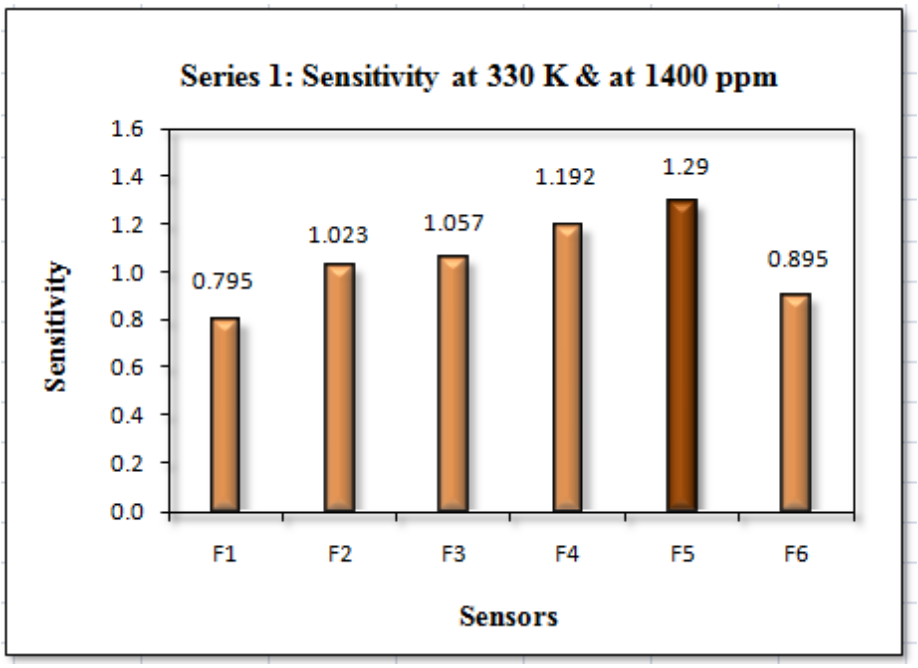


Fig. 2: variations of sensitivity with CO_2 gas concentration at 330 K

From Fig. 1 and 2 for the CO_2 gas detection and sensing at room temperature (300 K) and at temperature 330 K respectively, exhibited that,

As CO_2 gas concentration increases up-to 1200 ppm, sensitivity increases by small amount. At about 1400 ppm of CO_2 gas concentration, sensitivity becomes maximum. With further increase in CO_2 gas concentration, sensitivity decreases. From Fig. 2 (Bar Graph), sensitivity was found to be 1.318 (maximum) for F5 sensor, amongst the prepared all sensors. From figures, it is manifested that, as temperature increases, sensitivity decreases because size of porosity increases and therefore number of pores in given area decreases. This means that the prepared sensors work better at room temperature (300 K). In brief, among the prepared sensors, F5 sensor showed optimum sensitivity at 1400 ppm of CO_2 gas concentration [6,7].

Static Responses of sensors

Static responses of the series of (SnO_2:PPy) system , was studied at 1000, 1200 and 1400 ppm of CO_2 gas concentration [8-10]. The variation in sensitivity was plotted as a function of time in second. From the variations, response and recovery times were calculated and listed in the following tables, separately for each series. Static response of this series at 1000, 1200 and 1400 ppm of CO_2 gas concentration is shown Fig. 3.

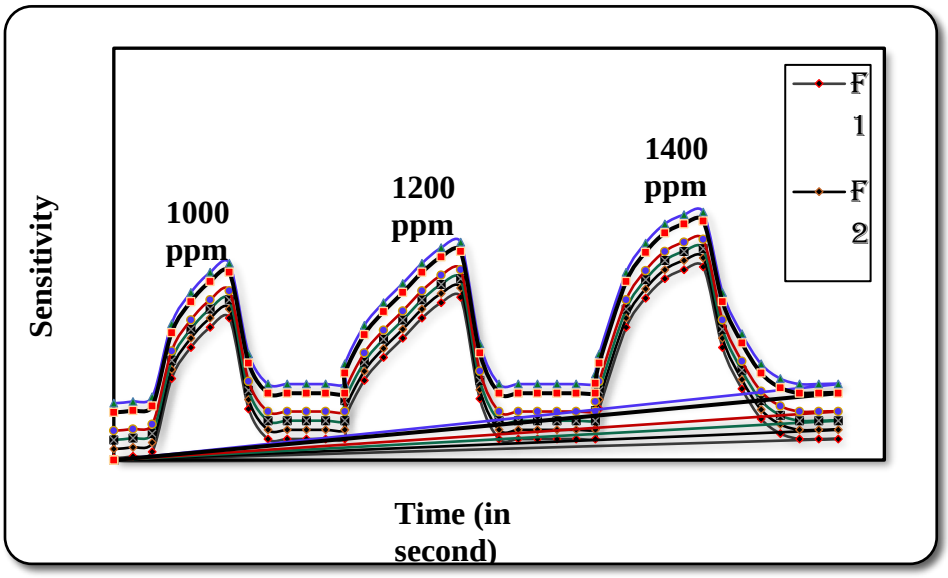


Fig. 3.: Static response (response and recovery times) of series of (SnO_2:PPy) system

Table 2. Response and Recovery times of series of (SnO_2:PPy) system

Sr. No.	Sample Compositions	Sensor	Response time (s) for 1400 ppm	Recovery time (s) for 1400 ppm
1	100SnO_2:0 PPy/Al_2O_3/GP	F1	118	152
2	98SnO_2:2 PPy/ Al_2O_3/GP	F2	103	149
3	96SnO_2:4 PPy/ Al_2O_3/GP	F3	97	143
4	94SnO_2:6 PPy/ Al_2O_3/GP	F4	91	139
5	92SnO_2:8 PPy/ Al_2O_3/GP	F5	81	129
6	90SnO_2:10 PPy/ Al_2O_3/GP	F6	89	134

From table 2, it is clear that, F5 sensor shows less response time (81 s) and less recovery time (129 s), i.e. F5 sensor is faster in operation that other prepared sensors from series (SnO_2:PPy) .

CONCLUSIONS

F5 sensor shows less response time and less recovery time, therefore F5 sensor is faster in operation that other prepared sensors from series (SnO_2:PPy). The sample F5 sensor (92SnO_2:8 PPy/ Al_2O_3/GP) offers high sensitivity, rapid response and recovery to CO_2 gas.

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Investigation of Frequency and Temperature Dependent Electrical and Structural Characterization of PVC-PMMA Thin Films with Salicylic Acid Doping

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ABSTRACT

This research explores the electrical, molecular, and structural characteristics of PVC: PMMA Polyblend (1:2) doped with 8% salicylic acid. AC conductivities and dielectric constants were measured over a temperature range of 303 K to 353 K using a Precision LCR meter, revealing nuanced with dopant concentration, temperature, and frequency. FTIR spectroscopy highlighted distinct peak differences in PVC-PMMA films with and without the dopant, emphasizing the impact of salicylic acid on molecular interactions. XRD analysis demonstrated an amorphous nature in both doped and undoped thin films, while SEM and EDX revealed heterogeneous structures with varying dopant percentages. The study provides valuable insights into the intricate interplay between temperature, frequency, and dopant concentration in the electrical and structural properties of PVC: PMMA blends. These findings contribute to the understanding of material behavior for potential applications in diverse fields such as materials science and pharmaceuticals.

Keywords: *PVC-PMMA; AC conductivity; dielectric constant; frequency; salicylic acid; FTIR; XRD; SEM; EDX*

INTRODUCTION

Polymer composites have garnered significant attention for their diverse applications in the field of electronics, owing to their tunable electrical properties and flexibility. Among these materials, Polyvinyl Chloride (PVC) and Poly(methyl methacrylate) (PMMA) blends have gained prominence as potential candidates for various electronic and optoelectronic devices due to their intriguing characteristics, such as high dielectric strength, thermal stability, and ease of processing. To further enhance their electrical performance, the introduction of dopants has emerged as a promising strategy.

EXPERIMENTAL

Thin films of PVC-PMMA with different dopant concentrations were prepared using the isothermal evaporation technique. Preparation of a Polyblend thin film of PVC-PMMA in 1:2 weight proportional, the dopant and the polymer mixture were dissolved in a solvent (THF) were mixed in solution form .for a complete Homogeneous solution was kept for two or three days. after two or three days solution are in a homogeneous form then the solution mixture was poured onto a perfectly planed glass plate floating freely in a pool of mercury for perfect leveling. it was thereafter allowed to evaporate at room temperature further, and it was dried for two days to remove any traces of solvent. the

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dry film removes from the glass plate and cuts into pieces of desired size then measure the thickness of the thin film by DIGMATIC micrometer, which was then coated on two sides with silver paint then by using the multimeter check whether the two electrodes working or not .then investigate the conductivity .Two sets of films were fabricated: one without salicylic acid (0% dopant) and the other with 8% salicylic acid as the dopant. AC conductivity measurements were performed using 4284 A precision LCR meter (Agilent Make), covering a frequency range of 20 Hz to 1MHz. The measurements were carried out at two different temperatures: 303 K to 353 K. The ln f and ln AC conductivity and dielectric values were recorded for further analysis.

Graph related to Dielectric constant of PVC-PMMA 1:2 with 0% SA and 8% SA

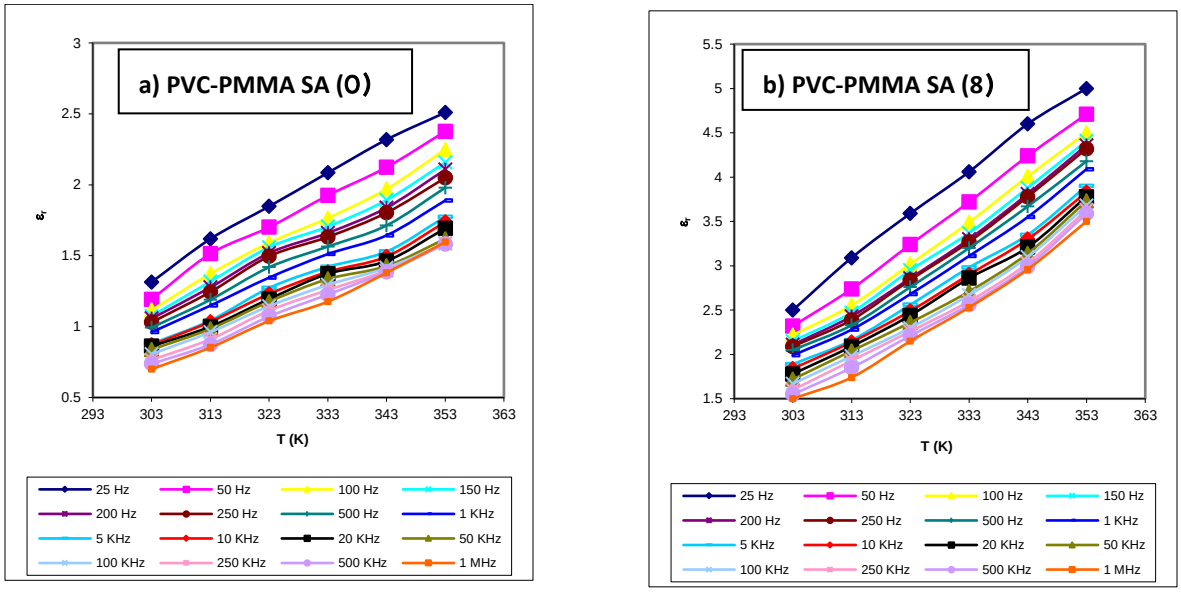


Fig 1.1. (a-b)Variation of ε_r with T(K) at different frequencies for 1:2 PVC-PMMA System

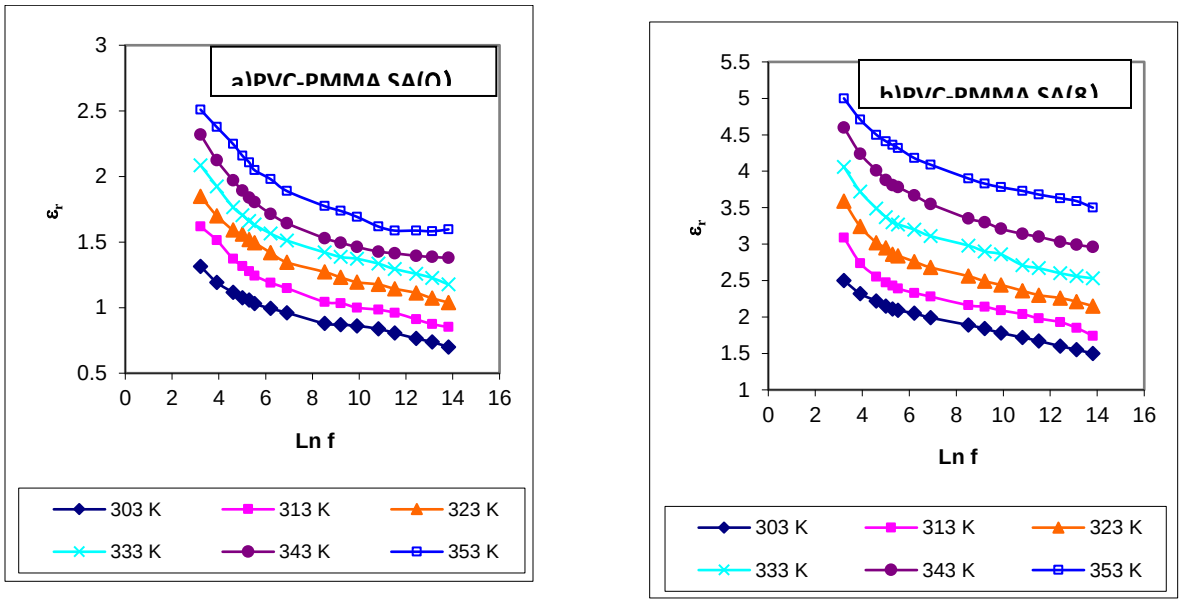


Fig 1.2.(a-b)Variation of ε_r with Ln f at different temperatures for 1:2 PVC-PMMA System

Graph related to AC Conductivity of PVC-PMMA 1:2 with 0% SA and 8% SA

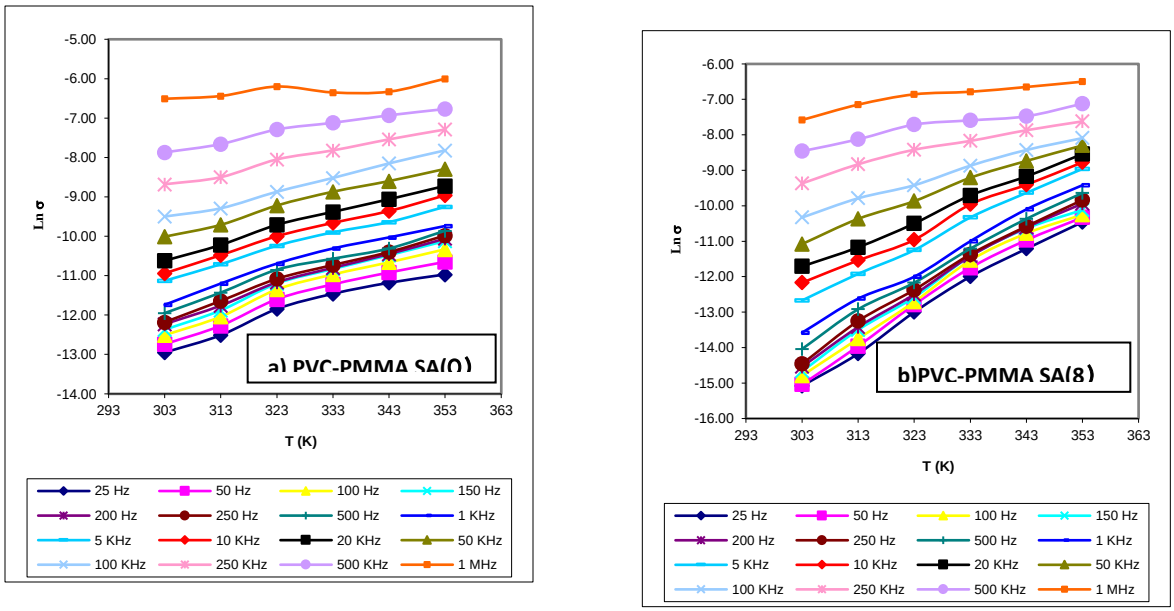


Fig 1.3. (a-b)Variation of Ln σ with T (K) at different frequencies for 1:2 PVC-PMMA System

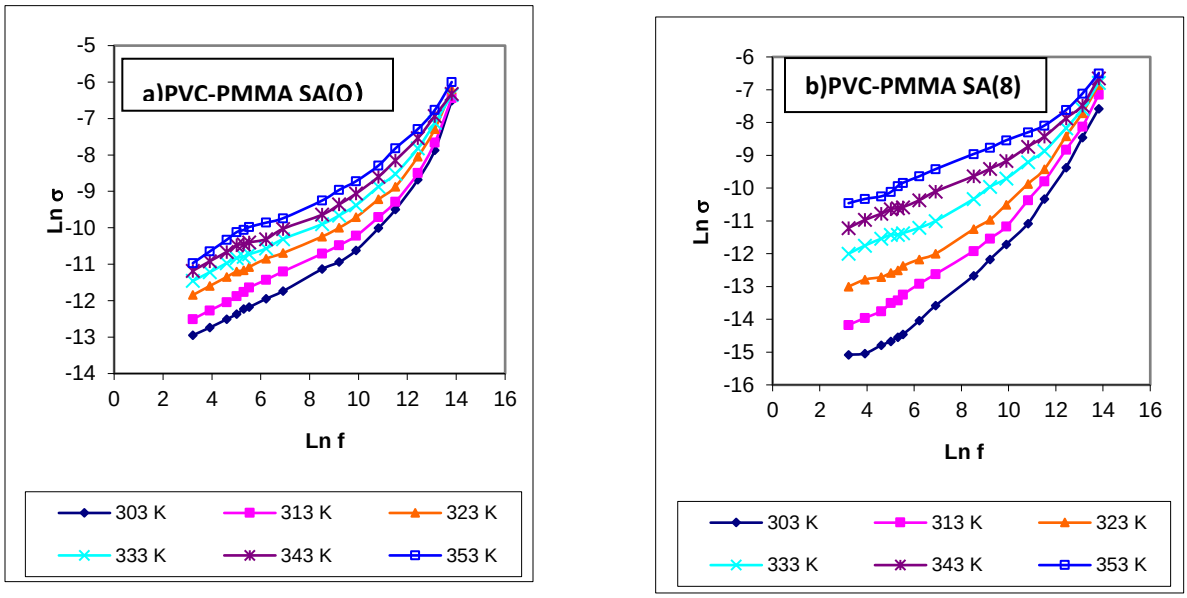


Fig 1.4.Variation of Ln σ with Ln f at different temperatures for 1:2 PVC-PMMA System

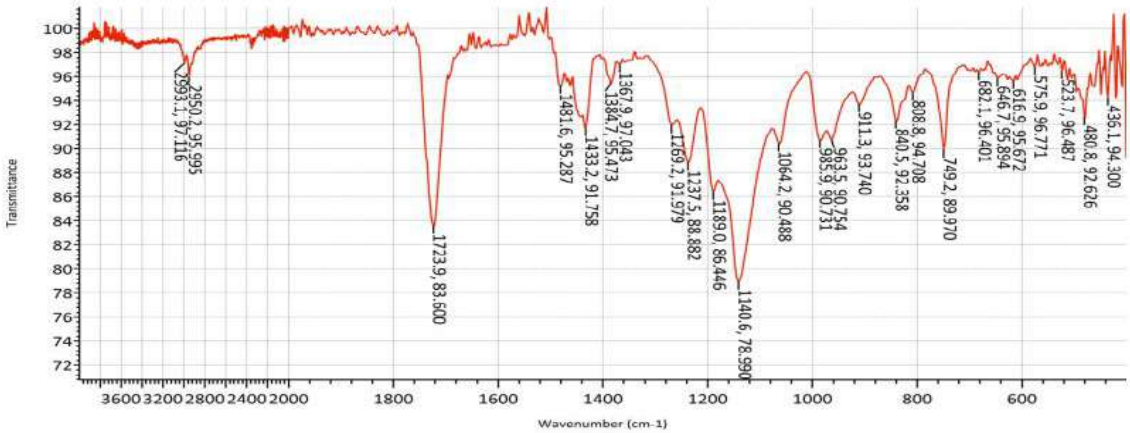


Fig 1.5 FTIR of 1:2 (PVC-PMMA) SA (0)

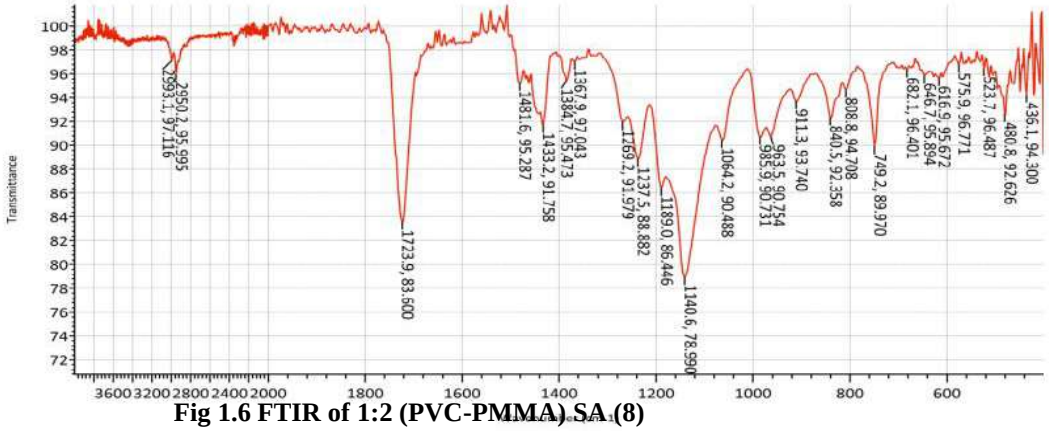


Fig 1.6 FTIR of 1:2 (PVC-PMMA) SA (8)

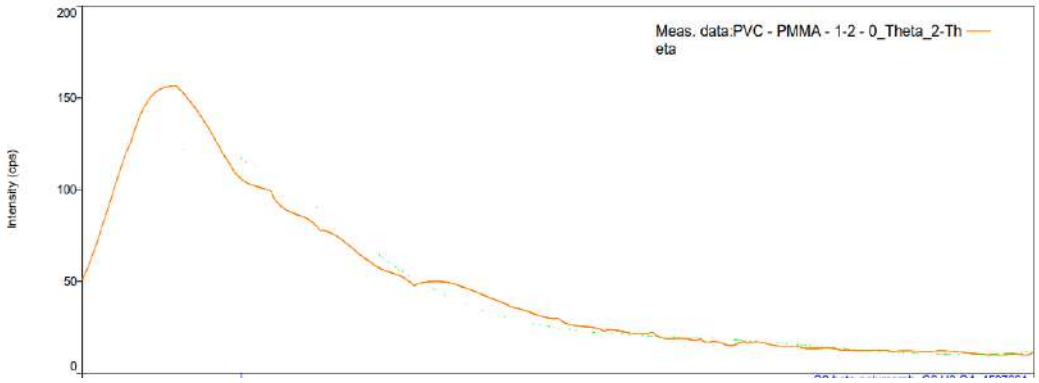


Fig 1.7 XRD Spectra of 1:2 PVC-PMMA 0% SA

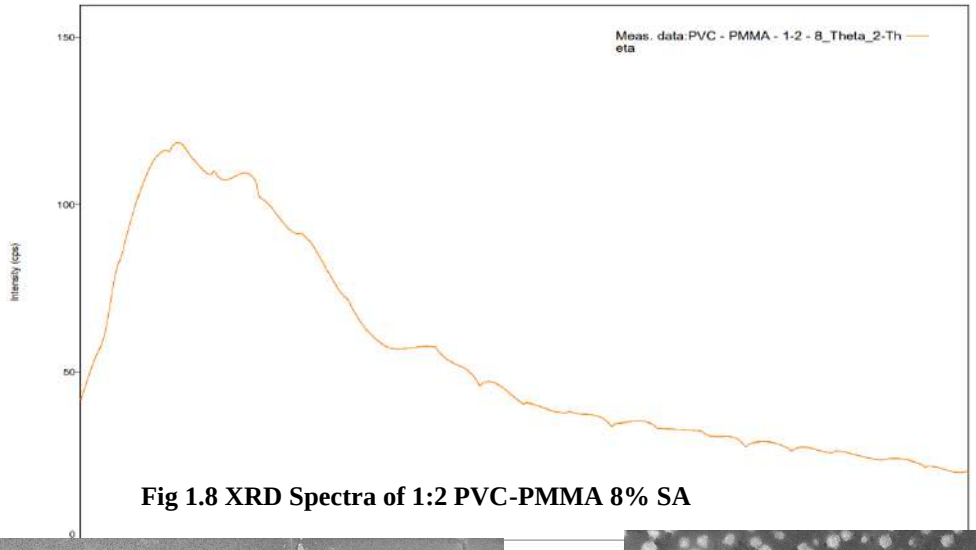
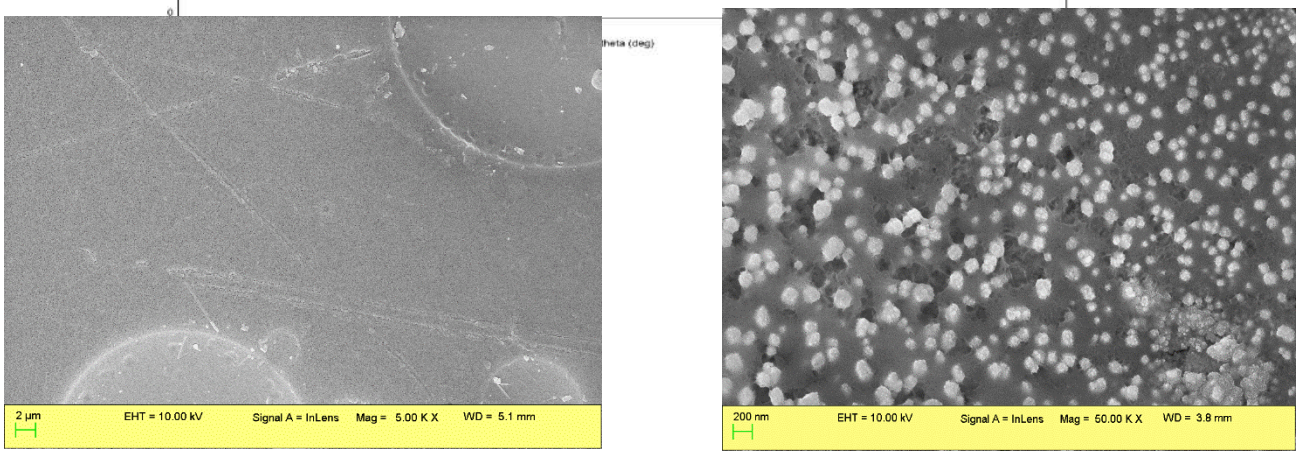
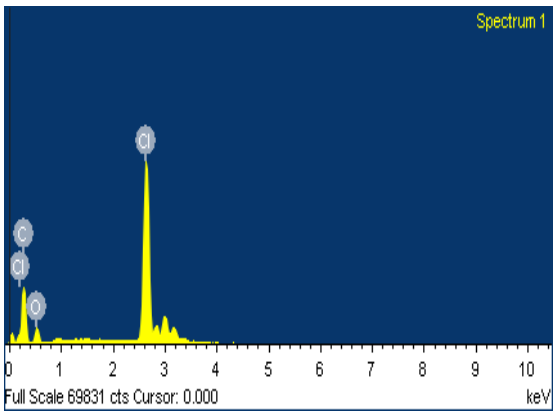


Fig 1.8 XRD Spectra of 1:2 PVC-PMMA 8% SA



SA **Fig 1.10 SEM of 1:2 PVC-PMMA 8% SA**



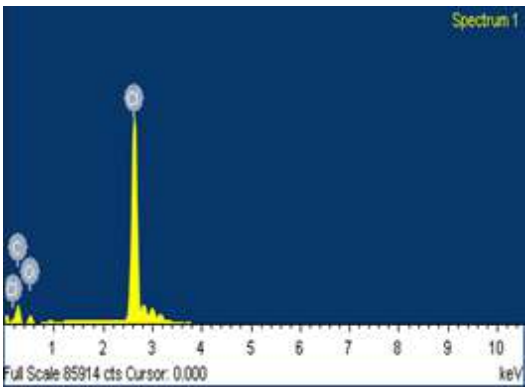


Fig 1.11 SEM of 1:2 PVC-PMMA 0% SA

Fig 1.12 SEM of 1:2 PVC-PMMA 8% SA

RESULTS AND DISCUSSION

AC conductivities and dielectric constant:

The AC conductivities and dielectric constant, XRD, SEM, EDAX of PVC:PMMA blends (1:2)doped with 8% percentages of Salicylic acid were examined in this study. Measurements were taken using a 4284 A precision LCR meter (Agilent Make) with a frequency range of 20 Hz to 1 MHz. The tests were conducted over a temperature range of 303 K to 353 K.

Here's a summary of the key findings:

1. Variation of dielectric constant with temperature at different frequencies with and without dopant

2. Variation of dielectric constant with frequency at different temperatures with and without dopant

3. Variation of AC conductivity with frequency at different constant temperatures with and without dopant

4. Variation of AC conductivity with temperature at different constant frequencies with and without dopant

5. Variation of dielectric constant with concentration of dopant at various temperatures.

6. AC conductivity with concentration of dopant at various temperatures

The study explored PVC: PMMA blends (1:2) doped with 8% salicylic acid, examining various properties using a Precision LCR meter. Dielectric constant increased with temperature due to enhanced dipole flexibility, particularly notable in the polar PVC: PMMA blend. Conversely, dielectric constant decreased with increasing frequency, attributed to orientation polarization struggling to match field variations at higher frequencies. AC conductivity rose with frequency, indicating higher loss currents in response to changing electric fields. Notably, the dielectric constant increased with dopant percentage but decreased in AC conductivity, suggesting the salicylic acid's impact on the blend's functional sites. This sheds light on the nuanced interplay between temperature, frequency, and dopant concentration in the electrical and structural properties of the PVC: PMMA blends.

FTIR:

The FTIR spectroscopy is a very useful technique to elucidate the intermolecular interaction between PVC, PMMA and Salicylic Acid. FTIR spectra were collected using an Agilent Micro Lab instrument. The spectra were recorded in the range of 4000-400 cm^{-1} each sample was scanned 64 times, and background scans were taken 32 times to ensure accuracy and reliability. The FTIR spectra of PVC/PMMA/SA films were depicted in Fig. 1.5 demonstrates the FTIR spectrum of PVC-PMMA thin film without doping and Fig 1.6. Demonstrates the FTIR spectrum of PVC-PMMA thin film with doping.PVC-PMMA with SA. The FTIR spectra of PVC-PMMA thin films with and without an 8% SA dopant reveal notable differences in peak wavenumbers and intensities. The prominent peaks and their implications are discussed below In Fig 1.5.FTIR of PVC-PMMA 0% SA the peak 1062-1064.2 cm^{-1} rocking vibration of CH_2 group of PVC.The Peak 2950.2 In both film with and without SA which shows C-CH_3 ,C-H Stretching in PMMA (Rajendra and Uma (2000)) .The Peak 1481.6 C-H Stretching in PMMA. The Peak 1481.6 C-H Stretching in PMMA. The peaks at 2993.1 cm^{-1} and 2951-2950.2 cm^{-1} corresponds to the stretching of–CH_3 and –CH_2– groups of PMMA.The band 616.9-617 cm^{-1} demonstrate the C–Cl bond of the isotactic and syndiotactic structure of PVC.Broader and stronger bands in the region 1300-1000 cm^{-1} correspond to C–O stretching vibrations which usually consists of two asymmetric coupled vibrations. i.e. C—C (=O)—O and O—C—C.The Peak at 749.2 cm^{-1} corresponds to out of plane C—H bending in PVC. A sharp band located at 1723.9 cm^{-1} was ascribed to the carbonyl group (C=O) in the film, which is typically attributed to PMMA.. Similarity Peak at 840.5 cm^{-1} PVC-PMMA without SA: Intensity of 94.708 and PVC-PMMA with 8% SA: Intensity of 92.801This peak is associated with CH_2 rocking vibrations in PVC. In Both Film the band at 1433-1433.2 cm^{-1} is due to the wagging of methylene groups in PVC and/or owing to the asymmetric stretching of O–CH_3 group of PMMA. FTIR analysis highlights the presence of both PVC and PMMA components in the film. The intensity of various peaks provides information about the relative composition and structural aspects of the film. The reduction in intensity for specific PVC-related peaks suggests a decrease in the PVC content and potential structural changes. Fig 1.6 .FTIR of PVC-PMMA 8% SA which shows the stretching vibrations of C-H bonds 2849.5 cm^{-1} [21]. The bands at 1328.8 cm^{-1} represents the deformation of –CH_2 in PVC and attributed

the overlapping CH_2 wagging in PMMA, 1249 cm^{-1}, The peaks at 609 cm^{-1} demonstrate the C–Cl bond of an isotactic and syndiotactic structure of PVC.609.4 cm^{-1} signifies C-Cl bonding. The characteristic peak at 1722-1723.9 cm^{-1} can be attributed to the C=O stretching vibration of acrylate carboxyl group of PMMA and Both Film the asymmetric stretching of CH_3 group was observed at 1433.2-1435 cm^{-1}. The bands at1140.6- 1141 cm^{-1} and1237.5- 1238 cm^{-1} are because of the C–O–C absorption and the stretching vibration of $–OCH_3$ group of PMMA. The characteristic absorption bands of PMMA occur at 1189.6-1190 cm^{-1}, 1064-1064.2 cm^{-1}, 985-985.9 cm^{-1} and 840-840.5 cm^{-1} [26, 28]. In PVC-PMMA doped SA thin film The 1727.6 cm^{-1} characteristic peak is attributed to the C=O stretching vibration of the acrylate .The band located at 1148-1146.2 cm^{-1} was attributed to the C–O group carboxyl group of PMMA and.In Both Film The bands at 961-963.5 cm^{-1} are of CH_2 rocking vibration. The bands at 688-689.6 cm−1 and Peak at 436.1 cm^{-1} PVC-PMMA without SA: Intensity of 94.300 and PVC-PMMA with 8% SA: Intensity of 93.656 .This peak is attributed to C-Cl stretching in PVC. The decrease in intensity in the doped film suggests a reduction in the PVC component. The decrease in intensity indicates changes in the polymer structure due to the presence of SA.Peak at 1384.7 cm^{-1} PVC-PMMA without SA: Intensity of 95.473 .PVC-PMMA with 8% SA: Intensity of 95.505.This peak represents the CH_3symmetric deformation in PVC. The marginal difference in intensity suggests minor changes in the polymer structure. Peak at 1587.8 cm^{-1}.PVC-PMMA without SA: Absent .PVC-PMMA with 8% SA: Intensity of 98.436.This strong peak corresponds to the CO stretching in SA, confirming the successful incorporation of SA into the doped film. Peak at 2950.2 cm^{-1} .PVC-PMMA without SA: Intensity of 95.995.PVC-PMMA with 8% SA: Intensity of 95.158.This peak is linked to CH_3stretching in PMMA. The similar intensities suggest that SA has a limited effect on PMMA. Peak 1587.8 cm^{-1} corresponds to CO stretching in SA, confirming the successful incorporation of SA into the film. Peak 23 at 1727.6 cm^{-1} indicates the presence of C=O stretching vibration of the acrylate carboxyl group of PMMA and is attributed to the SA dopant. In the film doped with 8% SA, several new peaks emerge, suggesting successful incorporation of SA: The presence of SA is evident with a strong peak at 1587.8 cm^{-1}, representing CO stretching in SA. Other peaks related to PVC and PMMA, including C-Cl stretching and CH_2 rocking vibrations, are also present. The FTIR analysis indicates that SA has a limited effect on the characteristic peaks of PMMA, as the peak related to CH_3 stretching remains similar in intensity.

The introduction of Salicylic Acid into the PVC-PMMA thin film is confirmed by the appearance of SA-specific peaks. The decrease in the intensity of PVC-related peaks in the doped film suggests a reduction in the PVC component, indicating a change in the polymer structure due to SA doping. SA has a limited impact on PMMA, as indicated by the consistent intensity of PMMA-related peaks. This FTIR analysis underscores the importance of studying the molecular interactions and structural changes when incorporating SA into PVC-PMMA films, which has implications for various applications, including materials science and pharmaceuticals. The FTIR analysis confirms the presence of SA in the film, as evidenced by the SA-specific peaks. The peaks related to PVC and PMMA are still present in the film, indicating the coexistence of these components with SA. The similar intensity of PMMA-related peaks suggests that SA has a limited effect on PMMA. This analysis provides essential information about the molecular interactions and structural changes occurring when SA is introduced into the PVC-PMMA thin film, highlighting the impact of the dopant on the film's chemical composition and structure.

Result from XRD Spectra and SEM and EDX analysis:

XRD of undoped and doped thin film show almost amorphous Nature. There are no sharp peaks in all the X-RD patterns. It is well known that the absence of peaks in intensity versus 2θ curve indicates that the (thin films) samples are amorphous in nature. Energy dispersive X-ray (EDX) was engaged for elemental analysis of the PVC-PMMA Polyblend without and with SA thin film. The EDX spectrum presented in Fig.1.11-1.12. Confirmed sharp peaks due to the following elements: fig 1.11 shows C (67.84%), O (13.21%) and Cl(18.94 %) and fig 1.12 shows C (56.81%), O (11.07%) and Cl (32.12 %) in addition to hydrogen. The occurrence of these elements will generate charges on the surface of the polymer and create electrostatic forces of attraction between the samples

Explanation from SEM Photography Scanning electron microscope images of the 1:2 PVC-PMMA blend without SA and with SA. The images exhibit heterogeneous structure in both blends. Fig 1.9 shows the morphology of blends show a phase separated region. The PVC domains are visualized as the hole s from which the material was pulled out. Systems the phase separations were observed. This is in agreement with result reported by (Yongseok Kim et al., 2008), (Rajendran S. et al, 2008).fig 1.10. Shows as dopant percentage increases. That is due to the increase in amorphousity. This is in agreement with XRD results.

CONCLUSIONS

In conclusion, the study investigated (1:2) PVC:PMMA blends doped with 8% salicylic acid. AC conductivity and dielectric constant variations were studied at different temperatures and frequencies, revealing nuanced interactions. FTIR analysis confirmed the successful incorporation of salicylic acid, impacting PVC but having a limited effect on PMMA. XRD patterns indicated an amorphous nature in both doped and undoped thin films. SEM images showed a heterogeneous structure, with increasing dopant percentages leading to higher amorphousity. Overall, the findings highlight the complex interplay of temperature, frequency, and dopant concentration on the electrical and structural properties of PVC:PMMA blends.

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Cupric Oxide (CuO) Doped Tin Oxide (SnO_2) MOS Multilayer CO_2 Gas Sensor

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ABSTRACT

Nanoparticles of cupric oxide and tin oxide are synthesized via liquid-phase method. The samples are prepared in the form of multilayer thick films by screen printing technique having based of alumina, samples having different mol % of tin oxide and copper oxide.

CO_2 gas concentration increases from 600 ppm to 1500 ppm, there is little increase of sensitivity, from 600 ppm to 1100 ppm, sensitivity increases linearly and becomes maximum at 1100 ppm. With further increase in CO_2 gas concentration, sensitivity increases by little amount. The XRD pattern of (CuO-SnO_2) 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 CO_2 gas. The response time is faster than recovery time. The sample A3 sensor (15CuO:85SnO_2) offers high sensitivity, rapid response and recovery to CO_2 gas.

Keywords: *Nanoparticles; CuO-SnO_2; multilayer thick films; CO_2 Gas Sensors*

INTRODUCTION

Semiconductor gas sensor is known as metal oxide semiconductor gas sensors. Metal oxide Semiconductor sensors (MOS) are also known as chemiresistive gas sensors and have been considered as solid-state gas-sensing materials [1-3]. Khanidtha Jantasom et al. 2013 [4] studied gas sensing properties of SnO_2-CuO Nanocomposites for CO_2 gas. XRD and SEM shows that SnO_2-CuO nanocomposites have a tetragonal and monoclinic structure respectively. It was observed that the nanocomposite products were highly sensitivity to CO_2 gas at room temperature. Satyendra Singh et al. 2014 [5] prepared CuO–SnO_2 nanocomposite by sol–gel route as a sensor by using screen printing methods are used to fabricate thin and thick film samples respectively. For CuO–SnO_2 thick and thin films maximum response. Shravanti Joshi et al. 2015 [6] used simple hydrothermal route method to form heterojunction nanocomposites between p-type CuO and n-type SnO_2 , which nanocomposite exhibited superior sensitivity with short response/recovery times. Fumin Ren et al. 2015 [7] for selectively sensing BTEX (benzene, toluene, ethylbenzene, and xylol) CuO/SnO_2 composites were prepared by a facile microwave-assisted approach. Gas sensing results shows that the sensor based on 3 mol% CuO/SnO_2 composite has the best selectivity and sensitivity. Arindam Das and

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Dipankar Panda 2019 [8] prepared functional metal oxide of SnO_2 tailored by CuO via a coprecipitation chemical route followed by annealing in air.

Many metal oxides are suitable for detecting combustible, reducing, or oxidizing gases by conductive measurements Composite metal oxides usually show better gas response than the single component if the catalytic actions of the components complement each other [9-10]. The main purpose of this work was to develop CuO doped SnO_2, nano-crystalline composites sensors which operate at relatively low temperature and sensitive in low possible detection limit with better selectivity.

EXPERIMENTAL

In the present work of paper, we have used sol-gel method (which is under liquid phase synthesis) for the synthesis of pristine nano-particles of CuO, SnO_2 and Al_2O_3 [11-13]. 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 CuCl:$6H_2O$ (0.2 M) was prepared. After addition of 1 ml of glacial acetic acid to above aqueous solution it was heated to 100^oC 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 70^0C for 24 hours so as to gets completely dried powder of CuO.

Synthesis of Tin Oxide (SnO_2)

For Synthesis of SnO_2 Stannous chloride dehydrate ($SnCl_2.2H_2O$), Ammonia Solution and de ionised water were used during reaction. All the chemicals used in this study were of GR grades are used without any further purification. 2 g (0.1 M) of stannous chloride dehydrate ($SnCl_2.2H_2O$) was dissolved in 100 ml water. When the complete dissolution occurs about 4 ml ammonia solution was added to this aqueous solution with continuous magnetic stirring. After the 20 minutes of stirring white gel precipitate was formed. This precipitate was allowed to settle for 12 hours. After this it was filtered and by using de-ionised water washed 2-3 times. The obtain precipitate were mixed with 0.27 g activated charcoal (carbon black powder). Then the powder was kept in vacuum oven at 70^oC for 24 hours so as to gets completely dried SnO_2 powder.

Synthesis of Alumina (Al_2O_3)

All chemicals used were analytical grade. Aluminium chloride, $AlCl_3$ (MOLYCHEM), 25% NH_3 solution (QUALIGEN Fine Chemicals) and polyvinyl alcohol (PVA) were used as raw materials for the synthesis of aluminium oxide nanoparticles. 1M alcoholic $AlCl_3$ 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 (Al_2O_3).

Fabrication of Sensors

Three series of the samples prepared were CuO:SnO_2 with Al_2O_3 base of multilayer sensors. The different combinations are shown in tables 1.

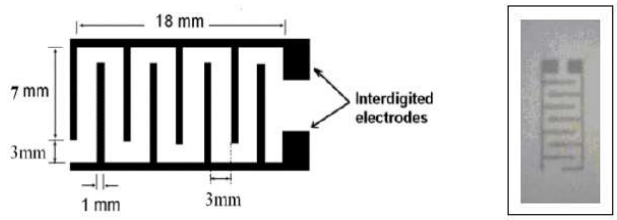
Table 1 Samples Codes of Series: CuO: SnO_2/Al_2O_3/GP

Sr. No.	Sample Codes	Composition of CuO (mole %)	Composition of SnO_2 (mole %)
1	A1	5	95
2	A2	10	90
3	A3	15	85
4	A4	20	80
5	A5	25	75
6	A6	30	70
7	PC	100	0
8	PS	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 though a fabric screen onto a substrate.

Multilayer preparation

Fig. 1 (a), and 1(b) show fabrication of interdigited electrodes, actual photographs of interdigited electrodes respectively.



(a) **(b)**

Fig. 1 (a) Fabrication of interdigited Electrodes (b) Actual photograph of interdigited electrodes

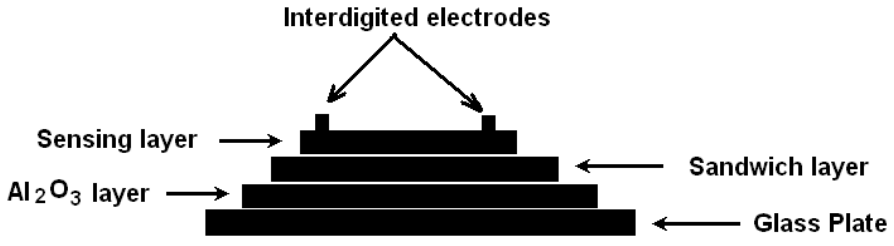


Fig.2 Design of multilayer Sensor

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, Interdigited electrodes were fabricated 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: SnO_2 / Al_2O_3/GP

The obtained product of fine nanopowder of CuO and SnO_2 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 SnO_2 (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 : SnO_2 system was further calcinated at temperature 800°C for 5hrs. in the auto-controlled 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: SnO_2 / Al_2O_3/GP Gas Sensors.

Sample Code	Composition Layers:---- Upper /Al_2O_3/Glass plate (GP)	Thickness (x 10^{-4} cm) Upper Layer(1)	Al_2O_3 Layer(2)	Total (1+2)
A1	05CuO:95SnO_2/ Al_2O_3/GP	4.1	29.3	33.4
A2	10CuO:90SnO_2/ Al_2O_3/GP	3.8	28.5	32.3
A3	15CuO:85SnO_2/ Al_2O_3/GP	2.6	29.7	32.3
A4	20CuO:80SnO_2/ Al_2O_3/GP	3.9	28.8	32.7
A5	25CuO:75SnO_2/ Al_2O_3/GP	4.9	28.1	33
A6	30CuO:70SnO_2/ Al_2O_3/GP	4.1	30.2	34.3

Electrical Measurements

Electrical measurements were performed with a Keithley 6487 voltages source cum picoammeter using setup shown in fig. 3. A constant voltage source in the range 1 to 10V is supplied to the sensor electrodes and the current through the sensor measured. The sensor resistance can be calculated by using Ohm's law. The range of voltage used is between $\pm$10 V, in increment of 1V.

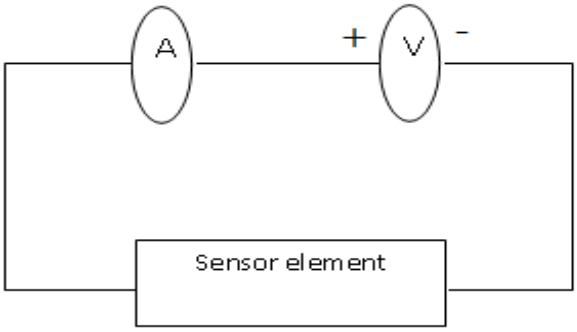


Fig.3 Circuit Configuration of Electrical Measurement

RESULTS AND DISCUSSION

XRD of CuO &SnO_2 Nanomaterial and their dopings

The average crystallite size was calculated by Debye-Scherer's equation with the help of XRD patterns as shown in figure 4. 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-Scherer'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).

All the peaks are showing very sharp; it observed that there is no impurities means the prepared sample is having high purity. The peaks position and (h k l) values mentioned, some of the (h k l) values shows bar on the top, it means that the negative direction of the corresponding (h k l). From table 3, it is exhibited that the A3 sample 15CuO:85SnO_2 has small crystalline size [14].

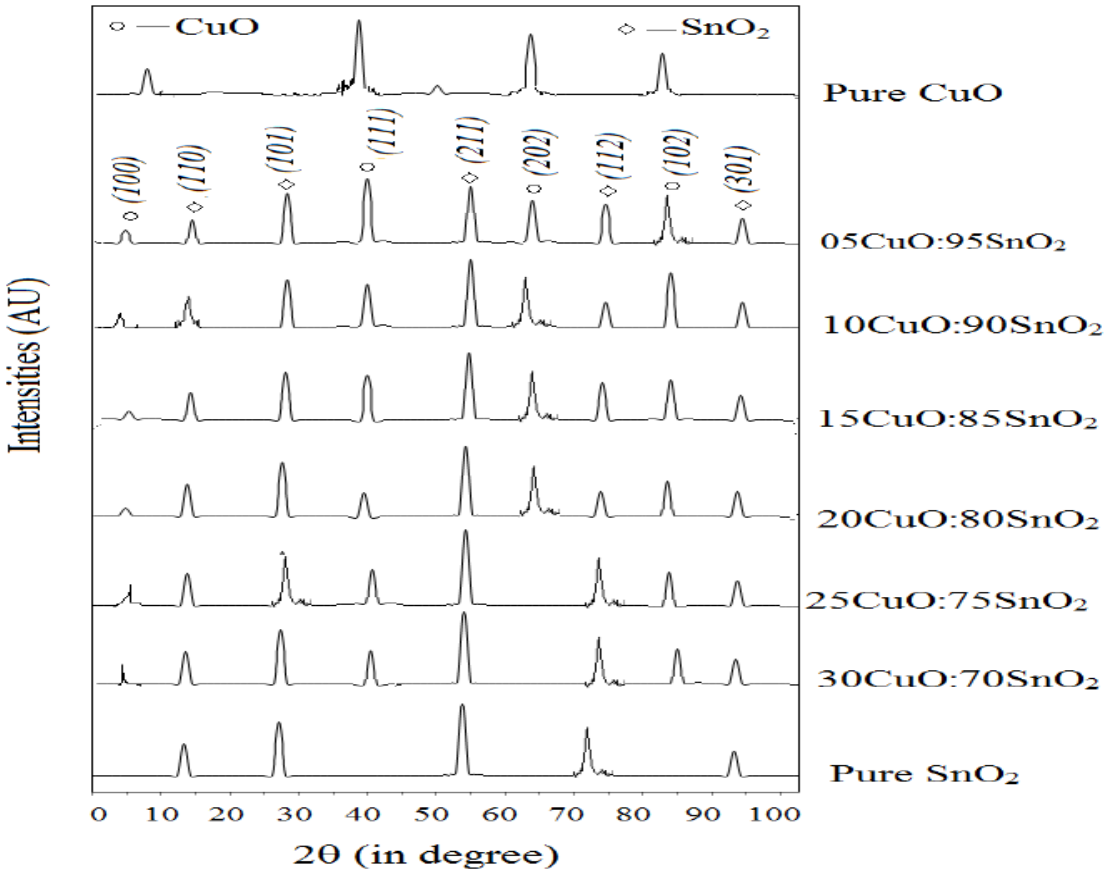


Fig.4. XRD spectra of Pure CuO, Pure SnO_2 and CuO doped with SnO_2 Nanomaterial

Table 3. Average crystallite size of CuO, SnO_2 and doping

Sample Code	Chemical Composition of CuO:SnO_2 (mole %)	Maximum Intensity Peak Position (2θ) degree	FWHM (2θ) degree	Average Crystallite Size (D) in nm
PC	Pure CuO	43.32	0.1865	162.22
A1	05CuO:95SnO_2	49.11	0.2522	122.45

A2	10CuO:90SnO_2	54.65	0.1934	153.31
A3	**15CuO:85SnO_2**	**55.71**	**0.2312**	**89.65**
A4	20CuO:80SnO_2	55.02	0.1832	113.43
A5	25CuO:75SnO_2	54.12	0.2433	154.18
A6	30CuO:70SnO_2	54.44	0.2132	167.87
PS	Pure SnO_2	53.04	0.2823	132.34

Scanning electron microscopy (SEM) Analysis

From SEM picture (figure 5 (a) to (c)), it is observed that all the samples viz. Al_2O_3, CuO, SnO_2 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 [11-14] 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 SnO_2 , nano materials were studied by SEM and its picture is shown in the Fig. 5

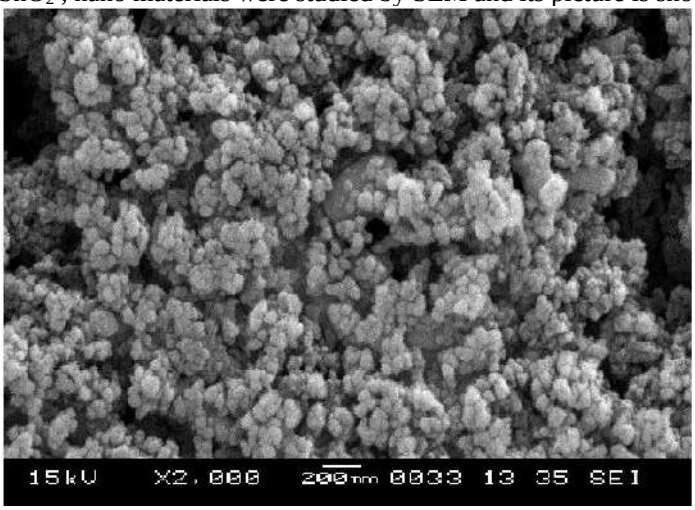


Fig. 5 (a) *SEM picture of Al_2O_3*

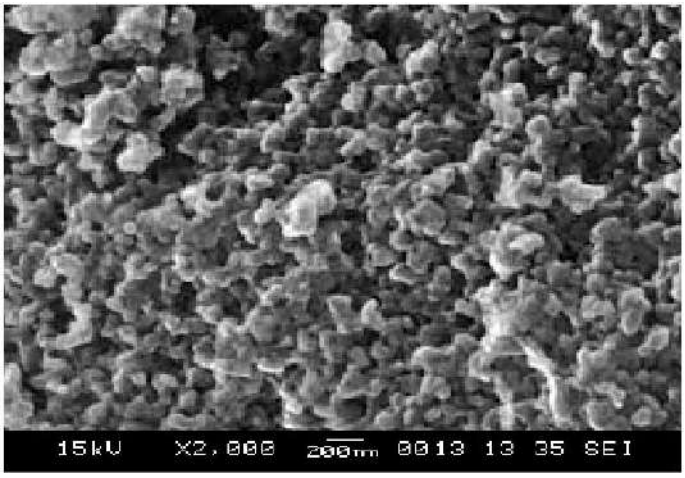


Fig. 5 (b) *SEM picture of CuO*

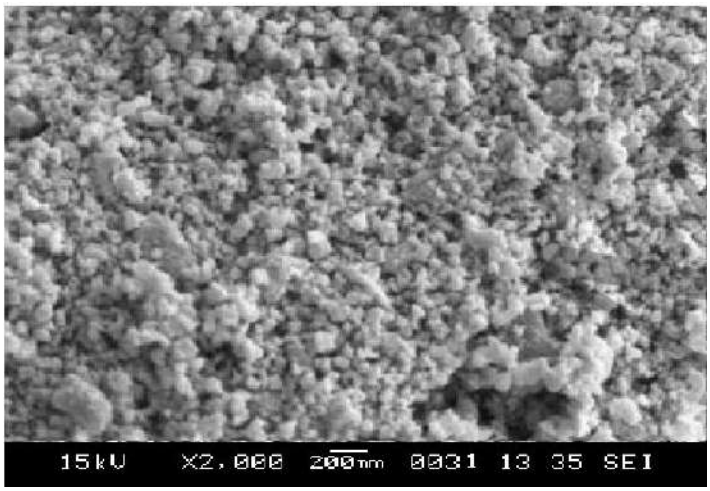


Fig. 5 (c) *SEM picture of SnO_2*

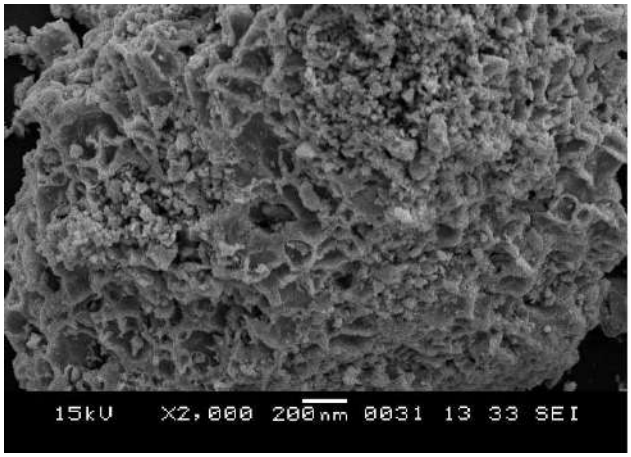


Fig. 6 (a) *SEM picture of 05CuO:95SnO_2*

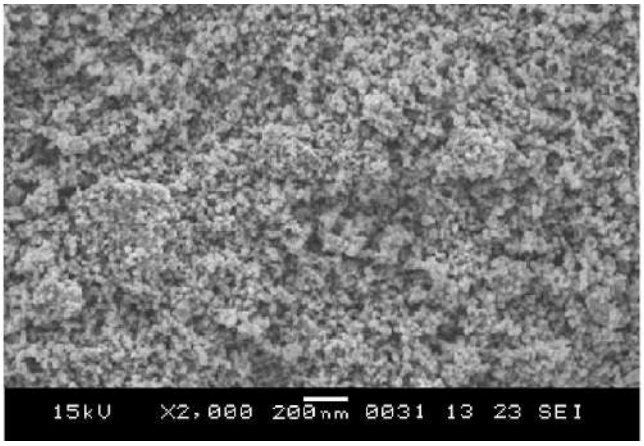


Fig. 6 (b) *SEM picture of 10CuO:90SnO_2*

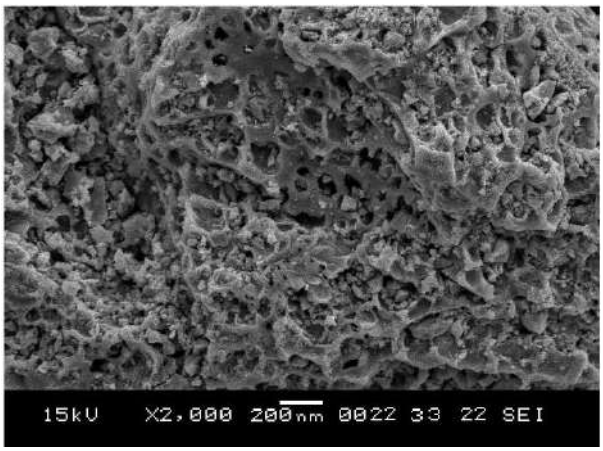


Fig. 6 (c) *SEM picture of 15CuO:85SnO₂*

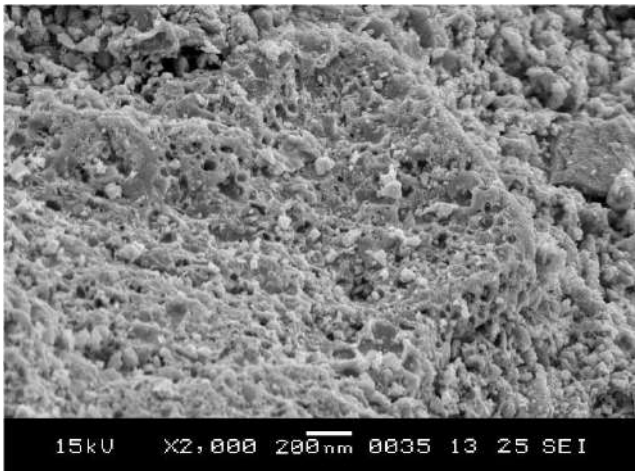


Fig. 6 (d) *SEM picture of 20CuO:80SnO₂*

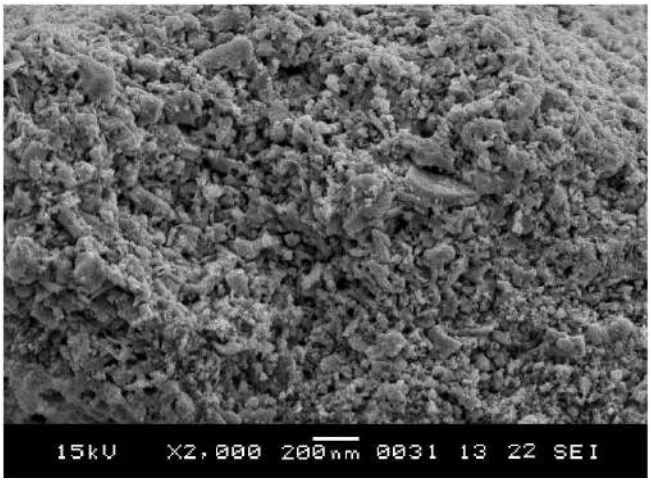


Fig. 6 (e) *SEM picture of 25CuO:75SnO₂*

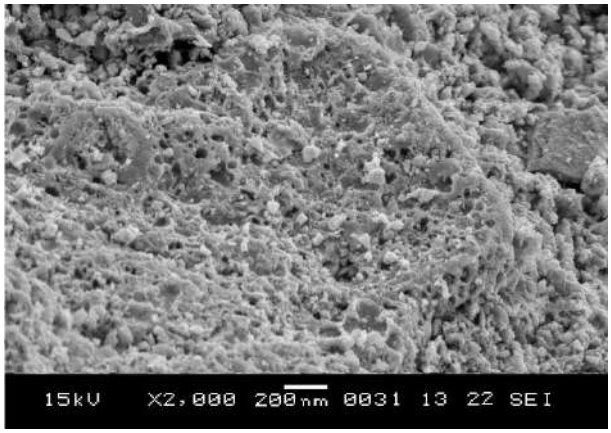


Fig. 6 (f) *SEM picture of 30CuO:70SnO_2*

The surface morphologies of pure Al_2O_3, CuO, SnO_2, and their dopings materials were studied by SEM and its picture are shown in the figures 5 to 6. 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 [14].

Table 4. shows the average diameter and number of pores per inch of pure Al_2O_3, CuO, SnO_2, 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_2O_3	95	154
PC	CuO	80	172
PS	SnO_2	87	160
A1	05CuO:95SnO_2	72	183
A2	10CuO:90SnO_2	78	171
A3	**15CuO:85SnO_2**	**59**	**206**
A4	20CuO:80SnO_2	69	192
A5	25CuO:75SnO_2	65	195
A6	30CuO:70SnO_2	75	157

From the SEM pictures (table 4), it is observed that 15CuO:85SnO_2, 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 [14-15]. It is also found that average diameter of pore in case of 15CuO:85SnO_2 are small as compared to other doping. This also tends to exhibit large surface area and exhibited high response of the samples.

Detection of CO_2 gas: Gas Sensing Properties

CO_2 acts as an oxidizing agent in some chemical reactions, such as the production of carbonates. It can also participate in redox reactions, where it can accept electrons and become reduced and hence its resistance increases with increase of CO_2 gas concentration [16]. The sensitivity of the sensor is given by,

$$S = \left(\frac{R_{gas} - R_{air}}{R_{air}} \right) = \left(\frac{\Delta R}{R_{air}} \right)$$

Where, R_{gas} = resistance of the sensor in presence of gas and
R_{air} = resistance of the sensor in air

The variations of sensitivities and sensors with concentration of CO_2 gas at room temperature are shown below.

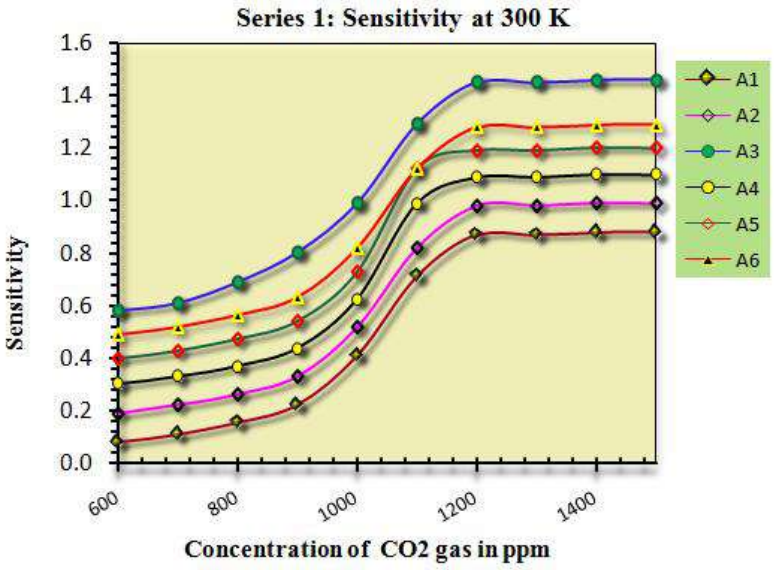


Fig. 7: The variations of sensitivity with CO_2 gas concentration

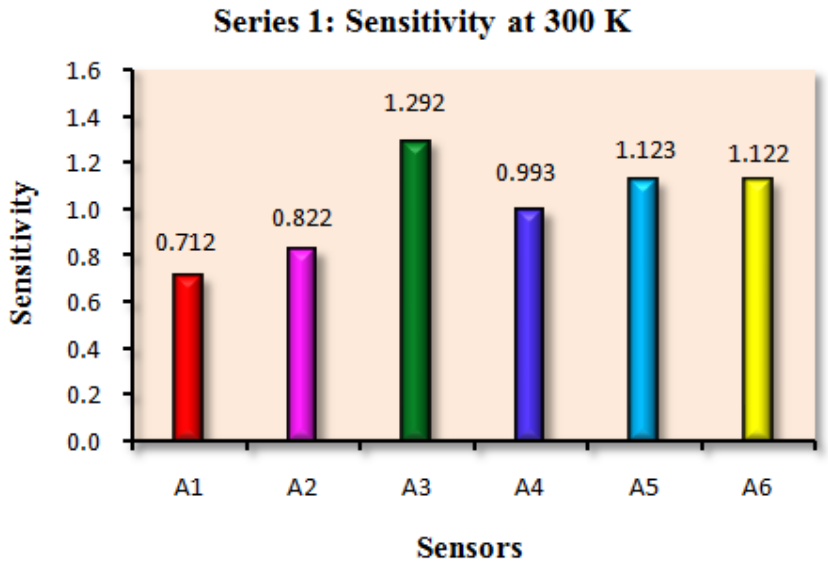


Fig. 8: Sensitivity of different sensors at 1100 ppm

From CO_2 gas detection [17-18] graphs (Fig. 7 and 8) it is observed and manifested that: As CO_2 gas concentration increases from 600 ppm to 1500 ppm, there is little increase of sensitivity, from 600 ppm to 1100 ppm, sensitivity increases linearly and becomes maximum at 1100 ppm. With further increase in CO_2 gas concentration, sensitivity increases by little amount. From Fig. 8, sensitivity was found to be 1.292 (maximum) for A3 sensor ($15CuO:85SnO_2$) amongst the prepared sensors.

CONCLUSIONS

The XRD pattern of (CuO-SnO_2) system samples shows 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 CO_2 gas. The response time is faster than recovery time therefore the A3 sensor ($15CuO:85SnO_2$) is found to optimized sensor for CO_2 gas.

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Synthesis and Characterisation of Cupric Oxide (CuO) Doped Tungsten Oxide (WO_3) Multilayer Thick Films[1]

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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-WO_3. The XRD pattern of (CuO-WO_3) 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:75WO_3) is found to optimized multilayer thick film.

Keywords: *Sol-Gel Method; (CuO-WO_3); 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.

WO_3 films are more attractive due to their high catalytic behavior on the surface of the film. The resistance of the WO_3 increases & decreases in the presence of oxidizing and reducing gases respectively. WO_3 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 WO_3 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 WO_3 thick films. CuO doped and undoped WO_3 thick films gas sensors were prepared using screen-printing method on alumina substrates. A structural properties of WO_3:CuO thick films had monoclinic phase and triclinic phase of WO_3 together. Artur Rydosz et al. 2014 [14] investigated results on nanocrystalline CuO and WO_3 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 (WO_3) thin films Cupric oxide (CuO) thin films were deposited by RF magnetron sputtering. FuchaoYang et al 2018 [16] worked on acetone odor detection. With the formation of the interfacial heterojunction, the WO_3@CuO

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shows the best sensing performance. Soo-Yeon Cho et al. 2019 [17] fabricated 10 nm scale p−n heterojunction nanochannel with ultrasmall grained WO_3/CuO nanopatterns to study ethanol sensing. WO_3/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, WO_3 and Al_2O_3, and also (CuO-WO_3) 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, WO_3 and Al_2O_3 [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 CuCl:$6H_2O$ (0.2 M) was prepared. After addition of 1 ml of glacial acetic acid to above aqueous solution it was heated to 100^{o}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 70^0C for 24 hours so as to gets completely dried powder of CuO.

Synthesis of Tungsten Oxide (WO_3)

For Synthesis of WO_3 particles were simply precipitation method was used. Firstly, Sodium tungstate (Na_2WO_4) 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 100^0C in an oven for 1 hour and further the precipitates were passed from calcination processes in muffle furnace at 500^0 C for 4 hours to get WO_3 powder.

Synthesis of Alumina (Al_2O_3)

All chemicals used were analytical grade. Aluminium chloride, $AlCl_3$ (MOLYCHEM), 25% NH_3 solution (QUALIGEN Fine Chemicals) and polyvinyl alcohol (PVA) were used as raw materials for the synthesis of aluminium oxide nanoparticles. 1M alcoholic $AlCl_3$ 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 (Al_2O_3).

Fabrication of Sensors

Three series of the samples prepared were CuO:WO_3 with Al_2O_3 base of multilayer sensors. The different combinations are shown in tables 1.

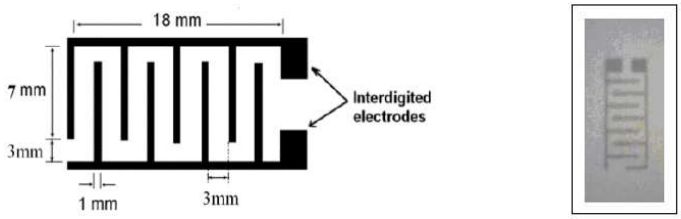
Table 1 Samples Codes of Series: CuO: WO_3/Al_2O_3/GP

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 though a fabric screen onto a substrate.

Multilayer preparation

Fig. 1 (a), and 1(b) show fabrication of interdigited electrodes, actual photographs of interdigited electrodes respectively.



(a) **(b)**

Fig. 1 (a) Fabrication of interdigited Electrodes (b) Actual photograph of interdigited electrodes

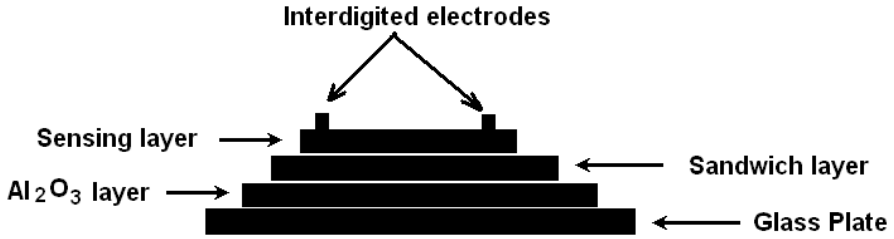


Fig.2 Design of multilayer Sensor

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, Interdigited 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 : WO_3system 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: WO_3 / Al_2O_3/GP Gas Sensors.

Sample Code	Composition Layers:---- Upper /Al_2O_3/Glass plate (GP)	Thickness (x 10^{-4} cm)		
		Upper Layer(1)	Al_2O_3 Layer(2)	Total (1+2)
B1	05CuO:95 WO_3/ Al_2O_3/GP	4.1	29.3	33.4
B2	10CuO:90 WO_3/ Al_2O_3/GP	3.8	28.5	32.3
B3	15CuO:85 WO_3/ Al_2O_3/GP	2.6	29.7	32.3
B4	20CuO:80 WO_3/ Al_2O_3/GP	3.9	28.8	32.7
B5	25CuO:75 WO_3/ Al_2O_3/GP	4.9	28.1	33
B6	30CuO:70 WO_3/ Al_2O_3/GP	4.1	30.2	34.3

RESULTS AND DISCUSSION

XRD of CuO &WO_3 Nanomaterial and their dopings

The average crystallite size was calculated by Debye-Scherer'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-Scherer'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 WO_3, is observed at 23.21^o and this peak corresponds to the plane (0 2 0) of WO_3 in monoclinic structure (JCPDS Card No.3-1124) with 100% intensity. The other peaks of WO_3 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 WO_3. This manifested that the WO_3 is well crystallized. As compared with diffraction peaks of WO_3, those of CuO are wide and weak due to small grain sizes [22]. From table 3., it is seen that the sample 25CuO:75 WO_3 has small crystalline size.

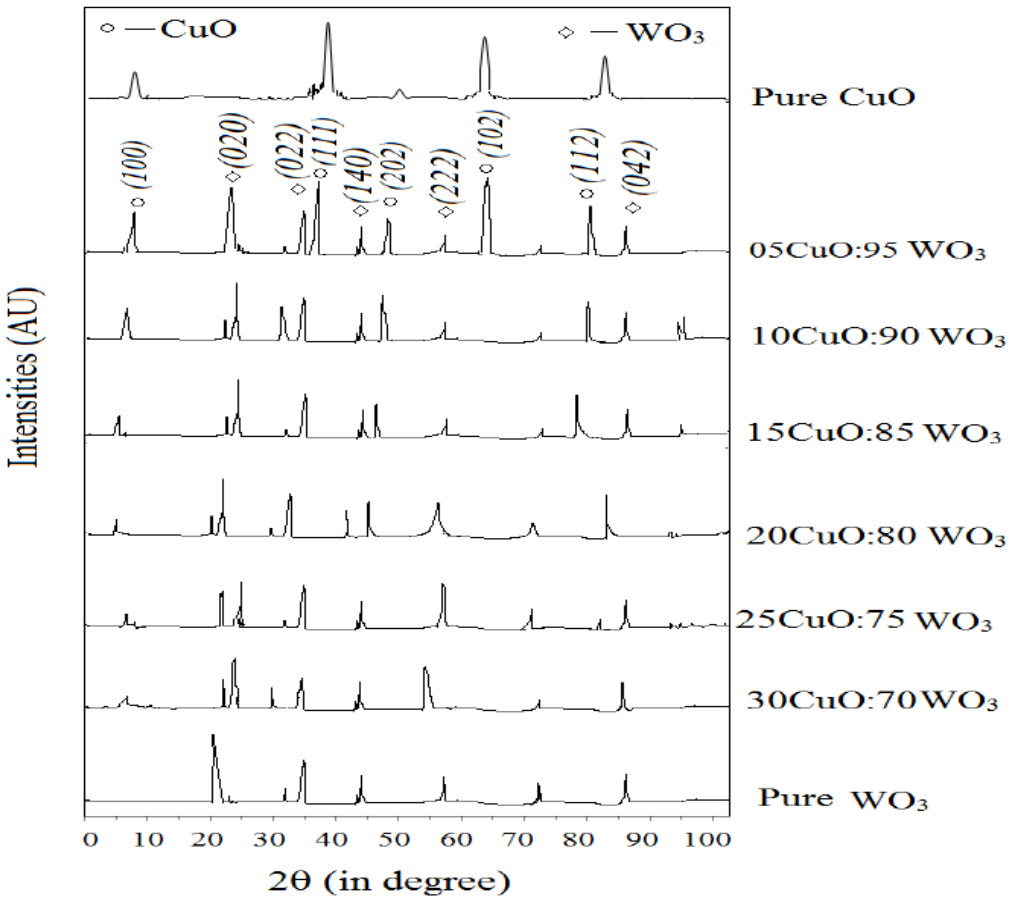


Fig.3. XRD spectra of Pure CuO, Pure WO_3 and CuO doped with WO_3 Nanomaterial

The crystallite size (D) of WO_3 and CuO doped WO_3 was calculated from Scherer's formula using FWHM and it is listed in the table 3, as below.

Table 3. Average crystallite size of WO_3 and CuO doped WO_3

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 WO_3	**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.

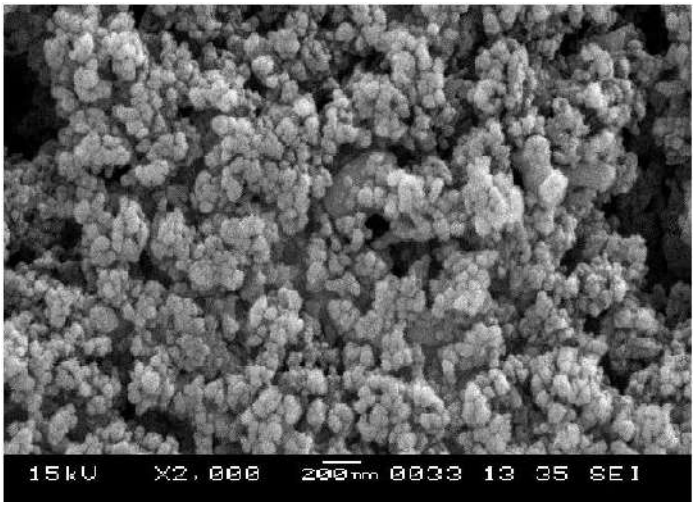


Fig. 4 (a) *SEM picture of Al_2O_3*

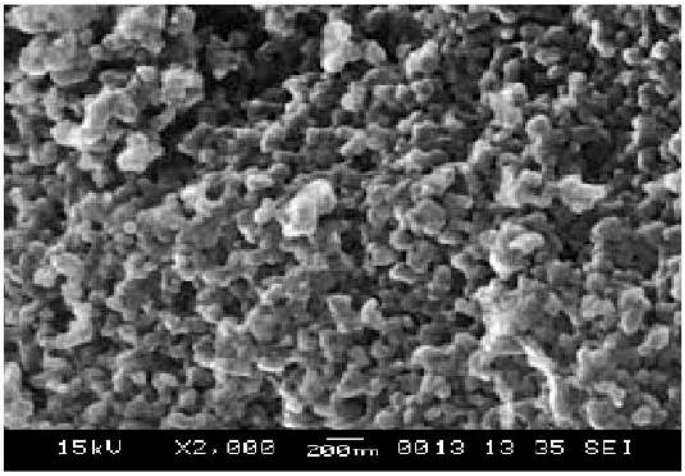


Fig. 4 (b) *SEM picture of CuO*

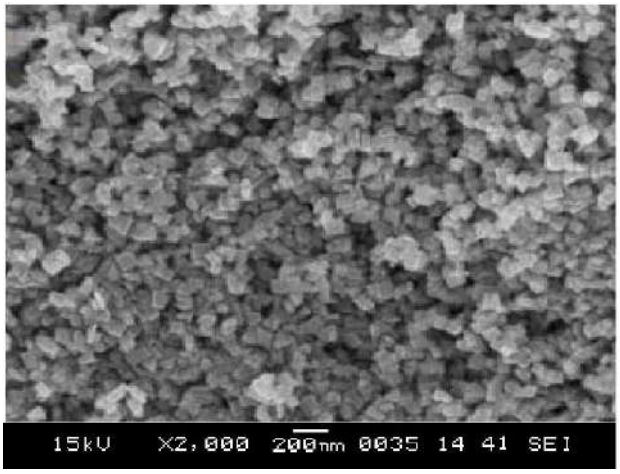


Fig. 4 (c) *SEM picture of WO_3*

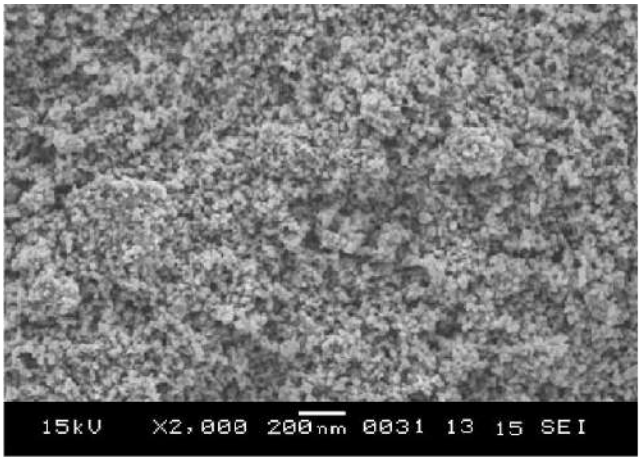


Fig. 4 (d) *SEM picture of 05CuO:95WO_3*

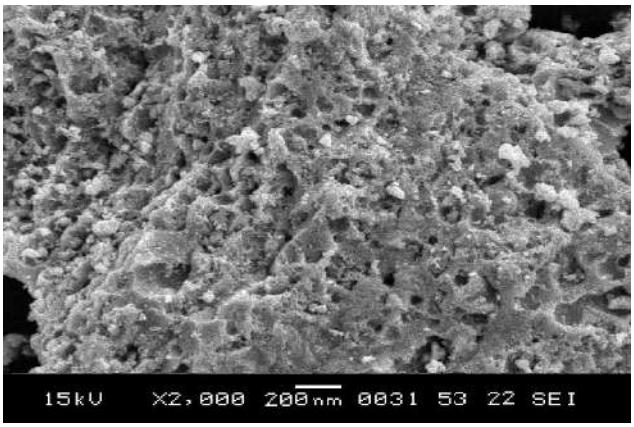


Fig. 4. (e) *SEM picture of 10CuO:90WO_3*

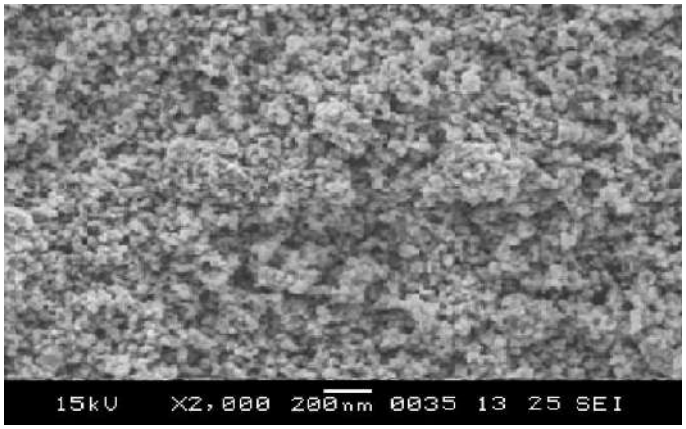


Fig. 4. (f) *SEM picture of 15CuO:85WO_3*

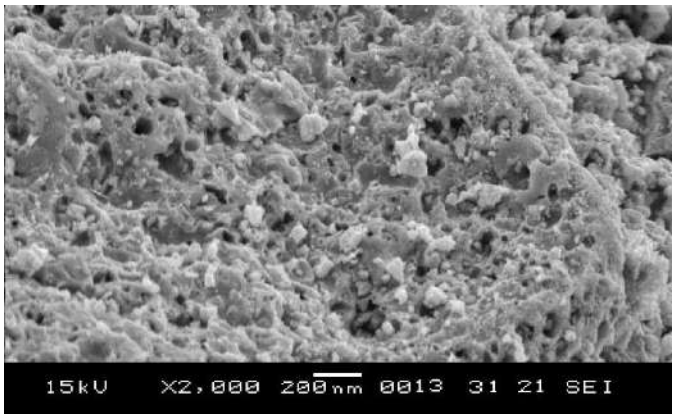


Fig. 4. (g) *SEM picture of 20CuO:80WO_3*

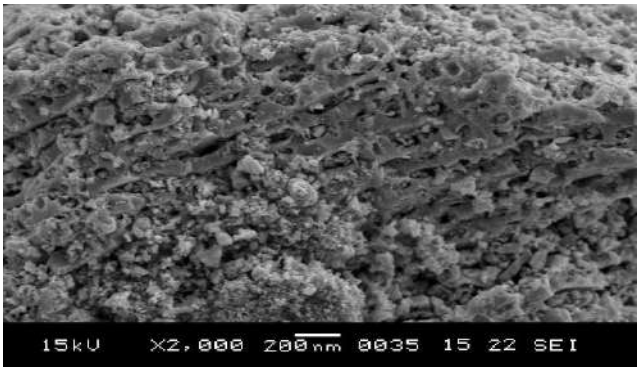


Fig. 4 (h) *SEM picture of 25CuO:75WO_3*

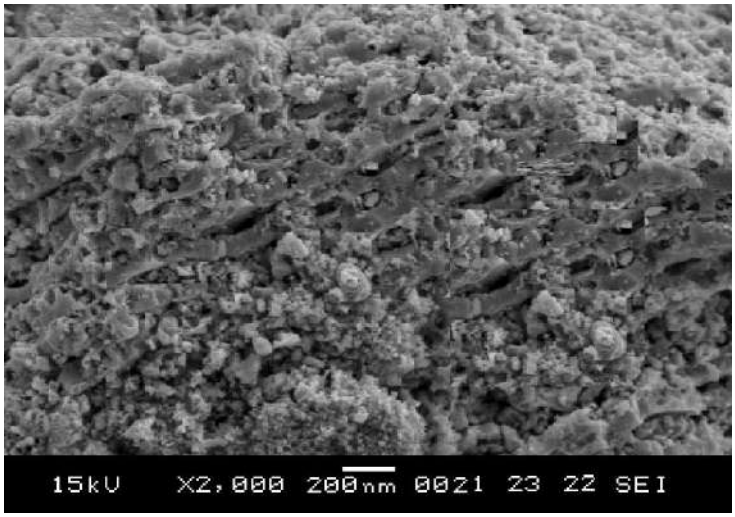


Fig. 4. (i) *SEM picture of 30CuO:70WO_3*

Fig. 4. SEM picture of Samples of Series CuO:WO_3

The surface morphologies of pure Al_2O_3, CuO, WO_3, 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 Al_2O_3, CuO, WO_3 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_2O_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:75WO_3**	**52**	**218**
B6	30CuO:70WO_3	71	177

From the SEM pictures (table 4), it is observed that, Sample Code B5 i.e. (**25CuO:75WO_3)**, 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:75WO_3)** 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-WO_3) 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:75WO_3)** is found to optimized multilayer thick film sensor.

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Electrical Response of PVC-PMMA Thin Films: A Comprehensive Investigation into the Effects of Frequency, Temperature, and Salicylic Acid Dopant[1]

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ABSTRACT

This research delves into the electrical properties of Polyvinyl Chloride (PVC) - Polymethyl Methacrylate (PMMA) Polyblend thin films with a 1:1 weight ratio, investigating the impact of varying salicylic acid (SA) dopant percentages (0%, 2%, 4%, 6%, 8%). Film fabrication employed the isothermal evaporation technique, and AC conductivity measurements were conducted across a frequency range of 25 Hz to 1 MHz at temperatures of 313 K, 323 K, 333 K, 343 K, and 353 K. The primary focus of this study is on the variations in dielectric constant and AC conductivity concerning temperature, frequency, and dopant percentage.

Keywords: *PVC-PMMA; AC conductivity; Dielectric constant; frequency; salicylic acid*

INTRODUCTION

Polyvinyl Chloride (PVC) and Polymethyl Methacrylate (PMMA) Polyblend thin films have emerged as a subject of considerable interest in materials science due to their versatile properties and potential applications in various fields. The combination of PVC and PMMA, two distinct polymers with contrasting characteristics, offers a unique platform for tailoring the properties of thin films to meet specific requirements. In the realm of polymer blending, the addition of dopants further expands the scope for manipulating the physical and electrical characteristics of these films. This study focuses on PVC-PMMA Polyblend thin films, with particular emphasis on the incorporation of salicylic acid (SA) as a dopant. Salicylic acid is chosen for its potential influence on the electrical properties of the Polyblend, and its incorporation into the polymer matrix is facilitated through the use of Tetrahydrofuran (THF) as a solvent during the thin film preparation process. THF, a common and versatile solvent, plays a crucial role in ensuring the uniform dispersion of the polymers and dopant, leading to well-defined thin films with controlled morphologies. The fabrication of these thin films using the isothermal evaporation technique allows for precise control over the film composition, enabling a systematic exploration of the effects of varying SA dopant concentrations. The electrical properties, particularly the AC conductivity and dielectric constant, are investigated across a range of temperatures and frequencies. Understanding the interplay between temperature, frequency, and dopant concentration is essential for optimizing the performance of these polyblend thin films for potential applications in electronic devices, sensors, and other advanced technologies.

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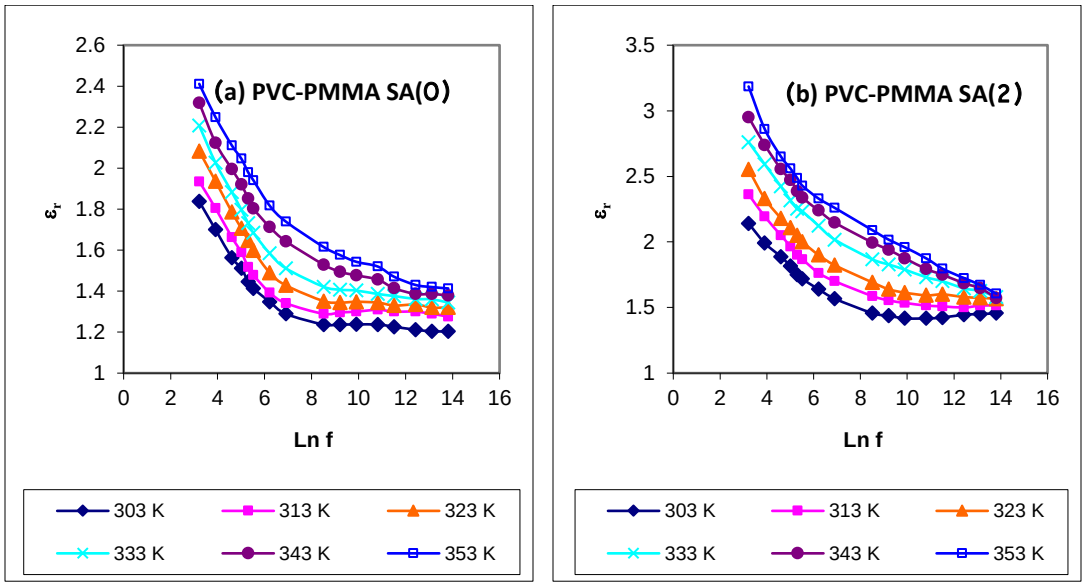
Polymer blends and composite materials are widely used in various industrial applications due to their unique properties. Polyvinyl Chloride (PVC) and Polymethyl Methacrylate (PMMA) are two common polymers known for their versatility and widespread applications. In this study, we investigate the effect of salicylic acid (SA) as a dopant on the structural and chemical properties of PVC-PMMA thin films. SA is a compound with a phenolic structure, and its introduction into the polymer matrix may lead to changes in film properties, making it an interesting area of study.

EXPERIMENTAL

Thin films of PVC-PMMA with different dopant concentrations were prepared using the isothermal evaporation technique. Preparation of a Polyblend thin film of PVC-PMMA in 1:1 weight proportional, the dopant and the polymer mixture were dissolved in a solvent (THF) were mixed in solution form .for a complete Homogeneous solution was kept for two or three days. after two or three days solution are in a homogeneous form then the solution mixture was poured onto a perfectly planed glass plate floating freely in a pool of mercury for perfect levelling .it was thereafter allowed to evaporate at room temperature further, and it was dried for 2 days to remove any traces of solvent. the dry film removes from the glass plate and cuts into pieces of desired size then measure the thickness of the thin film by DIGMATIC micrometer, which was then coated on two sides with silver paint then by using the multimeter check whether the two electrodes working or not .then investigate the conductivity .Two sets of films were fabricated: one without salicylic acid (0% dopant) and the other with 2%,4%,6%, 8% salicylic acid as the dopant. AC conductivity measurements were performed using an LCR meter, covering a frequency range of 20 Hz to 1 MHz. The measurements were carried out at five different temperatures 313 K, 323 K, 333 K, 343 K, and 353 K.

GRAPH RELATED FOR DIELECTRIC CONSTANT AND AC CONDUCTIVITY



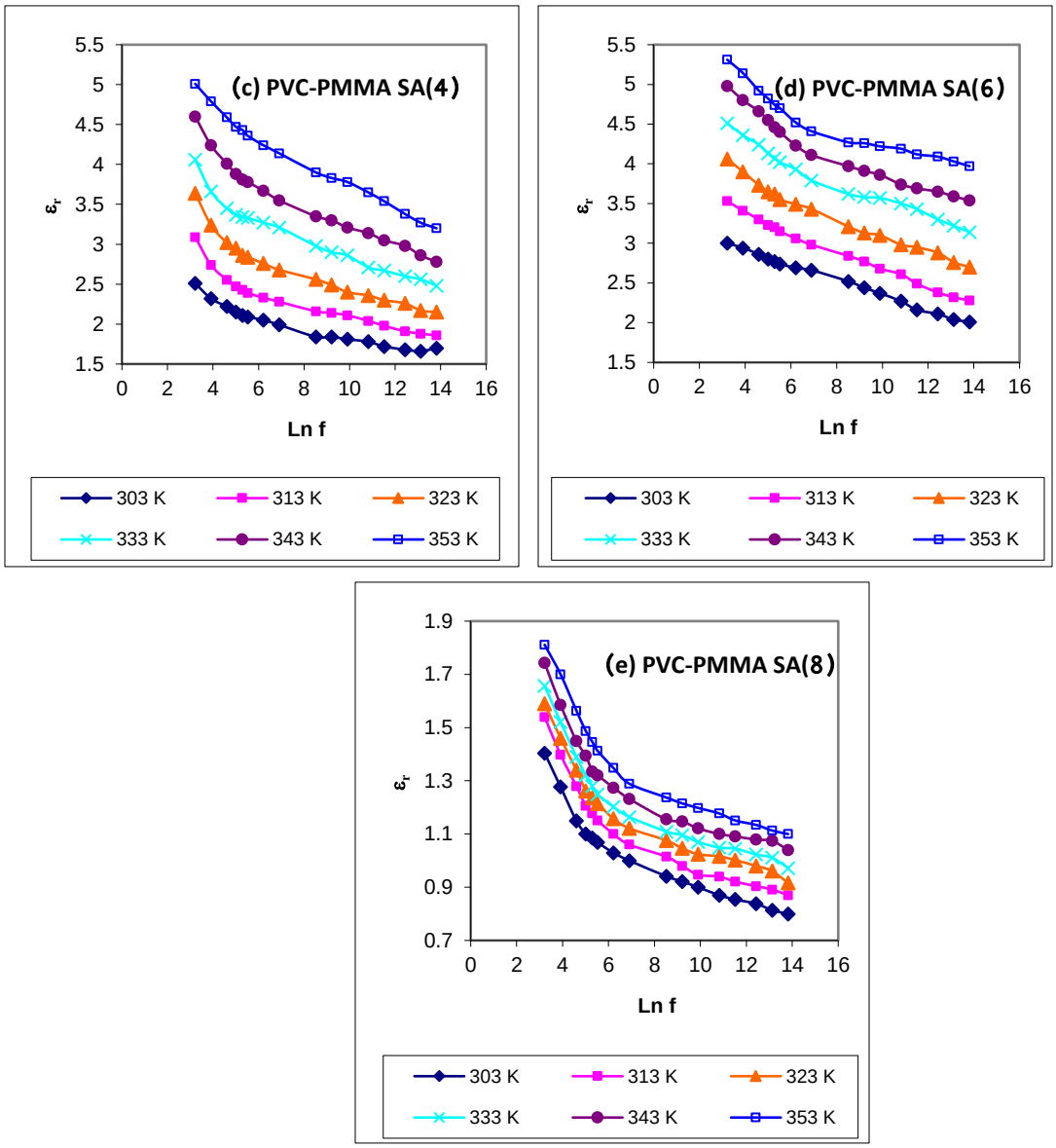
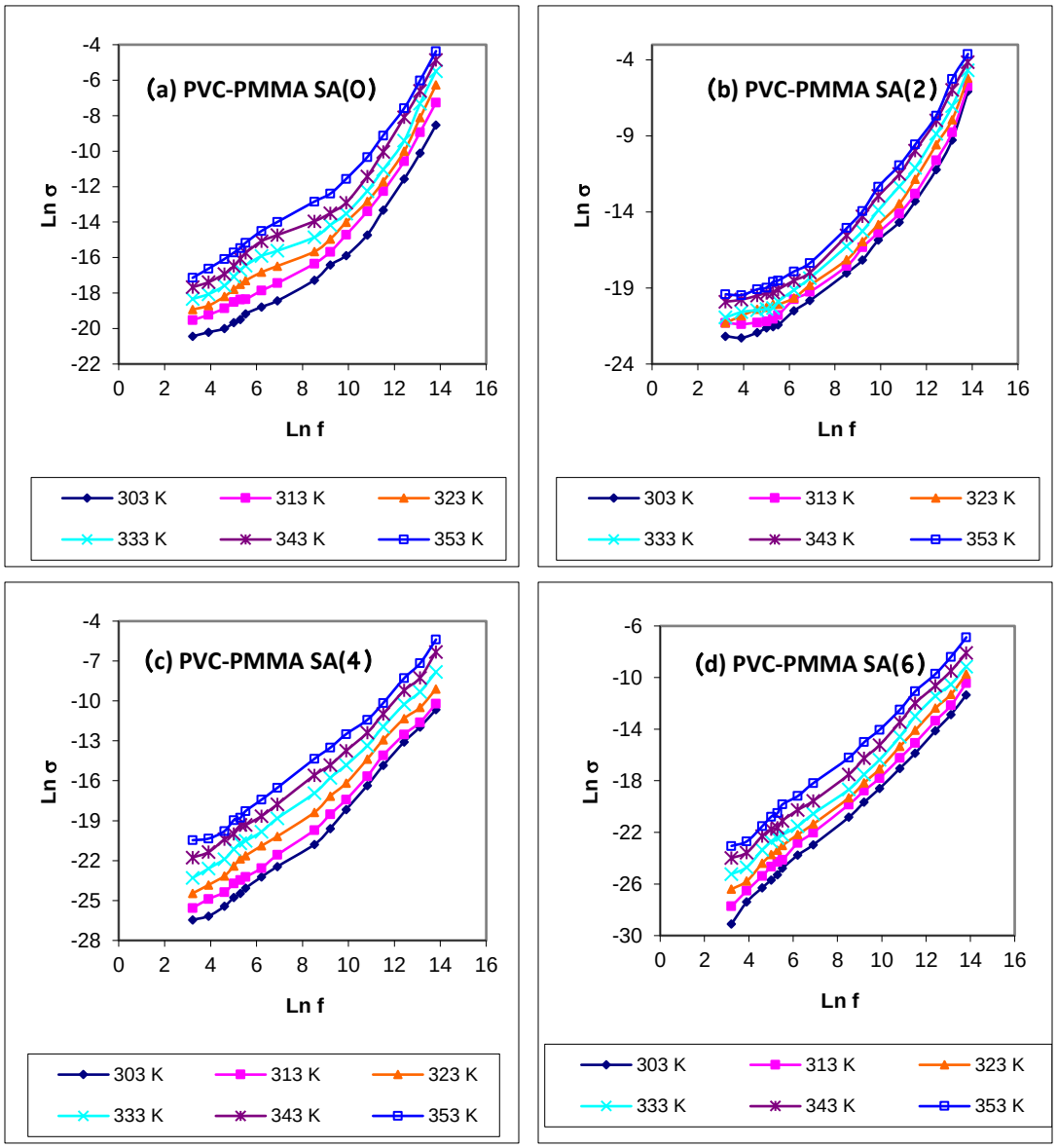


Figure 1.1 (a-e): Variation of ε_r with Ln f at different temperatures for 1:1 PVC-PMMA doped with different wt% of SA


(a) PVC-PMMA SA(0)
(b) PVC-PMMA SA(2)
(c) PVC-PMMA SA(4)
(d) PVC-PMMA SA(6)
Ln σ
Ln f
303 K
313 K
323 K
333 K
343 K
353 K

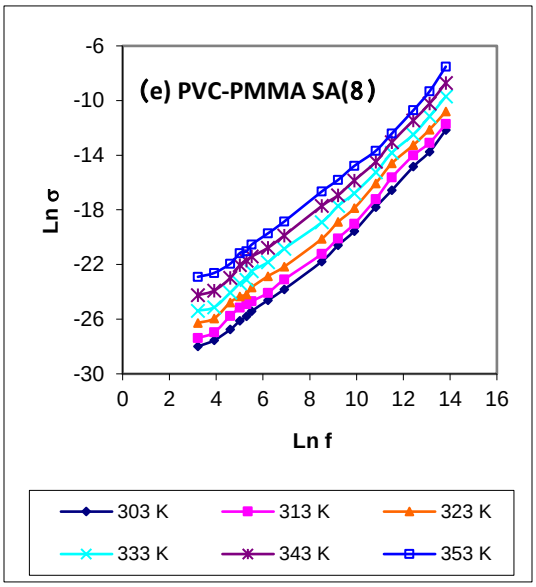


Figure 1.2 (a-e): Variation of Ln σ with Ln f at different temperatures for 1:1 PVC-PMMA doped with different wt% of SA

RESULTS AND DISCUSSION

In this section, we examine the behavior of PVC-PMMA thin films with and without a dopant (Salicylic Acid) with respect to alternating current (AC) conductivity and dielectric constant. We observe how these properties are influenced by frequency, temperature and dopant.

At constant temperature, Dielectric Constant decreases the increase of frequency

At constant temperature, Dielectric constant increases with the percentage of dopant and then decreases

At constant temperature, AC conductivity (σac) increases with increase in frequency

At constant frequency, AC Conductivity (σac) very marginally increases with the increase of temperature

At constant frequency, AC conductivity (σac) gradually decreases with the increase in the dopant percentage

In our study, we observed a decrease in the dielectric constant of our samples as the frequency increased Fig 1.1(a-e) this can be explained by considering the polarization and polarizability of the dielectric samples. In practical scenarios, a dielectric faces an alternating current (AC) field, changing its direction over time. The ability of dipoles to align with the field during each alternation affects the total polarization. The relative permittivity, measuring polarization, behaves differently at various frequencies. When a dielectric is placed in an electric field between capacitor plates, polarization occurs. This polarization aligns polar species with the applied field and alters the distribution of electric charges in the dielectric. Under a static or low-frequency AC field, the net polarization involves electronic, atomic, and orientation polarization. However, at higher frequencies, the orientation polarization struggles to keep up with field variations, causing a decrease in dielectric constant.

Effect of Frequency on AC Conductivity We observed an increase in AC conductivity (σac) with higher frequencies at various constant temperatures in Fig 1.2(a-e). Let's break down why this happens: Imagine you have a capacitor with a dielectric material. When this capacitor is charged under an alternating current (AC) voltage or electric field described by $E = E \cos \omega t$, certain phenomena come into play. These include ohmic resistance, impedance, heat absorption, and the Debye relaxation process, all contributing to the frictional resistance within the system. In simpler terms, as the AC voltage is applied, a loss current occurs due to these factors. This loss current is essentially the movement of charge carriers experiencing resistance and undergoing processes like Debye relaxation, resulting in a

conversion of electrical energy into heat. In summary, the increase in AC conductivity with frequency is a consequence of the capacitor's response to the changing electric field, leading to higher loss currents and enhanced conductivity.

Effect of Dopant (SA) on Dielectric Constant The dielectric constant of samples gets increased with increase in dopant percentage. If we again increase dopant percentage then dielectric constant decreases. Effect of Dopant (SA) on AC Conductivity AC conductivity gets decreased with increase in dopant percentage. As the salicylic acid is least interested in making any kind of association with PVC-PMMA blend, its presence becomes unnecessary. This stranger particle may exert its overshadowing impact on the functional sites of the poly-blends. This may be the reason for decrease in conductivity with increase in dopant percentage.

CONCLUSION

The observed trends highlight the complex interplay of frequency, temperature, and dopant concentration on the electrical properties of PVC-PMMA thin films. These findings contribute valuable insights for applications involving dielectric materials, providing a foundation for further exploration and optimization of these materials in various technological contexts. Understanding these behaviors is crucial for the development of advanced electronic devices and materials with tailored electrical characteristics.

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Electrical Applications of SnO_2 doped with ZnO Ammonia gas sensor

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ABSTRACT

SnO_2 and ZnO are prepared using stannous chloride and zinc chloride with water as a solvent. Nanocrystalline SnO_2-ZnO composite thick films are created through screen printing technique. The structure is examined using field emission scanning electron microscopy (FE-SEM).The FE-SEM shows nanocrystalline spherical stannous oxide and ZnO rod shapes.

Keywords: SnO_2, ZnO, Ammonia gas sensor

I. INTRODUCTION

The rapid industrial growth across various sectors has led to environmental pollution, posing a significant threat to human health and the ecosystem. To address this issue, the development of highly sensitive and selective sensors for detecting hazardous gases in the atmosphere is crucial. Metal oxide-based nanocrystalline chemical sensors have emerged as promising options due to their reliability and ease of production.

To enhance sensor sensitivity, various techniques are employed, such as using composite systems of nanomaterials, altering composition, reducing particle size, surface modification, and experimenting with different chemicals. Smaller particle sizes result in increased surface area, promoting greater gas diffusion and reactivity on the sensor surface, thereby enhancing sensitivity.

Researchers initially focused on single metal oxide-based sensors, but they exhibited drawbacks such as low sensitivity, selectivity to gases with similar characteristics, and longer response/recovery times. The use of composite metal oxide-based nanomaterial systems has shown promise in improving sensor performance. Sensitivity and selectivity can be enhanced by utilizing mixtures of metal oxides or composite systems.[1-3]

The electronic structure of nanocrystals in composite sensors can be altered through interactions between different components, leading to increased reactivity with target gases. Adjusting the composition, structure, and work function of nanocomposite sensors significantly improves selectivity. Moreover, modifying chemical components or their quantities offers opportunities to enhance sensitivity

In summary, the development of advanced sensors, particularly those based on composite metal oxide nanomaterials, is vital for effectively detecting and addressing the challenges posed by environmental pollution resulting from industrial activities.[4]

To improve the characteristics of gas sensors, researchers have explored mixed metal oxide systems. Adding a small quantity of ZnO to CuO-doped SnO_2, for instance, shifted the temperature sensitivity of CO to a higher range [5]. These mixed metal oxide systems fall into three categories:

1. **Chemical Compounds:** Resulting from interactions between different oxides, examples include $ZnSnO_3$ and Zn_2SnO_4 in the ZnO-SnO_2 system [7], and $CdIn_2O_4$ formed by the interaction of CdO with In_2O_3 [8].
2. **Solid Solutions:** Formed by mixing two metal oxides, like TiO2 with SnO2, which creates solid solutions above a critical temperature [10-11].
3. **Interacting Nanocrystals:** Mixtures of metal oxide nanocrystals interacting with each other, such as In_2O_3-SnO_2, TiO_2-WO_3, belonging to this category [12-14].

Various methods are used for producing mixed metal oxide nanocomposites, including sol-gel techniques, aerosol spraying, sputtering, and blending of individual metal oxide nano powders. It's important to note that the nanocrystalline structure in the composite may differ considerably from that of the individual components.

The synthesis of nanocomposites, like TiO_2-SnO_2, may introduce high-volume defects due to the insertion of ions from one component into the lattice of the other. For example, in the synthesis of TiO2-SnO2 nanocomposites, nanocrystalline particles with high-volume defects are produced.

In this work, researchers focused on iso-type SnO_2-ZnO composite sensors, specifically studying sensitivity and response/recovery times. The aim is to enhance the performance of gas sensors, crucial for addressing environmental pollution challenges resulting from industrial activities.

II. Experimental

In the experimental process:

a) **Precursors:** Used AR grade stannous chloride and zinc chloride from Merck Ltd.

b) **Base:** AR grade diluted ammonia solution served as the base.

c) **Preparation of Solutions:** Stannous chloride and zinc chloride were separately diluted with de-ionized water while maintaining the pH using diluted liquid ammonia.

d) **Washing:** Resultant precipitates of stannous chloride and zinc chloride were washed with de-ionized water until chlorine ions were removed.

e) **Microwave Irradiation:** The chlorine-free precipitates were irradiated with microwave energy using a Samsung household microwave oven at a frequency of 2.45 GHz and power up to 1 kW for an optimum duration.

f) **Sintering:** The mixture of SnO and ZnO nanoparticles obtained was sintered at 400°C for 5 hours.

g) **Analysis:**
- **XRD:** Structure analysis was conducted using X-ray diffraction pattern (XRD) with a CuKα wavelength of 1.54 Å.

- **SEM:** Morphology was studied using scanning electron microscopy (SEM) .

Overall, the experimental process involved precise steps in preparing and analysing the SnO_2 and ZnO nanoparticles, aiming to understand their structure, morphology, and composition.

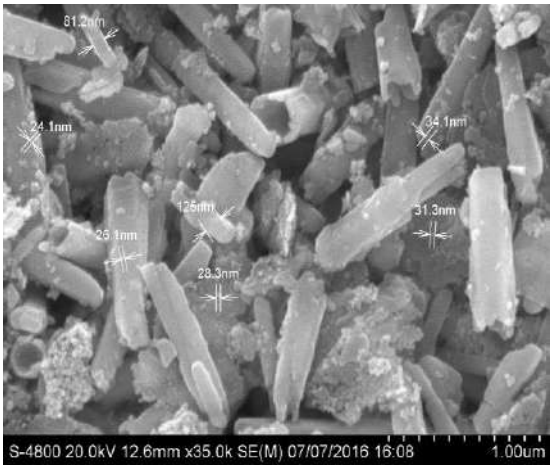
To prepare SnO_2-ZnO nano composite thick films:

1. **Synthesis:** SnO_2 and ZnO were separately synthesized using the microwave-assisted method.
2. **Quantities:** Different ratios of SnO_2 and ZnO were used for fabricating the composite thick films: 100%SnO2-0%ZnO, 80% SnO_2 - 20% ZnO, 60% SnO_2 - 40% ZnO, 40% SnO_2 - 60% ZnO, 20% SnO_2 - 80% ZnO, and 0% SnO_2 - 100% ZnO.
3. **Screen Printing:** Thick films of the synthesized SnO2-ZnO nano composite were prepared using the screen-printing technique.

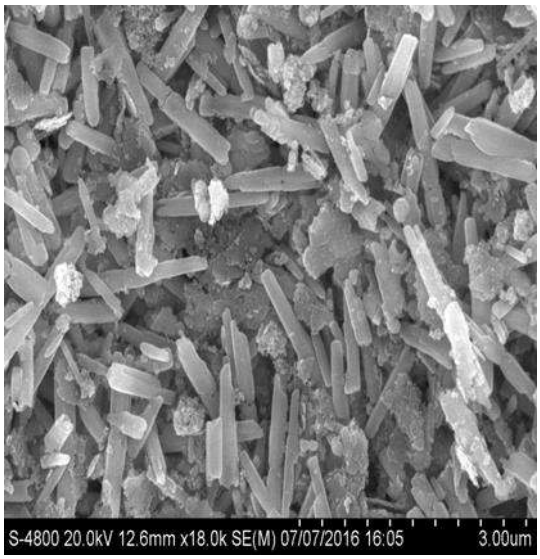
The chosen percentages of SnO_2 and ZnO in the composite films vary to study the impact of different compositions on the properties of the resulting thick films. The screen-printing technique is employed for its practical and effective application in fabricating these nanostructure composite films.

III.Result and Discussion

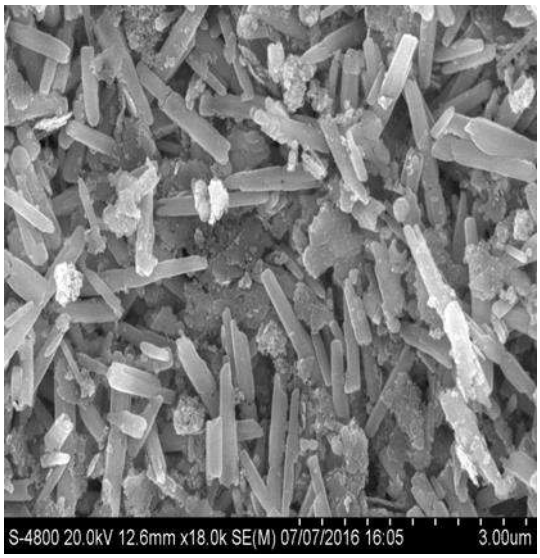
The composite film, comprised of both SnO_2 and ZnO, exhibits a structure where ZnO rods and tubes, along with clusters of spherical SnO_2 particles, are randomly dispersed. The micrograph reveals distinct ZnO rods with sizes of 81.2 nm and 125 nm. Additionally, smaller ZnO rods, smaller than 81.2 nm, are observed in the image. The micrograph also captures agglomerated clusters of spherical SnO_2 particles, with sizes ranging from 24.1 nm to 31.3 nm.



(a)



(b)



(c)

Fig 1(a-c) FE-SEM micrograph of 20%-80% =SnO_2–ZnO composite nanomaterial thick film

3.1 Electrical Characterization: The electrical characterization involved studying the I-V (current-voltage) characteristics of SnO_2-ZnO nano composite thick films at a temperature of 350°C. Figure 3 displays these characteristics, and the analysis was conducted using a Keithley 6487 picometer cum voltage source.

The measurements involved applying a forward bias voltage ranging from 0 to 10 V with a step increment of 2 V. The process was then repeated with negative voltage. The nature of the I-V characteristics for each specific sample indicates that the contacts exhibit an ohmic behaviour.

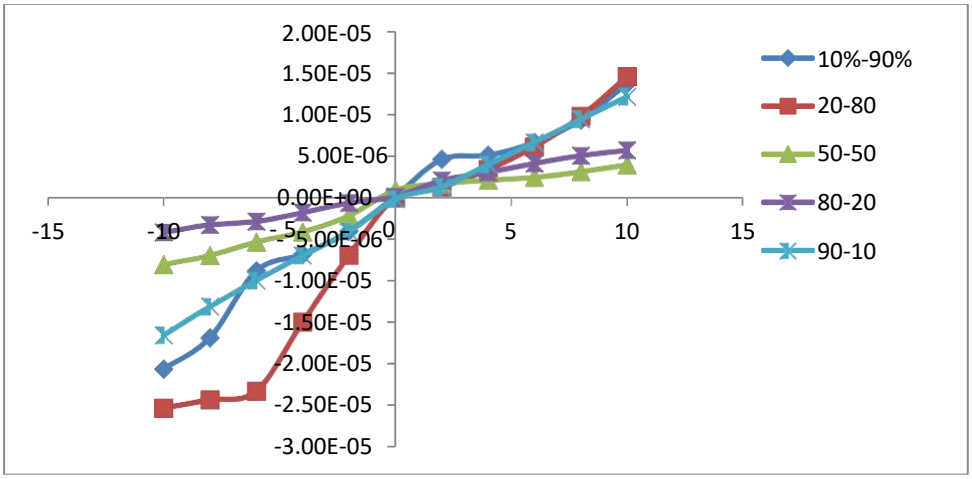


Fig 2 Characteristics of unmodified SnO_2–ZnO nanocomposites

3.2 Electrical Conductivity: The relationship between log (σ) and the reciprocal of temperature for all unmodified SnO_2-ZnO nano composite thick films is illustrated in the figure.

Notably, the sample with a composition of 80-20 shows the highest value of log (σ), indicating the highest electrical conductivity among the studied samples, while the sample with a composition of 20-80 exhibits the lowest conductivity. These variations in electrical conductivity are essential for understanding the sensor characteristics and their potential applications.

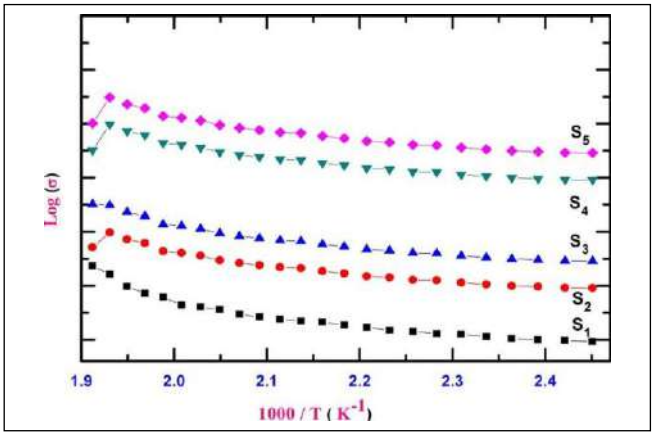


Figure 3: Electrical Conductivity

Figures 4 illustrate the gas response variation with operating temperature for pure SnO_2, ZnO, and SnO_2-ZnO composite thick films sensors in response to NH_3 gas. In both cases, it is evident that the gas sensitivity of the SnO_2-ZnO composite sensor increases with operating temperature, reaching its maximum at the optimum temperature and then decreasing. Among all sensors, the composite sensor with a 50-50 ratio exhibits the highest sensitivity to NH_3 gas.

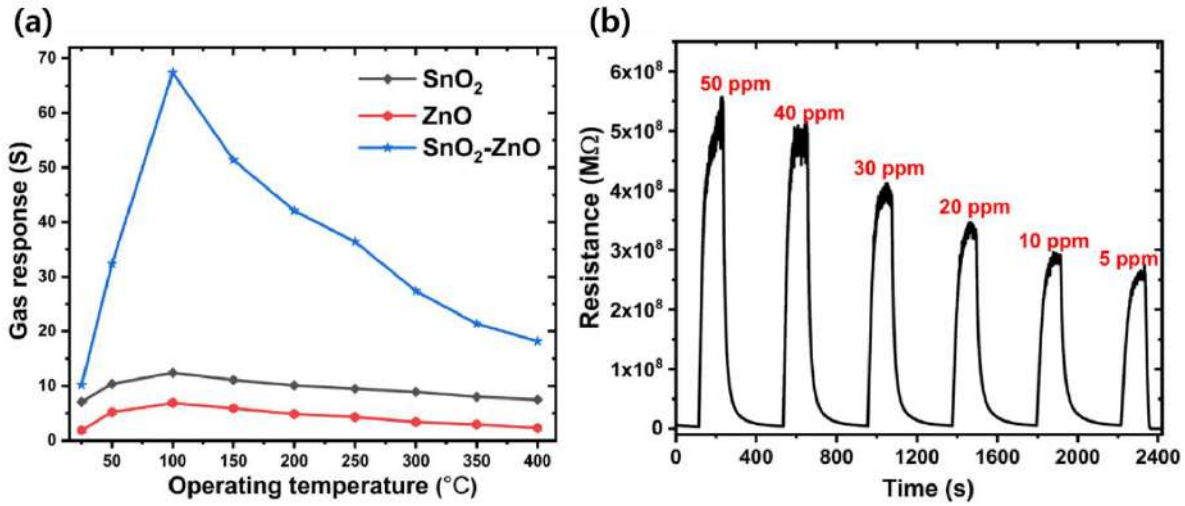


Figure 4: Gas response of SnO_2 and ZnO

Conclusion

In summary, the findings and analysis of this study indicate that the SnO_2–ZnO composite sensors array is not highly effective in detecting Ammonia. Interestingly, the composite materials demonstrated more favourable response behaviours compared to their pure counterparts.

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Applications of SnO_2 doped with PPy Ammonia Gas Sensor

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ABSTRACT

In the present work, SnO2 is doped with Polypyrrole (PPy) to form S1, S2, S3 and S4 sensors. Material characterization was done by XRD and SEM to check crystallinity and porosity respectively. SnO2 doped with PPy was found to be crystalline with average D size 50 nm to 110 nm. SEM picture showed that S3 sensor has more porosity and hence has large active area for sensing. S3 sensor showed maximum sensitivity (=1.842) at 72 ppm of ammonia gas at room temperature, among the prepared sensors. Therefore this sensor is best in industrial application where the NH2 leakage is to be detected.
Keywords: Doping, SnO2, PPy, SEM, Sensitivity.

1. Introduction

Ammonia is widely used in industrial process and medical diagnoses. Hence its detection is very impotent as it is hazardous gas. In present environment, we face with toxic, volatile and combustible gases in the environment. Detecting these harmful gases is vital in order to control air pollution, prevent human life, and protect nature from being damaged.

NH_3 sensors based on conducting polymers have shown better sensing responses among various sensors based on different materials. Polypyrrole (PPy) is one of the most stable conducting polymers under ambient conditions. It has attracted more attention as an NH_3 sensor because of its unique conducto-metric response to NH_3 [1-3].

Tin dioxide (SnO_2) with tetragonal phase is an n-type wide band gap (3.6 eV) semiconductor and suitable for various applications. Its outstanding electrical, optical and electrochemical properties of SnO_2 enable applications in solar cells as well as in gas sensor.

The use of Polypyrrole (PPy) for gas sensing has been a topic of significant research in recent years, due to its high conductivity, stability, and potential for use in a variety of applications. The use of ferric chloride ($FeCl_3$) as an oxidizing agent in the synthesis of PPy has been shown to further improve its electrical conductivity, and stability, making it a promising material for use in gas sensing applications [4-5].

The present study deals with the synthesis, characterization of SnO_2 doped with PPy, and sensitivity measurement.

2. Experimental:

A. Synthesis of SnO_2 Nanoparticles:

The SnO_2 nanoparticles were prepared by the sol–gel method. In a typical procedure, 8 g hydrated tin chloride ($SnCl_2{\cdot}2H_2O$) was dissolved in pure ethanol (C_2H_5OH). The solution was stirred with a magnetic stirrer for 30 min in a closed three-necked flask. About 5 ml of acetyl acetone was added drop wise for the hydrolysis of SnO_2. After another 30 min, the solution was continuously refluxed at 80°C for 5 h to form the SnO_2 sol solution which is then filtered to get nano-powder [6-7].

B. Synthesis of Polypyrole (PPy):

The Py monomer, anhydrous iron (III) chloride ($FeCl_3$) and methanol were used as received for synthesis of PPy. The solution of 7 ml methanol and 1.892 g $FeCl_3$ was first prepared in round bottom flask. Then 8.4 ml Py monomer was added to ($FeCl_3$ + methanol) solution with constant stirring in absence of light. The amount of Py monomer added to the solution (1/2.33 times of $FeCl_3$) was in such a way to get maximum yield. The resulting black precipitates are filtered and washed with copious amount of distilled water until the washings are clear. PPy so obtained is dried by keeping in oven at 600°C for 3 h. The synthesized material was characterized by using XRD and SEM [8].

C. Preparation thick films:

PPy is doped in nanomaterial of SnO_2 with different weight percentage. The binder was prepared by using 8 wt% butyl carbitol and 92 wt% ethyl cellulose. On chemically cleaned glass plate, paste of Al_2O_3 was screen printed and it was kept for 24 hr to dry it at room temperature and then heated at 100°C for 2 hrs to remove the binder. Paste of SnO_2+ PPy was then screen printed on Al_2O_3 layer. Again plate was dried at room temperature for 24 h and binder was removed by heating it at 150°C for 4 hrs. Finally integrated electrons (fig. 1) were made using silver paint for electrical connections (fig. 2). Sample codes are given in table 1.

Fig. (1)

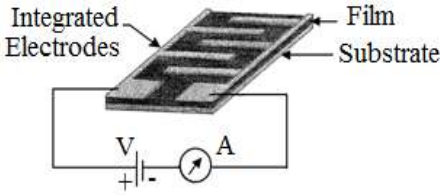


Fig. (2)

Table 1: Sample Codes

Sr. No.	Composites	Codes
1	95 %SnO_2 + 5 % PPy	S1
2	90 % SnO_2+ 10 % PPy	S2
3	85 % SnO_2+ 15 % PPy	S3
4	80 % SnO_2+ 20 % PPy	S4

3. Result and Discussion:

(i) XRD (X-Ray Diffraction):

Following Fig. 3. Shows XRD pattern of Pure SnO_2, PPy & S1, S2, S3, S4 sensors.

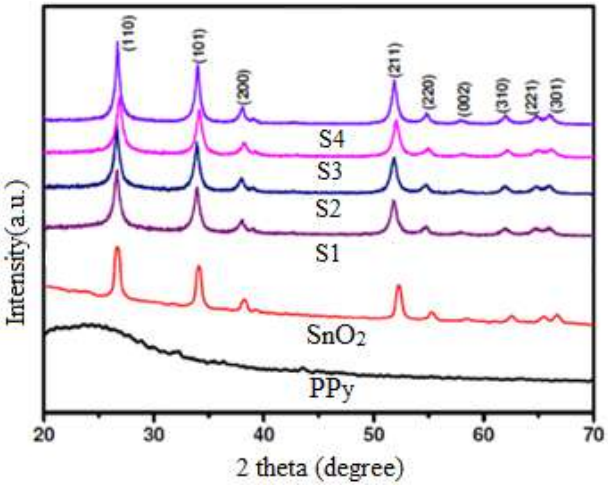
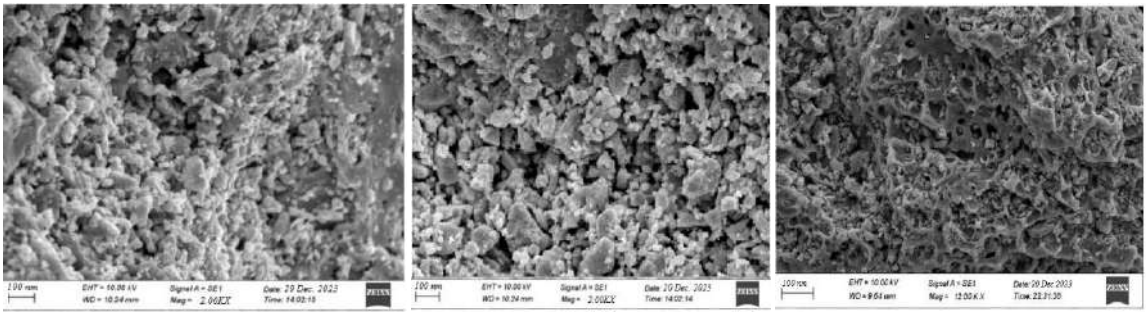


Fig. 3: XRD of SnO_2+PPy system

XRD pattern of PPy manifested amorphous nature of PPy. At 27° broad peak occurred which is the characteristics of amorphous nature of polypyrrole. The maximum intensity peaks of SnO_2 are located at 2θ = 28.4°, 34.2°, 36.7°, 54.2°, 56.1° and correspond to Bragg reflections (110), (101), (200), (211), (220), respectively. As doping of PPy in SnO_2 increases, intensity peak of SnO_2 decreases. XRD pattern showed crystalline nature of SnO_2+ PPy system with crystalline size (D) found to be in the range 50 nm to 110 nm. Crystalline size of S3 sensor was found to be least [9-10].

(ii) SEM Analysis:

The surface morphology of composites of SnO_2+PPy materials was studied by SEM.



(a) SnO_2 (b) PPy (c) S3 sensor

Fig. 4: SEM of SnO_2+PPy system

From SEM pictures of Pure SnO_2, PPy and SnO_2 doped with PPy materials, the average diameter of S3 sensor (85 % SnO_2+ 15 % PPy) was found to be least and hence number of pores per inch found to be more. This shows that S3 sensor has large effective are for sensing ammonia gas [11-12].

(iii) Sensitivity Measurement:

The sensitivity is expressed by the formula: $S = (R_N - R_A) / R_A$

Where,

R_N = Resistance of the sensor in presence of NH_3 gas environment and

R_A = Resistance of the sensor in presence of air.

When PPy is exposed to electron donating

gases such as NH

3

, a redox reaction occurs and its effective

number of charge carrier decreases, thus reducing its

conductance

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When PPy is exposed to electron donating gases like NH_3, a redox reaction occurs and its effective number of charge carrier decreases, thus reducing its conductance i.e. resistance increases during NH_3 exposure, indicating a p-type-like gas sensing behavior. SnO_2-PPy sensors exhibit good dependence (S3 sensor provides large surface area) on NH_3 gas concentration up to 70 ppm, where it reaches a saturation level at room temperature (300K). The variation of sensitivity with NH_3 gas concentration is shown in the figure 5. From graph, S3 sensor showed maximum sensitivity [13-15].

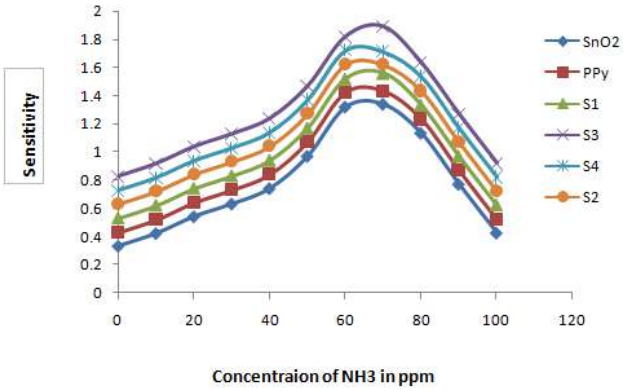

Fig. 5: S3 sensor showing maximum sensitivity at room temperature

4. Conclusion:

Porosity of S3 sample was found to be more and its average crystalline size was found to be 57 nm, from XRD pattern. S3 sensor showed more sensitivity (about 1.842) at 72 ppm concentration of NH_3 gas among the remaining sensor. This shows that S3 sensor is best among the other material to sense ammonia gas at room temperature (300 K).

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Fabrication of Nano-structured SnO_2-V_2O_5 Composite Thin Films for Enhanced Gas Sensing Performance

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ABSTRACT

In this study, pure SnO_2 with V_2O_5 nanopowders were synthesized using a sol-gel method with varying V_2O_5 ratios. Thin films of SnO_2:V_2O_5 were then produced through thermal vacuum deposition and utilized for gas sensor devices to detect volatile organic compounds and hazardous gases. The morphological, crystalline structure, textural properties, functional groups, optical properties, and thermal behavior were investigated using XRD. The XRD patterns revealed that the average crystallite sizes decreased from 7.8 nm to 4.5 nm with increasing V_2O_5 concentration. XRD analysis showed that the synthesized nanomaterials consisted of mesoporous networks of aggregated nanoparticles with a nearly spherical shape. The incorporation of V_2O_5 into SnO_2 nanopowders enhanced the structural and textural features necessary for gas sensor applications. Furthermore,composite with different weight of percentages V_2O_5 improved the gas response time and sensitivity. The electrical behavior of the sensors was evaluated by measuring the resistance of two deposited platinum electrodes for various gases (LPG, H_2, NH_3, and acetone) at different temperatures.

Keywords- SnO_2,V_2O_5, Nano-powder, Thin films, Gas sensor devices

I. INTRODUCTION

In many cases of environmental hazards, air pollutants are undetectable or invisible due to the nature of the emitted gases themselves. There are only a limited number of stationary or mobile monitoring stations available, primarily because of their high installation costs and the need for consistent maintenance to ensure their continued high performance and operation. According to the World Health Organization (WHO), Organic Volatile Compounds (VOCs) are substances with a boiling point below 250°C at standard atmospheric pressure. These compounds, including acetone, ethanol, and ammonia, are recognized as major toxic pollutants. They are characterized by their low molecular weight, typically less than 100 g/mol. Acetone, for instance, is a clear and colorless liquid classified as hazardous waste. Exposure to acetone, even at concentrations as low as 173 ppm, can lead to nerve and throat damage in humans. Therefore, there is a critical need for improved methods to detect and monitor these harmful pollutants. Traditional detection methods for air pollutants include spectrophotometry, chromatography, electrochemical analysis, catalytic luminescence, and gas sensors. Among these, gas sensors have emerged as one of the most effective detection techniques for monitoring air quality and identifying pollutants [1-2].

Tin dioxide (SnO_2) has garnered significant attention in research due to its ease of fabrication into thin films through various methods. It is widely regarded as one of the most promising sensing materials for gas sensor technology. This is attributed to its exceptional electrical, physical, chemical, and optical properties. As a wide-bandgap semiconductor with an energy gap (Eg) of approximately 3.6 eV, SnO_2 offers unique characteristics that make it particularly suitable for gas sensing applications.

The sensitivity and selectivity of sensor devices are heavily influenced by the choice of sensing materials. The morphological and compositional structure of nanomaterials play a crucial role in determining their sensing characteristics. Various morphological structures of SnO_2 nanomaterials have been prepared, including nanorods/belts, nanofibers, nanoparticles, hollow spheres, and 3D hierarchical nanostructures. Modulating the composition, size, and morphology of these materials can significantly impact their performance. Significant efforts have been made to enhance the gas sensing properties of SnO_2-based devices through the decoration of SnO_2 with noble materials and doping with other elements.Vanadium can exist in different oxidation states, including +2, +3, +4, and +5, and forms various phases such as VO, VO_2, V_2O_5, and V_2O_3.

Among these phases, V_2O_5 possesses a relatively low energy gap of 2.2 eV. Vanadium pentoxide (V_2O_5) is not only an important catalyst but also functions as an n-type semiconductor, promoting reactions for various compounds such as ammonia and hydrogen. Additionally, V_2O_5 exhibits sensing properties towards volatile organic compounds (VOCs). It has garnered attention for its ability to detect gases like acetone, ethanol, and organic amines, making it highly suitable for indoor gas detection, drunken driving tests, and even disease diagnosis. Furthermore, V_2O_5 can be utilized to enhance the response of SnO_2 sensors, further highlighting its potential in gas sensing applications. The method of preparation significantly influences the sensitivity and response of gas sensors. Factors such as selectivity, sensitivity, and degradation of performance over time depend on internal porosity, particle size, and surface morphology of the sensor material. Various techniques have been employed to fabricate SnO_2 and SnO_2 films, including thermal vacuum evaporation, vapor condensation, metalorganic deposition, magnetron sputtering, spray pyrolysis, and chemical vapor deposition. Each of these methods offers unique advantages and allows for the control of different aspects of film properties, contributing to the optimization of gas sensing performance [3-4].

In the present work, pure $SnO_2$and V_2O_5 composite SnO_2 metal oxide nanopowders were synthesized using the sol-gel technique, known for its ability to produce ultrafine porous powders with high homogeneity. Subsequently, thin films of pure $SnO_2$and V_2O_5 composite SnO2 were fabricated via thermal vacuum evaporation using the synthesized nanopowders. Various composite amounts of V_2O_5 (0, 1, 5, 10 wt%) were added to SnO_2 nanocrystalline sensors with the aim of enhancing their sensing properties towards different gases such as H_2, LPG, ammonia, and acetone. The study includes a comparative analysis of the sensing performance between pure and V_2O_5 composite SnO_2 nanoparticles.

2. Experimental method

Preparation of SnO_2 and SnO_2:V_2O_5 Nano-powders: The experimental setup for synthesizing pure SnO_2 and SnO_2 :V_2O_5 nanopowders involves the following steps:-

Materials: $SnCl_4.2H_2O$ (Sigma-Aldrich, Germany, 98%), HCl (ACROS ORGANICS, Germany, 37%), and V_2O_5 (Sigma-Aldrich, Germany, ≥99.6%) are used. These materials are sourced from reputable suppliers.

Preparation of SnO_2 Nanopowders: Tin chloride dihydrate ($SnCl_2.2H_2O$) is placed in a beaker, and then water is added to dilute it. Hydrochloric acid (HCl) is added gradually until the solution reaches a pH of approximately 1, and the mixture is stirred continuously [5].

Composites with V_2O_5: An aqueous acidic solution of V_2O_5 is added to the SnO_2 solution in different ratios (0, 1, 5, and 10 wt% of V_2O_5) for the Composites process.

pH Adjustment: Ammonia solution is then slowly added to the mixture while stirring until the pH of the solution reaches around it. This pH adjustment step is crucial as it helps convert tin chloride into SnO_2.
Stirring and Mixing: The solution is continuously stirred and mixed to ensure homogeneity and proper incorporation of V_2O_5 .
This experimental setup enables the synthesis of pure $SnO_2$and V_2O_5 Composite SnO_2 nanopowders using the sol-gel technique, with control over the pH of the solution to achieve the desired properties.

3. Materials Characterization

The physical properties of the prepared SnO_2 and V_2O_5-based powders were investigated using the following techniques:

X-Ray Diffraction (XRD): XRD patterns of the nanopowders were obtained using a Shimadzu 7000 Diffractometer. The instrument operated with Cu Kα1 radiation (λ=0.15406 nm) generated at 30 kV and 30 mA, with a scan rate of 2°/min for 2θ values ranging between 20° and 80°. This analysis allowed for the determination of crystal structure and phase composition.
In addition to the previously mentioned techniques, the physical properties of the prepared $SnO_2$and V_2O_5 -based nanopowders were further investigated using the following methods [6-7].

Optical Properties Measurements: Optical properties of the fabricated thin films were measured in transmittance and absorbance modes using a double-beam spectrophotometer (UV-Vis, Spectro Double 8 Auto cell). This analysis helps characterize the optical transparency and absorption properties of the thin films.
These additional techniques offer comprehensive insights into the structural, morphological, compositional, and optical properties of the synthesized nanopowder, which are crucial for understanding their potential applications.

Devices Fabrication- Cleaning the substrates that are 1 mm thick of microscope glass slides is done by placing them in methanol solution, then in acetone and washing several times with distilled wateranddrying.PureSnO_2 and Composite SnO_2withvarious V_2O_5 amounts (1, 5 and 10 wt%) thin films, Thin films of V_2O_5 at concentrations of 1%, 5%, and 10% by weight are deposited onto cleaned glass substrates using a thermal vacuum evaporator (Model EDWARD "auto 306"). The deposition process involves placing the prepared powders in tungsten boats, which are then exposed to an electric heater to evaporate the nanopowders under a vacuum of approximately 10^{-6} Pa. The deposition parameters include a current ranging between 20-25A and a constant deposition time of 30 minutes for each condition. After the evaporation process, the substrates are cooled to room temperature, and a copper mask is fixed onto the thin films. Finally, platinum electrodes are deposited onto the films using a sputtering instrument (Model Hummer TurboSputtering RF and DC) operating at a power of 100 W and a deposition time of 5 minutes.

4. Results and Discussions

The characterization of the prepared SnO_2 and V_2O_5 -based powders through X-ray diffraction (XRD) analysis elucidates the influence composite on SnO_2 .The XRD patterns of the nanopowders correspond with those reported in the JCPDS data (Card No. 41-1445) for the tetragonal rutile SnO_2 structure, as depicted in Figure 1. Specifically, the pure SnO_2 sample exhibits three major peaks [8-9] appearing at 2θ values of 26.58°, 33.89°, and 51.92°.

Importantly, no crystalline phases corresponding to vanadium or other vanadium compounds are detected in the XRD patterns. This absence suggests that vanadium may be incorporated into the tin oxide lattice, as illustrated in Figure 1(a). With an increase in vanadium concentration, the diffraction peaks shift towards higher diffraction angles, indicating potential lattice distortion or changes in crystallographic parameters due to the process. This observation highlights the structural modifications induced by V_2O_5 and underscores its significance in tailoring the properties of the SnO_2-based materials for various applications.

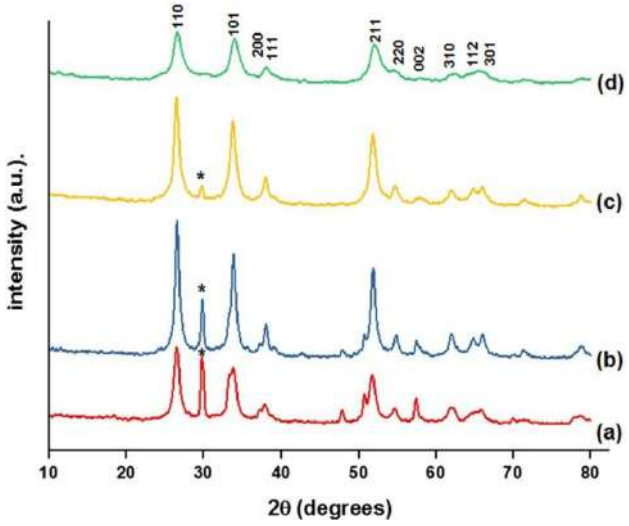

Fig.1 XRD patterns of SnO_2 nanoparticles prepared at different composing of V_2O_5 **a** pure, **b** 1 wt%, **c** 5 wt% and **d** 10 wt%

Minor differences in the XRD patterns and their intensity are observed as the percentage of V_2O_5 is increased, indicating varying values of compositing. Additionally, a peak observed at 2θ = 29.88° is attributed to the presence of SnO, according to JCPDS data (Card No. 06-0395). This suggests that both SnO properties of the SnO_2-based materials for various applications.

SnO coexist, even in the as-prepared SnO_2 or at low ratios of V_2O_5 concentration. However, this peak's intensity decreases with increasing ratio and completely disappears at 10% V_2O_5 composing, indicating the formation of a complete SnO_2 crystal structure with a tetragonal rutile structur. For further insight into the structure analysis, the mean crystallite size (D) is estimated using Scherer's Equation (1)

$$D=K ß/\beta \cos\theta \qquad (1)$$

The crystallite size (D) is calculated using Scherer's Equation (1), where K is a factor with a value of 0.9, λ is the wavelength of the incident X-ray beam (1.541 Å), β is the full width at half maximum (FWHM) of the peaks, and θ is the Bragg's diffraction angle in radians.

Specifically, the crystallite size of the powders, as determined from XRD analysis, ranges from 10.2 to 9.3 nm as the V_2O concentration increases from 0 to 1 wt%, 5 wt%, and 10 wt%, respectively. This indicates a trend of decreasing crystallite size with increasing V_2O_5 concentration, with values ranging from 8.4 to 4.3 nm.

So observed that there are no significant differences in the microstructure among the samples. The morphological shape of the nanopowders appears nearly spherical, with nanoparticle diameters ranging from 12 to 23 nm. Additionally, the particle sizes of the nanopowder decrease with an increase in the composite percentage. This indicates that it has an influence on the particle size distribution and morphology of the prepared materials.

The optical properties of both pure SnO_2 and V_2O_5 composite SnO_2 nanopowders after calcination are investigated using XRD. The absorption spectra of the prepared nanopowders are recorded in the range of 275–1100 nm. In the absorption spectra, the absorption peak of pure SnO_2 is observed around 300 nm. However, with the addition of V_2O_5, the absorption peak shifts, it shifts to 295 nm for 1 wt% V_2O_5/SnO_2 and to 310 nm for 5 wt% V_2O_5/SnO_2 . This shift in the absorption peak suggests changes in the optical properties of the nanopowders due to the process. The optical properties of both pure SnO_2 and V_2O_5 composited SnO_2 nanopowders after calcination are investigated using UV-visible spectroscopy. The absorption spectra of the prepared nanopowders are recorded in the range of 275–1100 nm. absorption peak suggests changes in the optical properties of the nanopowders due to the composite process [10-11].

5. Gas Sensing Performance-

To evaluate the sensing characteristics of the fabricated composite SnO_2-based gas sensor devices, specific amounts of gases (hydrogen, ammonia, acetone, and LPG) are injected into a handmade gas chamber. The concentrations of the injected gases and vapors are calculated in parts per million (ppm) using Equation (2)

$$C = (22.4pTVS)/(273MV) \times 1000 \quad (2)$$

Where C, ρ, T, M, VS represent the concentration of the examined gases in ppm, the density of liquid vapors (ammonia and acetone) (gml–1),ambient temperature(K), molecular weight of the liquid vapors (L), VS is the volume of the tested liquid (μ l), respectively.

Response is a critical factor in determining the performance of gas sensor devices. To assess this, fabricated gas sensor devices are tested under varying temperatures with different gases.. The gas response is quantified using the following equation (3)

$$S = (Ra)/(Rg) \times 100\% \quad (3)$$

where (Ra) represents the resistance of the sensor devices in presence of air and (Rg) is the resistance of the sensor devices in presence of the tested gas.

The output voltage is calculated from the sensor resist following equation

$$LOD = 3.3\sigma S$$

Variation (Rg) at different temperatures by a small electrical circuit shown in Fig.2, that consisting of load resistance RL (10 KΩ), variable resistance of gas sensor.

Rg and power supply 5V,where the multi meter was connected to RL, and the output voltage is measured [12]

$$V\ out = 5 - VL$$

The gas sensor properties are tested under relative humidity between 40 and 60% for three times. It appears that there is a decrease in responses as the operating temperature continues to increase. SnO_2 gas sensor exhibits a relatively lower response to acetone, H2, LPG, and NH3 compared to the V_2O_5 and SnO_2 sensor. The V_2O_5 composite SnO_2 sensor, on the other hand, demonstrates significant improvements in responses to these gases.

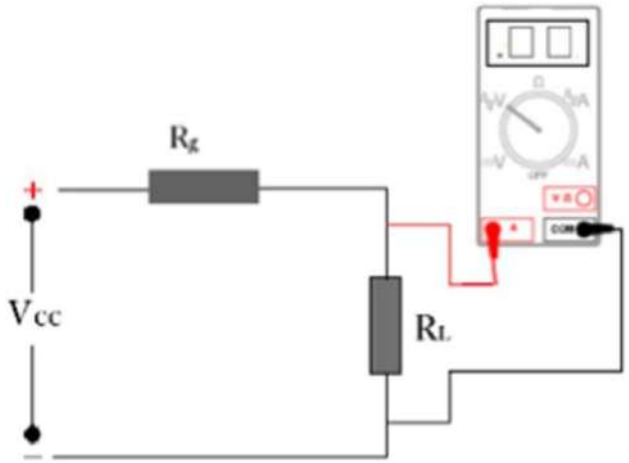

Fig.2 Electrical circuit for measuring voltage of gas sensor

6. The Gas Detection System-

The circuit diagram of a typical gas sensor system is illustrated in Figure (3), This system performs the following functions:

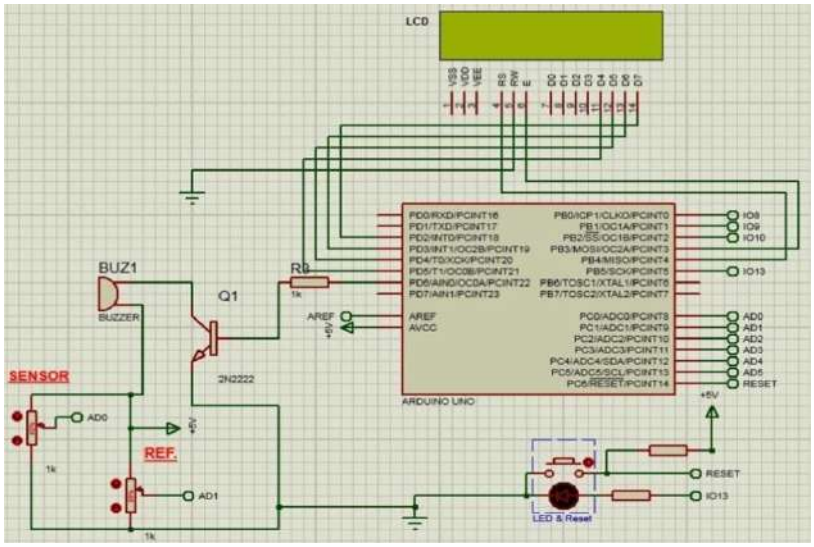

Fig.3 Circuit diagram of gas detection system

- It detects gas leakage using the fabricated sensor.
- Activates an alarm up on gas leakage detection.

7. Conclusions

Pure SnO_2 and V_2O_5 composited SnO_2 nanopowders were successfully synthesized via a sol-gel method, employing tin chloride dihydrate as the starting precursor. Various ratios of V_2O_5 were utilized in the synthesis process. high-quality SnO_2 thin films were produced through thermal vacuum evaporation under low pressure conditions. The maximum gas sensitivity for H_2 and LPG was achieved with V_2O_5 composited SnO_2 gas sensors containing a 5 wt%, reaching 109 % sensitivity at 190°C for H_2 and 108% at 210°C for LPG. For ammonia vapor and acetone vapor, the optimal for the best sensitivity was found to be 1 wt% V_2O_5 composited SnO_2 gas sensors, yielding 132% sensitivity at 250°C for ammonia vapor and 102% at 260°C for acetone vapor. The sensor voltage variation for H_2 and LPG was high across all fabricated sensors, while for NH_3 and acetone. Introducing

V_2O_5 into the SnO_2 system is expected to reduce costs compared to noble metal catalysts commonly used for such purposes, making it useful for commercialization and technological advancements.

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ARTICLE

Investigation of AC and DC Electrical Conductivity in Ethyl Cellulose (EC) and Poly Methyl Methacrylate (PMMA) Polyblends

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ABSTRACT

The study of AC and DC electrical conductivity is crucial for understanding the behavior of charge carriers within materials and their mobility. Ethyl cellulose (EC) stands out among cellulose ethers due to its favorable electrical, mechanical, and weathering properties. Poly Methyl Methacrylate (PMMA) is a thermoplastic known for its rigidity, transparency, and outdoor durability, making it a valuable material. Despite being insulating materials, both EC and PMMA exhibit limited free charge carriers and low mobility. In this research, AC and DC electrical properties of Ethyl Cellulose (EC), Poly Methyl Methacrylate (PMMA), and their blends doped with tetrahydrofuran (THF) film were investigated using isothermal evaporation techniques. The investigation focused on the effects of temperature, electric field, and frequency on electrical conduction mechanisms. Measurements were conducted across frequencies ranging from 1 KHz to 1 MHz at temperatures between 323 K and 373 K. Results indicate that AC electrical conductivity of Ethyl Cellulose (EC), Poly Methyl Methacrylate (PMMA), and their blend (EC/PMMA) increases with higher frequencies of the applied electric field. Meanwhile, DC electrical conductivity of Ethyl Cellulose (EC), Poly Methyl Methacrylate (PMMA), and their blend (EC/PMMA) rises with increasing temperature. X-ray diffraction (XRD) analysis further supports these conductivity changes in the blend.

KEYWORDS: Macromolecules, Tetrahydrofuran, Ethyl Cellulose, Poly Methyl Methacrylate, Current Conductivity.

1. INTRODUCTION

The polymer blends are combination of different polymer-matrix composites, a material important to the electronic industry for its dielectric properties in the use of capacitors. The physical mixing or blending of two polymers produces an alloy with quite different properties, which can be potentially useful [1]. The interest in organic and polymeric semiconductors has arisen, particularly because of their electro photo graphic and solar cell applications. The electrical conduction in iodine doped polystyrene (PS) and poly methyl methacrylate (PMMA) has already been reported by Chakraborty et al. [2]. Keller et al. reported the thermally stimulated discharge current (TSDC) study of poly blends of PS and PMMA [3]. Deshmukh et al. [4] reported electrical conduction in semiconducting PVC–PMMA thin film. The electrical conductivity of polyaniline doped polyvinylchloride (PVC) and poly methyl methacrylate (PMMA) thin films has been measured by studying the I–V characteristics at various temperatures in the range 323–363 K by Deshmukh et al. [5]. In the present investigation, the AC conductivity of Ethyl Cellulose (EC), Poly Methyl Methacrylate (PMMA) and their blend was measured to identify the mechanism of electrical conduction. The dielectric constants have been measured for different temperatures. A good number of reports [6–8] on the theory of electrical conduction and experimental findings have appeared in a number of such blends. Polymers like Ethyl Cellulose (EC) and Poly Methyl Methacrylate (PMMA) being essentially insulating

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materials, the number of free charge carriers is very small and their mobility is very low. In an electric field, it is expected that a redistribution of charges that are mobile enough to respond to the time scale of the applied field, may occur.

2. EXPERIMENTAL DETAILS

In the present work, Isothermal Evaporation Technique has been used, as it is best suited to the laboratory. Polymers of Ethyl Cellulose (EC) and Poly Methyl Methacrylate (PMMA) were obtained from S.D. Fine Chem. Ltd., Mumbai, India. The different quantities of given substances have been used for preparing film of thickness. The two polymers PMMA or Ethyl Cellulose (EC) were pure were taken in 1:1 ratio were dissolved in the common solvent THF (10 ml). And their blends were taken in 1:3 ratio dissolved in the common solvent THF (15 ml).The solution was kept for 3–4 days to allow polymers to dissolve completely to yield uniform solution. A glass (15 cm × 15 cm) thoroughly cleaned with water and later with was used as a substrate. To achieve perfect levelling (and uniformity in thickness of the film), a pool of mercury was used in a plastic tray. It was, thereafter, allowed to evaporate in air at room temperature. Further, it was dried for 48 h to remove any traces of solvent. The dry film was removed from the plate and cut into pieces (samples) of desired size. The films of other samples were prepared by the same method.

2.1. AC Conductivity Measurement

The film sample was loaded into the sample holder in oven. The a. c. frequencies were applied (in the range 1 KHz–1 MHz) across the sample by using the 4284 A precision LCR meter (20 Hz–1 MHz) supplied by Agilent Technologies, Singapore. The corresponding dielectric constants were measured by using LCR meter. From the dielectric data, the a. c. conductivity of the samples was calculated by using relation,

$$\sigma_{ac} = f\varepsilon' \tan\delta / 1.8 \times 10^{10}$$

Supplied by Mitutoyo Corporation Japan, was for the measurement of thickness of sample thin film. It is measuring range is 0–25 mm with resolution 0.001 mm. The thickness of the EC and PMMA blend film is 0.002 mm.

2.2. DC Conductivity Measurements

Determination of electrical entails the measurement of current (I) with respect to applied voltage (V) at different temperatures. For this, each sample film of thickness was coated with silver electrodes on either side and loaded inside the sample holder. The sample holder was placed inside the furnace (oven). The electric current (I) was measured by applying the voltage 50 V, 100 V, 150 V, . . . ,800 V, up to different constant temperatures 323 K, 333 K, 343 K, . . . ,373 K.

The dc conductivity of the sample was measured using a Keithely (model 617) programmable electrometer with an internal source. In set up, the sample is considered as resistance. Across the sample a voltage is applied and corresponding current was noted. Using Ohm's law the resistance R was calculated. From the resistance the resistivity was found out using the relation R = I/A where, *A* is area of the sample and *I* is the thickness. The conductivity is the reciprocal of resistivity. The parameters like electric field E, current density (J), electrical conductivity have been calculated.

3. RESULTS AND DISCUSSION

AC conductivity of all three samples have been investigated by carrying out Cp and Rp measurement by using LCR meter with respect to increase of frequency at various constant temperature 323 K to 363 K.

3.1. Effect of Frequency on AC Conductivity ($\sigma_{a.c.}$)

The AC conductivity has been measured by increasing the frequency from 1KHz to 1 MHz at various constant temperatures 323 K to 373 K for all the three samples dissolve in THF. It has been noticed that, $\sigma_{a.c.}$ increases with the increase in frequency. Raghavendra et al. [9] explained conductivity on the basis of the electron hopping mechanism. In all their studies, there is not much variation in the conductivity. In fact, the conductivity decreases by small magnitude as the frequency is increased [9]. On the other hand, the increase in conductivities observed by Bhattacharya et al. [10]. In present study, AC conductivity ($\sigma_{a.c.}$) increases with the increase of frequency at constant temperatures as shown in Figures 1–3 [11].

3.2. Effect of Temperature on AC Conductivity ($\sigma_{a.c.}$)

From the Figures 4–6, it is noticed that AC conductivity varies marginally increases with temperature, which

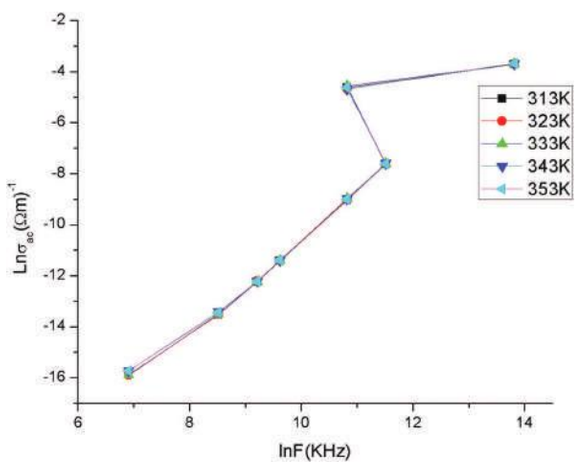

Fig. 1. Variation of conductivity with frequency at various constant temperatures (for pure EC).

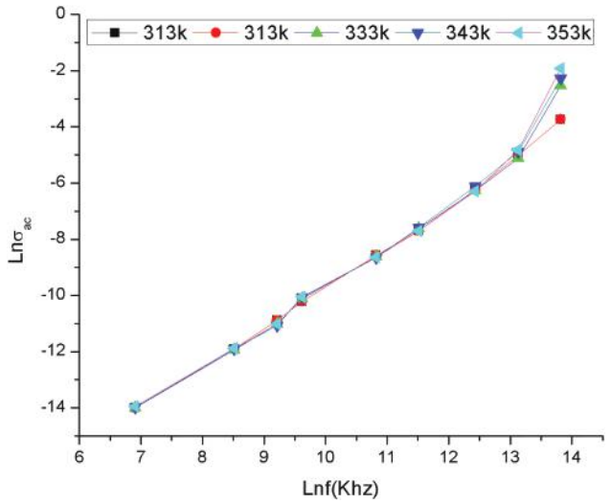

Fig. 2. Variation of conductivity with frequency at various constant temperatures (for pure PMMA).

shows almost temperature independent of AC conductivity. In the present study, we have noticed that AC conductivity of Ethyl Cellulose (EC), Poly Methyl Methacrylate (PMMA) and their blends varies marginally increases with temperature, which shows almost temperature independent of AC conductivity as shown in Figure 3. This model is based on the assumption that the energy states in the gap near the Fermi level are due to dangling bonds and exothermic reactions only paired defects are found in the gap [12].

3.3. Effect of Temperature and Frequency on AC Conductivity ($\sigma_{a.c.}$)

The AC conductivity has been measured by increasing the frequency from 1 KHz to 1 MHz at various constant

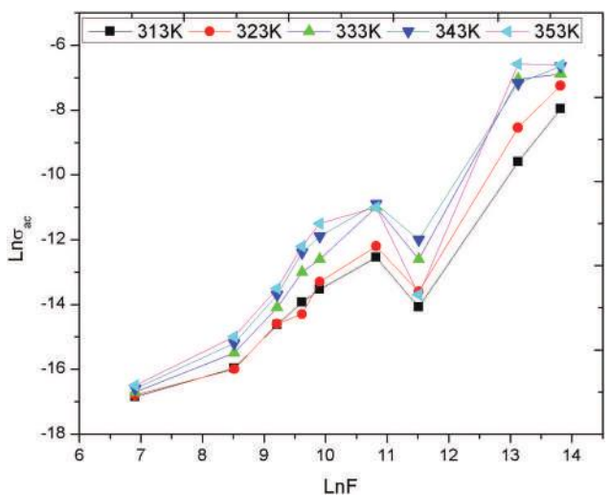

Fig. 3. Variation of conductivity with frequency at various constant temperatures (for EC/PMMA).

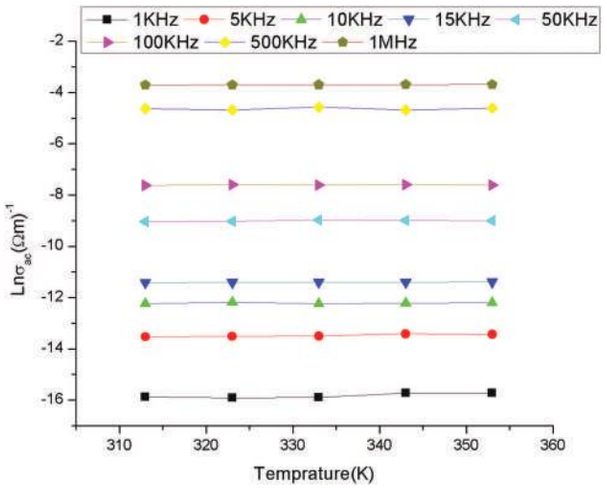

Fig. 4. Variation of conductivity with temperature at different constant frequencies (for pure EC).

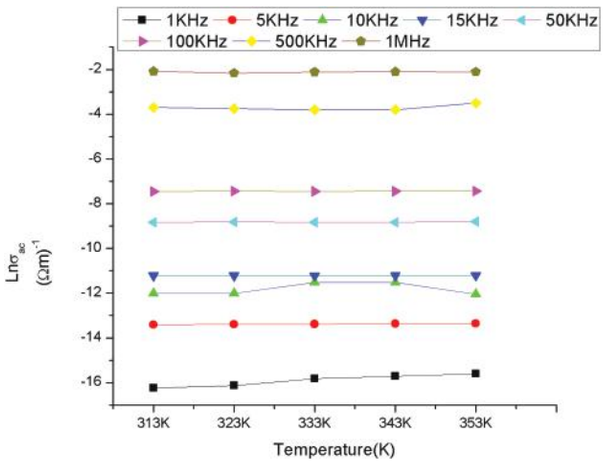

Fig. 5. Variation of conductivity with temperature at different constant frequencies (for pure PMMA).

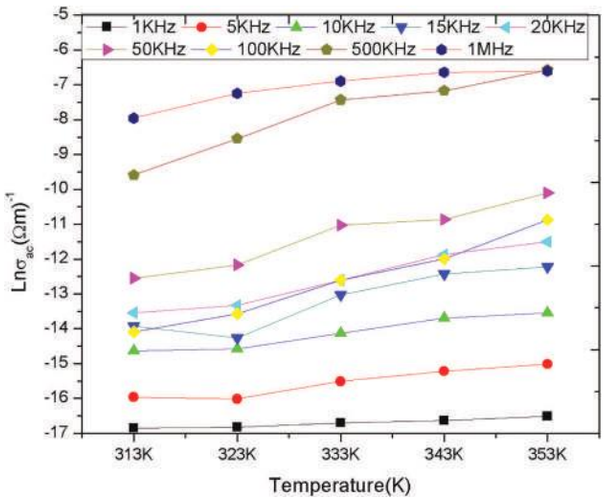

Fig. 6. Variation of conductivity with temperature at different constant frequencies (for EC/PMMA blend).

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temperatures 323 K to 373 K for all the three samples dissolve in THF. It has been noticed that, $\sigma_{a.c.}$ increases with increase in the frequency.

In a thin film capacitor, because of polycrystalline or amorphous nature of the film along with the deposition condition, it is expected that there will be some defects, impurities, imperfections in the atomic arrangements of dielectric. Field frequency dependent conductivity is caused by the hopping of electrons in localized states near the Fermi level and also due to the excitation of charge carriers to the states in the conduction bands.

If there are some free charge-carriers (due to presence of impurities, defects or imperfections in the polyblend film) then their movements from one band to another band or within the band by hopping process give rise to the conductivity. In order to understand the frequency dependent conductivity, suggested a multi-component system of conductivity which leads to a relation,

$$\sigma_{\text{Tot}} = \sigma_{d.c.} + \sigma_{a.c.} + \sigma_{\text{relax}}$$

where, $\sigma_{d.c.}$ has significant contribution at room temperature which often masks the contribution of the frequency dependent hopping term.

$\sigma_{a.c.}$ is caused by hopping conduction and

σ_{relax} is the contribution from Debye hopping mechanism.

The individual contribution of each component can be expressed in following form,

$$\sigma_{d.c.} = \sigma_0 \exp(-E_k/2kT)$$

$$\sigma_{a.c.} = A\omega^n \exp[-E(\omega T)/kT]$$

$$\sigma_{\text{relax}} = k\omega^2$$

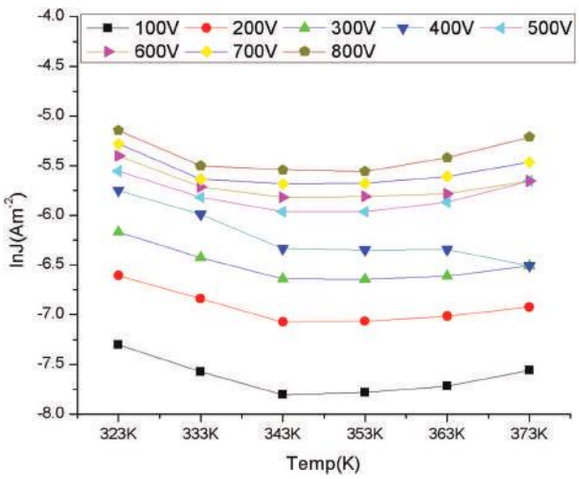

Fig. 7. Variation of current density (J) with temperature at different constant voltages (for pure EC).

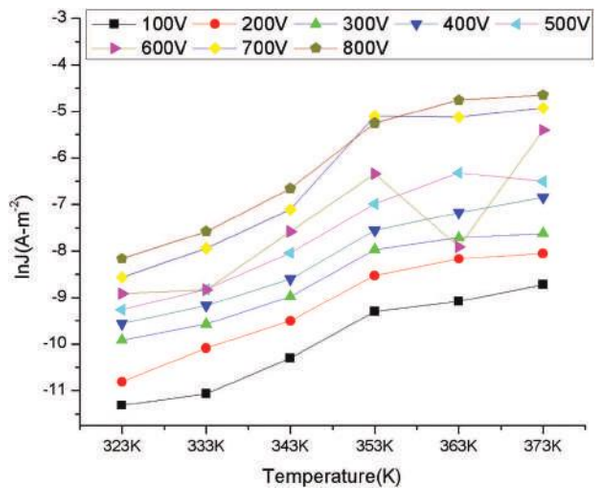

Fig. 8. Variation of current density (J) with temperature at different constant voltages (for pure PMMA).

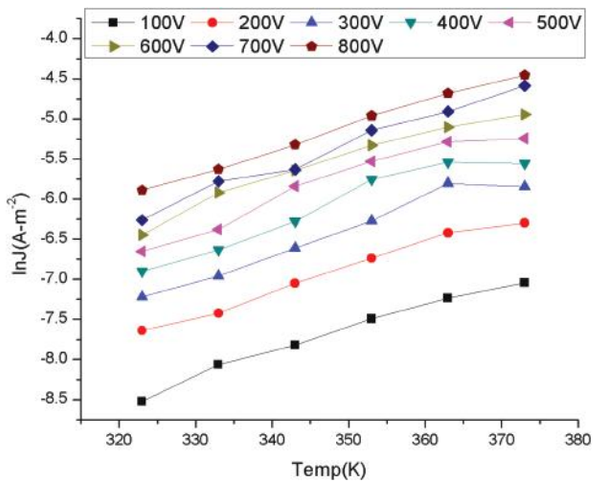

Fig. 9. Variation of current density (J) with temperature at different constant voltages (for EC/PMMA).

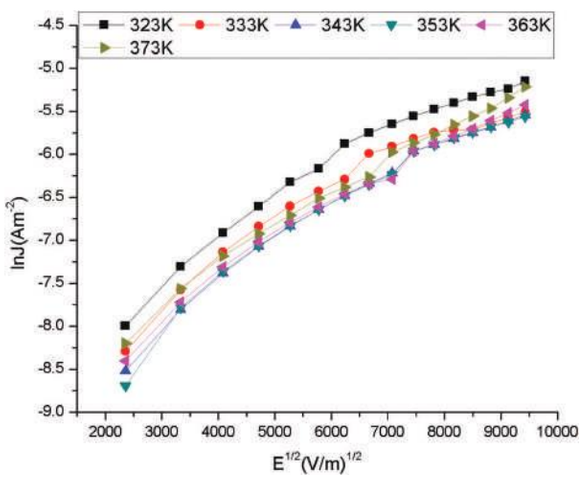

Fig. 10. Variation of current density (J) with square root of electric field ($E^{1/2}$) (Schottky plots) at different constant temperature (for pure EC).

where, σ_0, A and k are constants and the other terms have the usual meaning and $\sigma_{a.c.}$ and σ_{relax} are frequency dependent terms.

3.4. DC Conductivity

For all samples, there is rise in conductivity with increase in temperature. Conductivity of sample depends upon, (a) the number of charge carriers, and (b) their mobility. The increase in temperature produces a considerable change in the defect structure of material. Increase in number of charge carriers is due to thermal generation and ionization in temperature. Also increase in conductivity is approximately according to an equation,

$$\sigma = \sigma_0 e^{-Ea/kT}$$

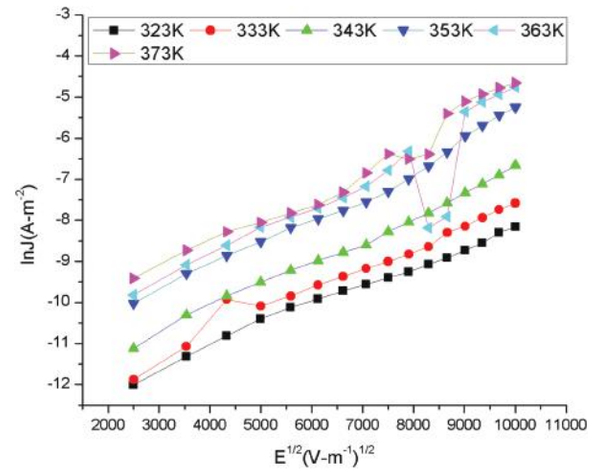

Fig. 11. Variation of current density (J) with square root of electric field ($E^{1/2}$) (Schottky plots) at different constant temperature (for pure PMMA).

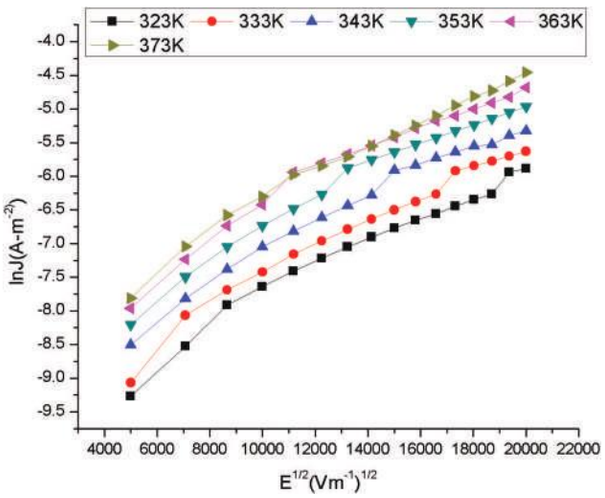

Fig. 12. Variation of current density (J) with square root of electric field ($E^{1/2}$) (Schottky plots) at different constant temperature (for EC/PMMA blend).

Therefore, increase in electrical conductivity with the increase of temperature, which occurs on account of generation of charge carrier due to thermal activation. Current density (J) increases with increase in the temperature as well as with increase in applied voltages (V) as shown in Figures 7–9.

The variation of current density with respect to electric field explains the mode of conduction such as tunnelling, space charge limited conduction, Schottky emission, and Poole Frankel there is non-linearity in the variation of current density with electronic field, which supports space charge limited conduction. Current Density (J) increases with respect to the applied electric field at various constant temperatures as shown in Schottky plots Figures 10–12.

3.5. X-ray Diffraction Spectra

This technique is an unambiguous tool in the scientific and industrial work for checking and identifying the materials. XRD analysis is an analytical technique which can determine the crystallite structure, crystallinity, and complexion in the polymer systems. XRD has been utilized to detect the crystallinity in the

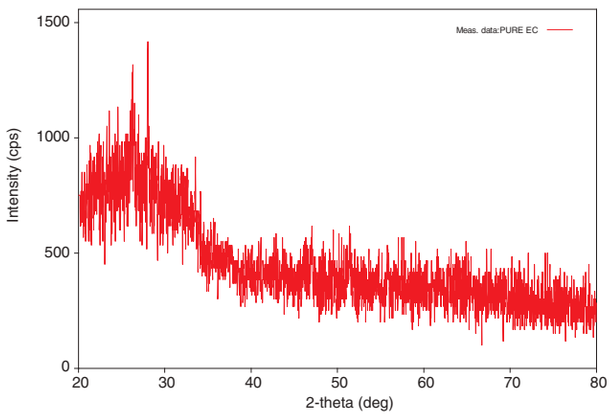

Fig. 13. XRD spectrum of EC.

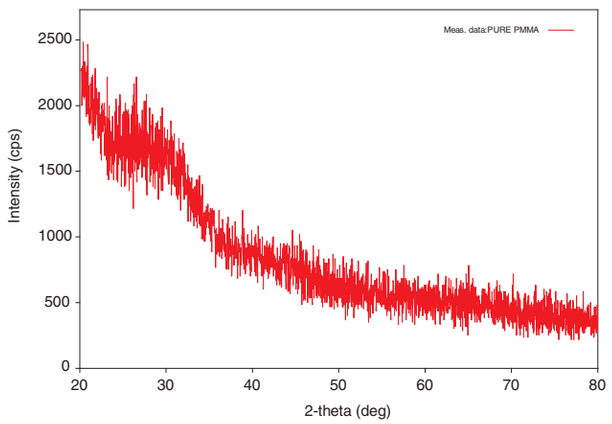

Fig. 14. XRD spectrum of PMMA.

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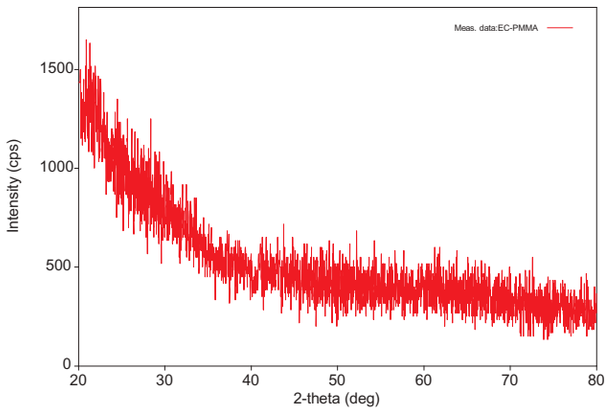

Fig. 15. XRD spectrum of EC/PMMA.

sample. The main aim of XRD study was to know the amorphousness of the sample. The absence of the peak in X-ray spectra confirmed the amorphous nature of the polymer sample. The crystalline peaks for scanning angle 2θ was varied from 20°–80° are absent in pure EC, pure PMMA and EC-PMMA. Therefore, XRD of EC, PMMA and EC-PMMA blend showed completely an amorphous nature as shown in Figures 13–15.

4. CONCLUSION

In the present study, thin films of all the three samples were prepared by Isothermal Evaporation Technique having different thicknesses. The AC electrical conductivity of Ethyl Cellulose (EC), Poly Methyl Methacrylate (PMMA) and their blend (EC/PMMA) increased with increasing frequency of applied electric field. The increase in dielectric constant is due to the greater freedom of moment of dipole molecular chains within the polymer blends. The DC electrical conductivity of the Ethyl Cellulose (EC), Poly-methyl Methacrylate (PMMA) and their blend (EC/PMMA) increased by increasing the temperature. The increase in temperature produces a considerable change in the defect structure of material. Increase in number of charge carriers is due to thermal generation and ionization in temperature. Which is refers to increase in electrical conductivity with the increase of temperature which occurs on account of generation of charge carrier due to thermal activation. The variation of current density with respect to electric field explains the mode of conduction such as tunnelling, space charge limited conduction, Schottky emission, and Poole Frankel there is non-linearity in the variation of current density with electronic field, which supports space charge limited conduction. The absence of peak in X-ray spectra confirms the amorphous nature. Thus XRD study reveals the amorphous nature of polymer films (EC, PMMA, EC/PMMA) which are prepared by Isothermal Evaporation Technique.

Highlights

(1) The AC and DC electrical conductivity studies are aimed at understanding the origin of the charge carrying species, their numbers and the way in which they move through the bulk of the material.
(2) AC and DC electrical conductivity study was performed to analyze electrical conduction behaviour in composite.
(3) The importance of polymers is mainly because polymers are still regarded as a cheap alternative material that is manufactured easily.
(4) AC and DC conductivity measurement is an important tool for studying the ionic transport properties of materials.

Ethical Compliance

Research experiments conducted in this article with animals or humans were approved by the Ethical Committee and responsible authorities of our research organization(s) following all guidelines, regulations, legal, and ethical standards as required for humans or animals.

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ARTICLE

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Efficient Synthesis and Photoluminescence Properties of $KSr_4(BO_3)_3$ Phosphors Doped with Gd^{3+}, Bi^{3+}, and Pb^{2+} for Phototherapy Applications

Journal of Electrical Systems

Abstract: - In this paper we have reported the synthesis and the photoluminescence properties of the phosphor $KSr_4(BO_3)_3$:Gd^{3+}, Bi^{3+}, and Pb^{2+} phosphors. This phosphor material were first time prepared by a recrystallization method followed by the sintering at 900°C for 2 hours. The structural properties of the phosphor were studied by X-ray Diffraction Pattern which was studied using Rigaku miniflex II X-Ray Diffractometer. The excitation and emission spectra were measured by using fluorescence spectrophotometer at the room temperature. The structural and morphological characteristics i.e. particle size and shape of particle were studied by using scanning electron microscopy. Elemental analysis provides verification of the elements present and a qualitative chemical composition of the synthesized materials via energy dispersive X-ray analysis (EDX).This shows the application of the phosphor in various fields like photocopying, phototherapy.

Keywords: Photoluminescence, EDX, SEM,Phototherapy

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I. INTRODUCTION

The host and activators may have a significant impact on photoluminescence. It may cover the entire electromagnetic spectrum, from ultraviolet to infrared. Most often, inorganic substances like phosphate, borate, sulphates, and fluorides are utilized as hosts, and rare earths with desired distinctive emission and excitation spectra are used as activators. Host lattices do not appreciably impact the electronic transitions of rare earth ions. [1] Applications for UV emitting phosphors are numerous. In addition to being used to create phototherapy lamps, UV-emitting phosphors are also utilized in low-pressure lamps, photochemistry, X-ray imaging equipment, water filtration and other applications.[2]

Phototherapy has a long history of use in the treatment of skin conditions. The causes and signs of different skin illnesses vary, but phototherapy is a very effective treatment for them. Since phototherapy has the fewest negative effects of all the treatments, the demand for phototherapy lamps on the global market is rising daily. Additionally helpful for treating various skin diseases and skin renewal, phototherapy is a good treatment option. [3] The primary and most crucial factors for treating the specific condition with phototherapy are the wavelength of the light selected for the treatment and the duration of the exposure.

UV light is divided into UVC (100–280 nm), UVB (280–315 nm), and UVA (315–400 nm). Whereas UV light (100-400 nm) is appropriate for treating skin problems, phototherapy that uses UVA light with the medication psoralen is referred to as PUVA phototherapy, while UVB phototherapy uses UVB light. For luminous ions, borate materials make ideal host lattices. Numerous rare earth doped borate compounds have high optical damage thresholds and UV transparency, making them excellent hosts for UV emitting phosphors. Due of their well defined UV emission, Gd^{3+}-activated phosphors have received a great deal of attention. The high efficiency of gadolinium borate phosphors, which range from orthoborates to pentaborates, has shown them to be potential candidates for use in optoelectronic devices. [4-8].

We have described the phosphor $KSr_4(BO_3)_3$ doped with different activator Gd^{3+},Bi^{3+},Pb^{2+} in this study. For the first time, these phosphors were created using the re-crystallization technique. The optical characteristics of these phosphors were explored. The borate group contains a variety of useful phosphors, such as $LaB_5O_9:Ce^{3+}$ [9], $LaMgB_5O_{10}:Ce^{3+}$ [10], $Na_2La_2B_2O_7:Ce^{3+}$ [11], and $LiSrBO_3:Gd^{3+}$.

II. EXPERIMENTAL

The phosphors $KSr_4(BO_3)_3:Gd^{3+},Bi^{3+},Pb^{2+}$ were synthesized first time by a recrystallization method. This process has a few key advantages, such as a relatively low temperature route, improved controllability, and ease of solubility. [12-13] Stoichiometric quantities of the metal nitrates $K(NO_3)$, $Sr(NO_3)_2$, boric acid, and gadolinium nitrate $Gd(NO_3)_2$,Bismuth nitrate $Bi(NO_3)_3$,Lead nitrate $Pb(NO_3)_2$ were used to make the phosphor. In a little volume of double-distilled water, the starting ingredients $K(NO_3)$ and $Sr(NO_3)_2$ were first dissolved. A magnetic stirrer was used to stir constantly for a few minutes while the stock solution of activators was added in nitrate form. By vigorously stirring for a few minutes at 50 ^oC, boric acid was dispersed in double-distilled water. Next, a drop at a time of this solution was poured into the mixture. After that, the entire homogeneous solution was put on a hot plate set to 70^oC to gradually evaporate any extra water. Finally, heat and crushing were applied to the dried precursor. A white crystalline powder of $KSr_4(BO_3)_3:Gd^{3+},Bi^{3+},Pb^{2+}$ were obtained after crushing the dry precursor and heating it for two hours at 900^oC. A spectrophotometer, powder XRD, scanning electron microscopy, and EDX were then used to characterize the resulting powder sample.

Figure1. -Flowchart of synthesis of phosphors by re crystallization method

III. RESULT AND DISCUSSION

The phosphor KSr_4 $(BO_3)_3$ doped with different activator Gd^{3+},Bi^{3+},Pb^{2+} were analysed using an X-ray Diffractometer with a scan speed of 5.000^{o}/min in the range of 10-80 ^{o}, and the results of the XRD analysis verified the crystallinity and phase purity of the compound. At room temperature, a fluorescence spectrophotometer was used to measure the excitation and emission spectra. The photomultiplier tube (PMT) detector voltage, spectral resolution, scan speed, and the width of monochromatic slits (0.1 nm) were all held constant throughout the examination of the samples. Scanning electron microscopy was used to examine the structural and morphological properties, including particle size and shape.

1.XRD analysis-

The XRD pattern, examined using a Rigaku Miniflex II X-Ray Diffractometer, confirmed the phase purity and crystalline structure of the produced phosphor. The XRD patterns for $KSr_4(BO_3)_3$ are shown in Figure 2. Each diffraction peak corresponds to the pure phase of the prepared sample, matching well with the standard data for $KSr_4(BO_3)_3$. The strong and precise diffraction peaks indicate that the sample has been properly crystallized. The Rietveld refinement data for the $KSr_4(BO_3)_3$ phosphor revealed lattice parameters of a = 11.0384 Å, b = 11.9897 Å, and c = 6.8845 Å, belonging to the space group Ama2 (No. 40). The unit cell volume is 911.174 Å^3, with Z = 4, and the angles α = 90.00°, β = 90.00°, and γ = 90.00°. The refinement achieved goodness-of-fit coefficient values of Rb = 11.03% and Rwb = 15.22%.

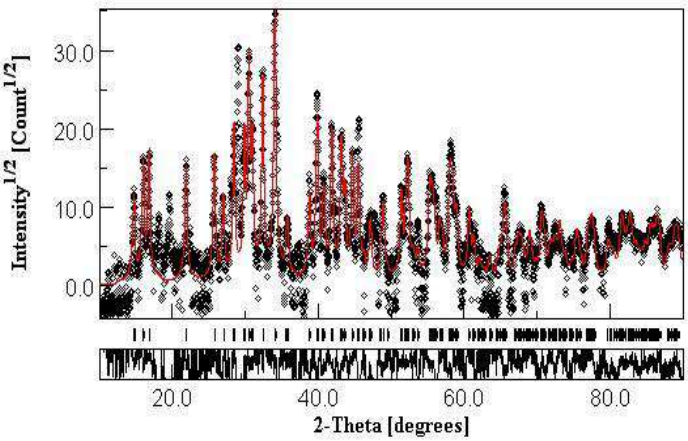


Figure2.- Reitveld analysis patterns for X-ray powder diffraction data of $KSr_4(BO_3)_3$.

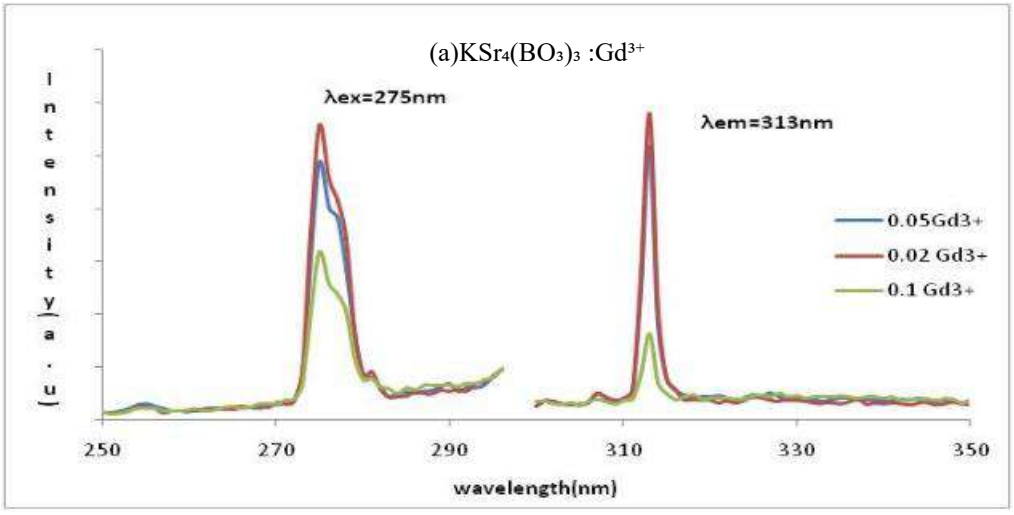
2. Photoluminescence Spectroscopy-

The accompanying figure 3 presents the excitation and emission spectra of $KSr_4(BO_3)_3$:Gd^{3+}, Bi^{3+}, Pb^{2+}, obtained using a Hitachi F-7000 fluorescence spectrophotometer at room temperature. The phosphor $KSr_4(BO_3)_3$:Gd^{3+} shows an excitation peak at 275 nm and an emission peak at 313 nm when excited at this wavelength. This emission at 313 nm, under 275 nm excitation, corresponds to the $^6P_{7/2} \rightarrow {}^8S_{7/2}$ transition.

Figure 3 (a). illustrates how the PL intensity increases with the concentration of the dopant Gd^{3+} ions up to 2 mol%, after which it begins to decline due to concentration quenching. Concentration quenching primarily occurs due to photon reabsorption, multipole-multipole phonon interaction, and non-radiative energy transfer between dopant ions. The likelihood of energy transfer between activator ions is determined by the nth power of the distance between them. As the concentration of dopant ions increases, the distance between them decreases, leading to increased energy transfer. The critical distance for energy transfer (Rc) can be determined using the equation given below

$$Rc = 2\left[\frac{3V}{4\pi XcZ}\right]^{\frac{1}{3}}$$

Rc stands for the critical distance, V for the unit cell's volume, Z for the number of cations, and Xc for the critical concentration of the activator ion (Gd^{3+}). The critical distance is discovered to be 17.09Å for the phosphor $KSr_4(BO_3)_3$:Gd^{3+} at V=911.144 Å3 , Xc=0.02, and Z=4. Nonradiative energy transfer is primarily caused by three processes: exchange interaction, radiative reabsorption, and multipole-multipole contact. When excitation and emission spectra match, there is radiation reabsorption; nevertheless, exchange interaction is considered when the critical distance is less than 5. Thus, neither of the procedures is relevant in this situation. [14]



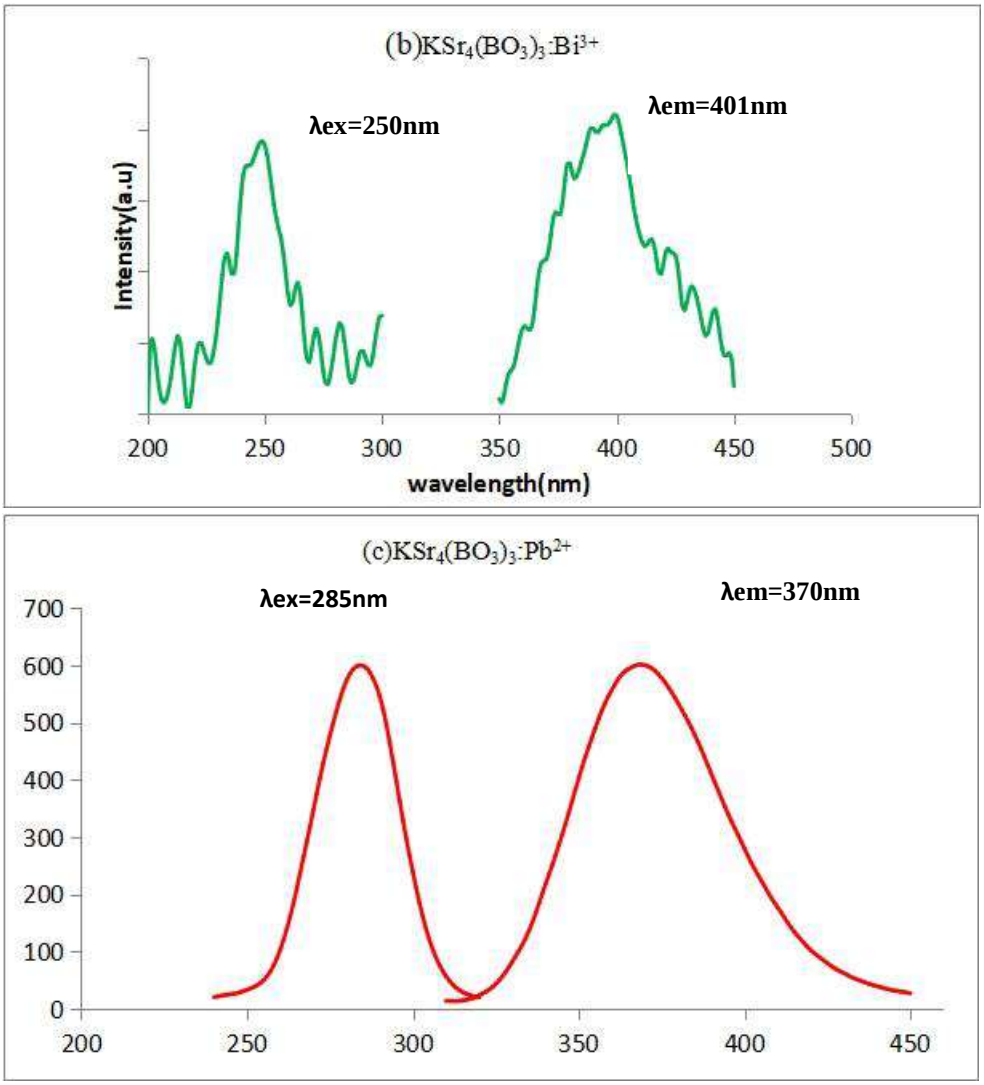


Figure3. - PL excitation and emission spectra of (a) $KSr_4(BO_3)_3$:Gd^{3+} (b) $KSr_4(BO_3)_3$:Bi^{3+}(c) $KSr_4(BO_3)_3$:Pb^{2+}

In Figure 3(b), broad excitation bands are observed between 220 nm and 290 nm, with a peak at 251 nm, corresponding to the $^1S_0 \rightarrow {}^3P_1$ transition of Bi^{3+}. When excited at 251 nm, an emission band appears at 401nm, indicating the transition from the $^3P_1$ excited state to the $^1S_0$ ground state. The absence of splitting or multiple bands in the emission spectra suggests that Bi^{3+} ions are likely occupying the positions of Sr^{3+} ions in the lattice. According to extensive literature on the luminescence of Bi^{3+} in inorganic hosts, Bi^{3+} typically absorbs light in the 220–290 nm range and emits in the 350–450 nm range.Figure 3(c) shows the photoluminescence spectrum of Pb^{2+} doped in the $KSr_4(BO_3)_3$ host material. The excitation band for the synthesized $KSr_4(BO_3)_3$:Pb^{2+} phosphor was observed at 285 nm, corresponding to the $^1S_0 \rightarrow {}^3P_1$ transition, and the emission band was observed at 370 nm, corresponding to the transition from the $^3P_1$ excited state to the $^1S_0$ ground state.This spectrum is characterized by the $^1S_0 \rightarrow {}^3P_1$ transition, originating from the $6s^2 \rightarrow 6p$ interconfigurational transition. Typically, at room temperature, emission is observed from the $^3P_1 \rightarrow {}^1S_0$ transition, although at low temperatures, the highly forbidden $^3P_0 \rightarrow {}^1S_0$ emission is also seen. There is not any splitting or multiple bands in the emission spectra observed, indicating that the Pb^{2+} ions are incorporated at only one site (Sr^{2+} ion site) in the crystal lattice. In many inorganic hosts, the emission band of the Pb^{2+} ion is in the UV region, but in some hosts, Pb^{2+} can emit in the visible region. This variability depends strongly on the site occupied by Pb^{2+} ions, the crystal structure of the host lattice,temperature and the electronegativity of the ligand.[15]

3. FE-SEM analysis-

By using the FE-SEM technique, as demonstrated in figure 4, the microstructural evaluation of the $KSr_4(BO_3)_3$ phosphors was carried out. The synthesised phosphors crystalline shape showed microgranularity

with a particle size range of 1 to 100 nm. This is appropriate for the high-energy emissions and absorptions from the phosphor particles outer surface. The luminescence intensity, which is controllable, is always impacted by the particle size and surface shape. The SEM scans show both larger and smaller individual particles, indicating that the particle sizes and shapes are random. Recrystallization is a gentle chemical method that saves time and money. It can be seen in the figures below that certain little particles with irregular shapes are present on top of the larger particles.

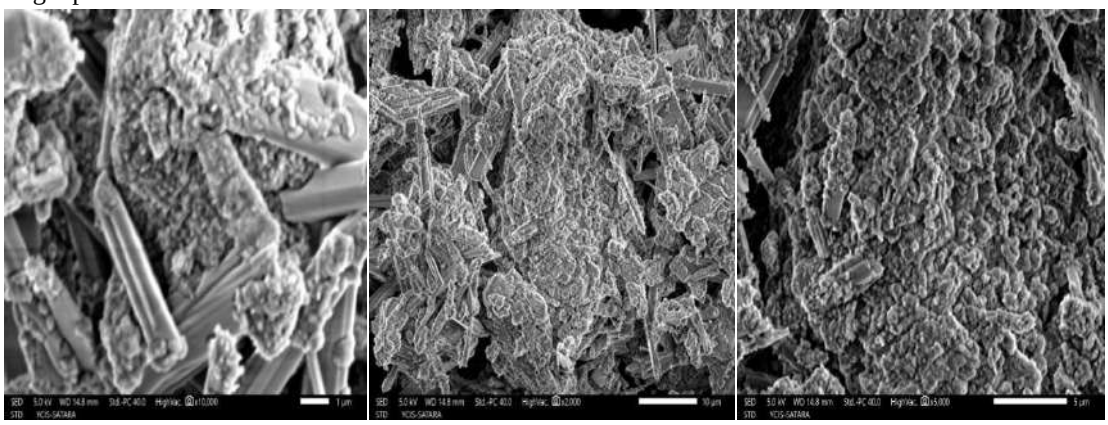
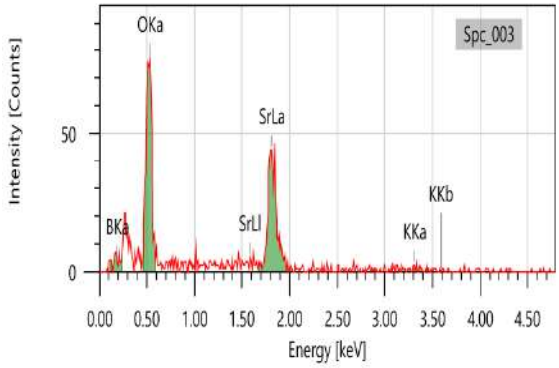


Figure 4.-SEM images of $KSr_4(BO_3)_3$

4. Energy Dispersive X-ray Analysis-

Through energy dispersive X-ray analysis, elemental analysis verifies the components in the produced materials and determines their qualitative chemical makeup (EDX). $KSr_4(BO_3)_3$:Gd^{3+}, Bi^{3+}, Pb^{2+} were formed by recrystallization method, and their formation was confirmed by EDX element analysis. The results shown in the next graphs figure 5 demonstrate how well the EDX data agree. However, it is quite challenging to use an EDX detector to find light elements like lithium and boron. However, the EDX graph's constant proportionality between the components demonstrates how the phosphors $KSr_4(BO_3)_3$ were formed correctly.



Element	Line	Mass%	Atom%
B	K	nd	nd
O	K	18.92+0.91	54.16+2.60
K	K	5.32+3.69	6.24+4.33
Sr	L	75.76+5.47	39.60+2.86
Total		100.00	100.00

Figure 5. EDX analysis of KSr4(BO3)3

IV. CONCLUSION

Recrystallization was employed to effectively synthesize the inorganic borate host phosphors $KSr_4(BO_3)_3$ doped with Gd^{3+}, Bi^{3+}, Pb^{2+}. This method is simple, rapid, low-temperature, and cost-effective. Photoluminescence (PL) studies indicate that this technique is particularly effective for synthesizing inorganic compounds with a borate host. When excited at 275 nm, $KSr_4(BO_3)_3$ doped with Gd^{3+} emits strongly at 313 nm. For $KSr_4(BO_3)_3$ doped with Bi^{3+}, an excitation at 251 nm results in an emission band at 401 nm, corresponding to the transition from the $^3P_1$ excited state to the $^1S_0$ ground state.For the synthesized $KSr_4(BO_3)_3$:Pb^{2+}phosphor, the excitation band was observed at 285 nm, corresponding to the $^1S_0 \rightarrow {}^3P_1$ transition, with an emission band at 370 nm, corresponding to the transition from the $^3P_1$ excited state to the $^1S_0$ ground state. $KSr_4(BO_3)_3$ phosphors doped with Gd^{3+}, Bi^{3+}, Pb^{2+} exhibit UV-B emission bands, making them highly suitable for phototherapy applications.

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NH_3Gas Sensing Applications of PPy Doped SnO_2Sensor to Study Sensitivity

Abstract: - In the present work, SnO_2 and PPy were prepared using standard chemicals under conditions and SnO_2 is doped by polypyrrole (PPy) in the proper stoichiometry. By changing doping percentage of PPy, four sensors S_1, S_2, S_3 and S_4 are prepared. Au electrodes and Platinum wires were used. Each sensor was calcinated at about 500^0C for 1h in ambient environment. To improve stability and repeatability, fabricated sensors were kept in N_2 environment for 2.5 h at about 180^0C and then in air for about 1.5 h. XRD technique was used for the phase characterization study of the prepared materials and SEM (scanning electron microscopy) was used for porosity measurement. The resistances of the prepared sensors were measured with the help of voltage drop method and then sensitivity was determined. Sensitivity of sensor was checked at different concentration of ammonia.

PPy doped SnO_2 composite; S3 sensor (15%PPy+ 85%SnO_2) showed enhanced sensitivity among the prepared sensors due to high porosity and high ionization absorption at the surface of sensor. PPy acted as assistant catalyst to increase conductivity. Sensitivity (R_g/R_a) was found to be maximum, 18.23 at 62 ppm of NH_3 gas concentration at an operating temperature of 30^0C. Also stability of the sensor was checked and found to be most stable.

Keywords:PPy, SnO_2 sensor, chemical precipitation method, sensitivity, stability, NH_3 gas, Screen Printing Technique

I INTRODUCTION

SnO_2 is a popular material for fabrication of gas sensors as it is best for reducing gasses detection. SnO_2 is a n-type semiconductor and its concentration of electron is established by concentration of stoichiometric defects such as oxygen vacancy like other metal oxide. Due to low cost, low weight, more porosity, simple design and high response, stannic oxide is generally used as best material. Many researchers stated that the sensitivity of SnO_2 can be enhanced by doping PPy [1-2].

Now a day, the atmosphere is being uncomfortable for breathing due to the many dangerous gasses present in the atmosphere. Therefore, it is vital to detect such dangerous and harmful gases in order to prevent human life, control air pollution, and protect nature from being damaged. Many people are facing problems with toxic, combustible and volatile gases in the atmosphere including domestic, laboratorial, and industrial places. Ammonia, one such hazardous and toxic gas and hence its detection is very important part. NH_3 is used in many places and in many applications, such as for cooling purposes in the industries and medical diagnoses and research. As hydrogen produced by the decomposition exerts high reduction effect on SnO_2, ammonia is a strong reducing gas [3-4]. Thus in the present work, it was decided to fabricate and use the sensors produced by using PPy doped in SnO_2 to sense ammonia gas. These prepared sensors had shown better response and stability during NH_3 gas detection.

II. EXPERIMENTAL

2.1 Synthesis of SnO_2 Nanoparticles:

GR grade chemicals of Sd-fine, India had been used for the study having purity 99.99%. SnO_2 had been prepared by taking 2g (0.1 M) of stannous chloride dehydrate ($SnCl_2.2H_2O$) which was dissolved in 100 ml H_2O. With magnetic stirring, after complete dissolution, 4 ml ammonia solution was added to this aqueous solution. Solution was stirred for about 30 minutes to get white gel precipitate [5-6].

Precipitate was left to settle for 9 to 10 h. The thick precipitate was then filtered and cleaned with distilled water 3-4 times by using de-ionized water. The washed and cleaned precipitate was combined with 0.27g carbon black powder (charcoal activated). The mixer was kept in vacuum oven at 85ºC for about 1 day to obtain the mixer in powder form. The dried sample then grinded to obtain fine power. This fine product of nanopowder of SnO_2 was calcinated at 700^oC upto 7 h in the auto-controlled muffle furnace (Gayatri Scientific, Mumbai, India.) to eliminate the impurities from product completely.

2.2 Synthesis of Polypyrole (PPy):

The Py monomer, anhydrous iron (III) chloride ($FeCl_3$) and methanol were used for synthesis of PPy [19]. The solution of 7 ml methanol and 1.892 g $FeCl_3$ was first prepared in round bottom flask. Then 8.4 ml Py monomer was added to ($FeCl_3$+methanol) solution with constant stirring in dark. The amount of Py monomer added to the solution (1/2.33 times of $FeCl_3$) was in such a way to get maximum yield. The resulting black precipitates were filtered and washed with copious amount of distilled water until the washings are clear. PPy so obtained was dried by keeping in oven at 600^{o}C for 3 h [7].

2.3 Preparation of Sensors:

PPy is doped with SnO_2 with different percentage. A paste is produced by using binder (butyl carbitol and ethyl cellulose). On clean glass plate with Al_2O_3 base, paste is screened out with the help of screen printing technique. Electrodes are formed on the side edge of the sensors for electrical connections.

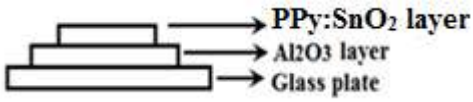


Fig. 1.Preparation of sensors

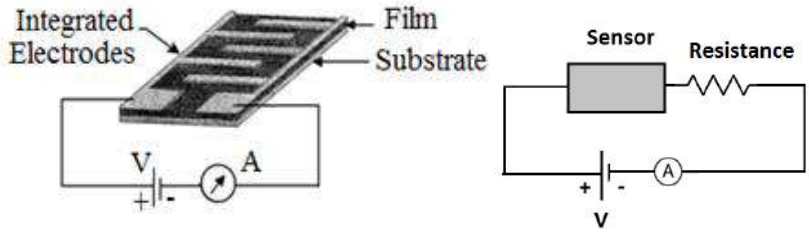


Fig. 2.Voltage drop method

For an hour, the prepared films were dried at 80-100^{o}C in calibrated oven. Due to this, all the organic materials (in the form of binders) and organic impurities were evaporated [8-9]. The surface resistance measurements were done by forming electrodes of silver paint on adjacent sides of the films. For drying the silver paint, the films were further heated at about 80^{o}C for half an hour. The prepared sensors are listed below in table 1.

Table 1:

Sr. No.	Composites	Sample codes
1.	5% PPy + 95% SnO_2	S1
2.	10% PPy + 90% SnO_2	S2
3.	15% PPy + 85% SnO_2	S3
4.	20% PPy + 80% SnO_2	S4

2.4 Sensitivity measurement:

Sensitivity [10-11] is defined as the ratio of resistance of the sensor due to presence of gas to the resistance in air environment and is given by

$$S = \frac{\text{Resistance in presence of gas}}{\text{Original resistance in air}} = \frac{R_{gas}}{R_{air}}$$

Where,

R_{gas} = Resistance of the sensor in presence of NH_3 gas environment and
R_{air} = Resistance of the sensor in presence of air.

III. RESULTS AND DISCUSSIONS

3.1 XRD Characteristics Study:

Fig.3 shows the X-ray powder diffraction (XRD) pattern of PPy doped SnO_2 materials.

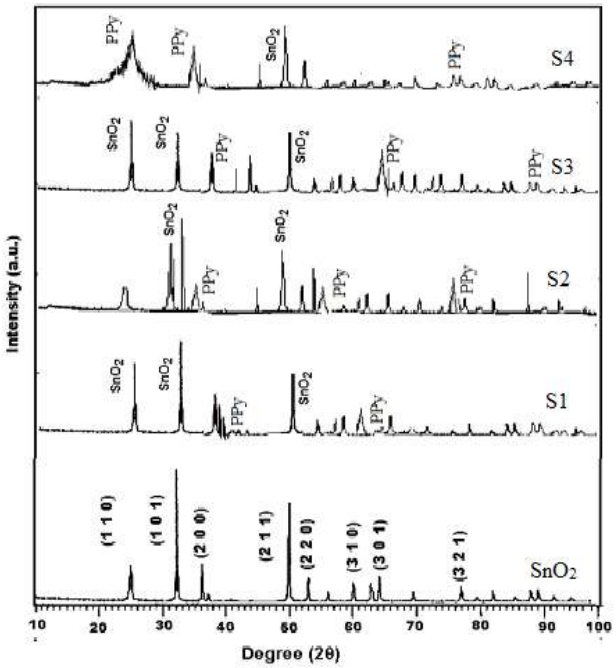
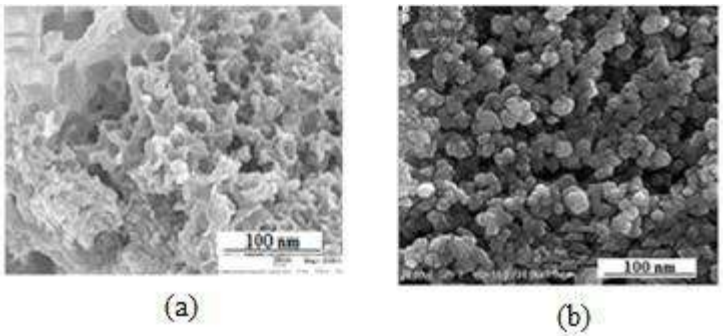


Fig.3.XRD of S_1, S_2, S_3 and S_4 sensors

As shown in XRD, even after calcinations at 600^0C for 1.5 h, phase was not changed and no new phase was seen.

X-Ray diffraction pattern of PPy exhibited that, it was amorphous in nature. The broad peak occurred at 24^0 and it is characteristics of amorphous nature of polypyrrole. The broad peak occurs due to the scattering of X-rays from polymer chains at the interplaner spacing. The maximum intensity position of amorphous also depends on monomer to oxidant ratio. The X-ray diffraction patterns of composites of PPy, SnO_2 and pure SnO_2, calcinated at 200^oC. Main peak, in case of pure SnO_2, is observed at 26.6^o and this peak corresponds to the plane (1 1 0) of SnO_2 in tetragonal structure (JCPDS Card No.3-1114) with 100% intensity and the average crystalline size by using Scherer's formula was found to be 92.24 nm [12-13]. All the peaks are for the composites materials for molar weight percentage of various samples that are perfectly matched.

3.2 SEM (Scanning Electron Microscope) Study:



(a) (b)

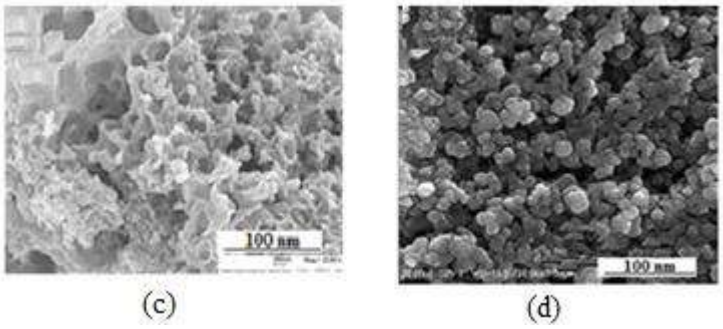


Fig.4.SEM of S_1, S_2, S_3 and S_4 sensors

From the SEM pictures, Fig. 4, it is observed that in every inch of the region, number of pores was different and an average number of pores was taken for comparative study. From every photo, porosity was calculated for one inch region. From figures, it is found that number of porosity of 15%PPy+ 85%SnO_2 (S3 sensor) composition is more among the prepared and pure samples. Due to high porosity [14-15], gas absorptive nature increases. This leads to the more NH_3 gas absorption and hence resistance of the S3 sensor is more and also sensitivity is found to be enhanced. Some of the pores are cylindrical and some are spherical, some are elongated and some pores have elliptical shapes. All these pores formed cavity which helped in the absorption of the gas.

3.3 Sensitivity Measurement:

Variation of sensitivity of sensors with concentration of Ammonia gas is shown in the following Fig. 5.

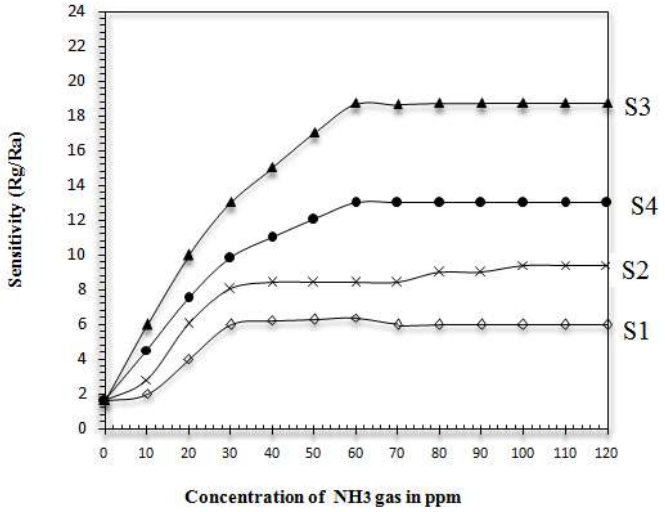


Fig.5.Variation of sensitivity with NH_3 gas concentration

As shown in Fig. 5, sensitivity of S1, S2 and S4 sensors is low as compared to that of S3 sensor. It was found that sensitivity of all the sensors increases linearly upto 60 ppm concentration of ammonia gas and then remains nearly constant. Maximum sensitivity (R_g/R_a) was recorded 18.23 at 62 ppm of NH_3 gas for S3 sensor (15%PPy+ 85%SnO_2).

The semiconductor gas sensor is based on the change of conductivity of the semiconductor material due to its interaction with gas. Electron transfer occurs between the semiconductor and the adsorbates when molecules of the gas are adsorbed on the surface of semiconductor. The adsorbates accept electrons from the semiconductor when the electron's affinity of the adsorbates larger than the work functions of the n-type semiconductor [16-17]. This transfer of electrons and absorption of electrons continue until Fermi-level of the gas-adsorbed semiconductor surface becomes equal to that of the bulk. Due to this, accumulation of charges occurs near the semiconductor surface and causes the induction of potential barrier. This enhances the resistance of the material thereby increases sensitivity. Free electrons generating from oxygen vacancies causes electrical conductivity.

3.4 Stability Measurement:

Variation of sensitivity of prepared sensors with time is shown in the following Fig. 6.

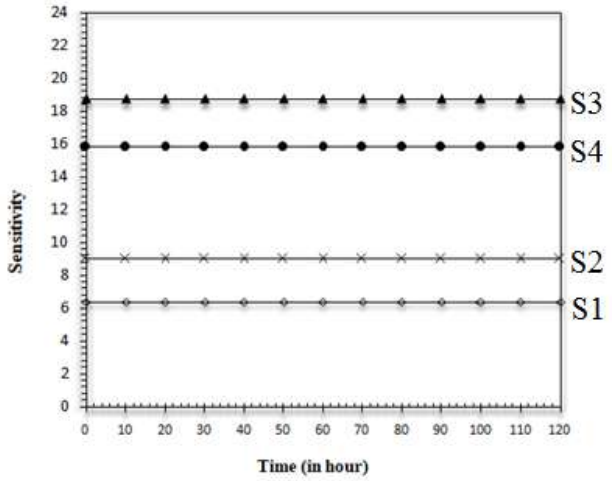


Fig.6.Variation of sensitivity with time (in hour)

The sensitivity variation [18] with time was checked for 120 hrs, and it was found that sensitivity was not changing with time i.e. sensors showed more stability.

III. CONCLUSION

PPy doped SnO_2 composite; S3 sensor (15%PPy+ 85%SnO_2) showed enhanced sensitivity among the prepared sensors due to high porosity and high ionization absorption at the surface of sensor. PPy acted as assistant catalyst to increase conductivity. Sensitivity was found to be maximum, 18.23 at 62 ppm of NH_3 gas concentration at an operating temperature of 30^0C. Also stability of the sensor was checked and found to be most stable.

IV. ACKNOWLEDGEMENT

The author would like to acknowledge Department of Physics, Vidya Bharati Mahavidyalaya, Amravati (India) for providing Research center to carry on this work.

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Exploring the Influence of Salicylic Acid Doping on the AC Conductivity and Dielectric Constant in PVC-PMMA Thin Films

Abstract: - This study examines the electrical and structural properties of thin films made from a blend of Polyvinyl Chloride (PVC) and Polymethyl Methacrylate (PMMA) in a 1:2 weight ratio. The films were analyzed both with and without an 8% addition of salicylic acid (SA) as a dopant. These films were created using the isothermal evaporation technique. The research focused on measuring alternating current (AC) conductivity across a frequency range of 20 Hz to 200 KHz at temperatures of 50°C and 150°C. Key points of interest included the AC conductivity and dielectric constant of the films.The study found that the undoped films showed an increase in AC conductivity with rising temperatures, which suggests enhanced mobility of charge carriers. As expected, the AC conductivity increased with frequency, showing that conductivity improves at higher frequencies. For the undoped films, the dielectric constant decreased as frequency and temperature increased, indicating that the material's response to an alternating electric field diminished. An important finding was that at a constant frequency, AC conductivity decreased with higher percentages of the dopant. This suggests that the presence of salicylic acid reduces the number of active sites in the PVC-PMMA blend, leading to lower conductivity. However, at higher temperatures, the AC conductivity of doped films increased, indicating that salicylic acid enhances conductivity at elevated temperatures. The effect of the dopant on the dielectric constant was noticeable but varied depending on specific conditions..

Keywords: PVC-PMMA, AC conductivity, dielectric constant, frequency, salicylic acid

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I. INTRODUCTION

Polymer blends, like those mixing Polyvinyl Chloride (PVC) and Poly(methyl methacrylate) (PMMA), are super popular in electronics because they're flexible and you can tweak their electrical properties. These PVC-PMMA blends are especially cool because they're strong, heat-resistant, and easy to work with. But, to make them even better at conducting electricity, scientists are adding stuff called dopants.

One interesting dopant is salicylic acid, a natural compound known for its electronic properties. When you add salicylic acid to PVC-PMMA blends, it can bring in more charge carriers, change how the material responds to electric fields, and affect how well it conducts electricity.

So, this study is all about checking out how PVC-PMMA thin films behave with and without 8% salicylic acid added. By playing around with temperature and frequency, the researchers want to see how these factors affect the films' ability to conduct electricity and their response to electric fields. The idea is to understand how dopants like salicylic acid can jazz up the electrical performance of these materials.

The paper dives deep into the experiments they did and what they found out. It's not just about confirming what people already thought; the results actually surprised them. This shows how much more we need to understand about how these polymer blends work electrically, especially if we want to use them in fancy electronic gadgets.

In simpler terms, the study looks at how adding salicylic acid, a fancy chemical, affects PVC-PMMA blends. This could make the blends better for electronics. They did tests with different temperatures and frequencies to see how it all works. And the results weren't what they expected, showing there's still lots to learn about these materials.

II. RELATED WORK

Investigated the electrical conductivity of polyaniline doped polyvinylchloride (PVC) and poly(methyl methacrylate) (PMMA) thin films by analyzing the I-V characteristics at various temperatures ranging from 323 to 363 K. Their study aimed to understand the conduction mechanisms in these materials.[1] Belsare et al. [2] conducted a study focusing on the AC electrical conductivity and dielectric constants of a specific material at different temperatures and frequencies. The AC electrical conductivity and dielectric constants were measured at temperatures of 323K, 333K, 343K, and 353K, as well as frequencies ranging from 1kHz to 1MHz. the dielectric constants demonstrated an increasing trend with temperature in the blends studied. The authors also provided evidence of miscibility in the blends through FTIR spectroscopy. These results contribute to the understanding of the electrical properties and behavior of the specific material under varying temperature and frequency conditions.

III. EXPERIMENTAL

Thin films of PVC-PMMA with different dopant concentrations were prepared using the isothermal evaporation technique. Preparation of a Polyblend thin film of PVC-PMMA in 1:2 weight proportional, the dopant and the polymer mixture were dissolved in a solvent (THF) were mixed in solution form .for a complete Homogeneous solution was kept for two or three days. after two or three days solution are in a homogeneous form then the solution mixture was poured onto a perfectly planed glass plate floating freely in a pool of mercury for perfect leveling .it was thereafter allowed to evaporate at room temperature further, and it was dried for 2 days to remove any traces of solvent. the dry film removes from the glass plate and cuts into pieces of desired size then measure the thickness of the thin film by DIGMATIC micrometer, which was then coated on two sides with silver paint then by using the multimeter check whether the two electrodes working or not .then investigate the conductivity .Two sets of films were fabricated: one without salicylic acid (0% dopant) and the other with 8% salicylic acid as the dopant. AC conductivity measurements were performed using an LCR meter, covering a

frequency range of 20 Hz to 200 kHz. The measurements were carried out at two different temperatures: 50°C and 150°C. The ln f and ln AC conductivity values were recorded for further analysis.

Graph related to AC conductivity PVC-PMMA 1:2 with 0% SA

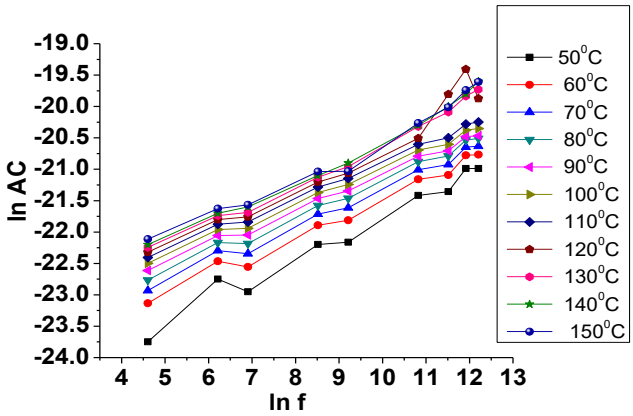

Fig 1.1 Variation of ln f vs ln AC Conductivity

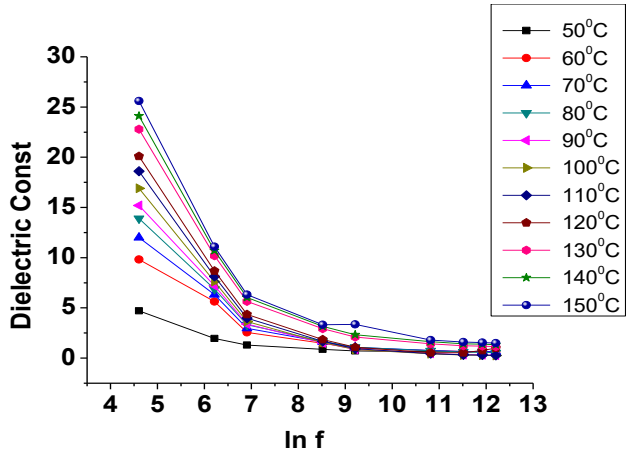

Fig 1.2 Variation of ln f vs Dielectric constant

Graph related to AC conductivity PVC-PMMA 1:2 with 8% SA:

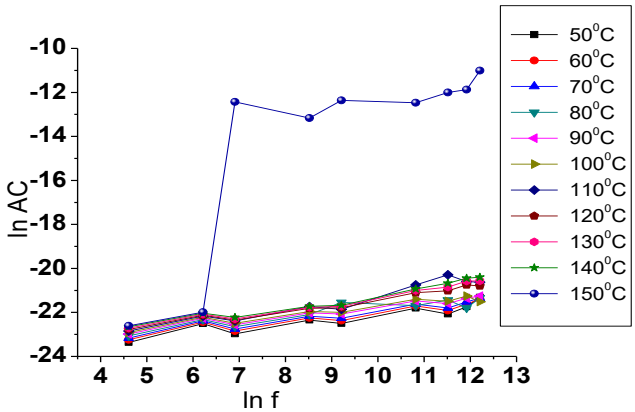

Fig 1.3 Variation of ln f vs ln AC Conductivity doped SA

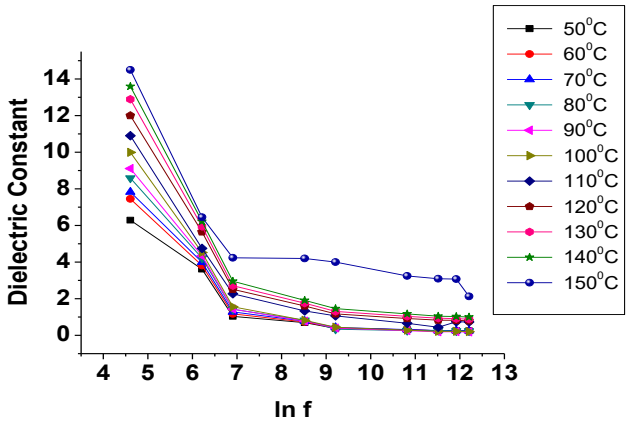

Fig 1.4 Variation of ln f vs Dielectric constant doped SA

IV. RESULTS AND DISCUSSION

In this section, we examine the behavior of PVC-PMMA thin films with and without a dopant (Salicylic Acid) with respect to alternating current (AC) conductivity and dielectric constant. We observe how these properties are influenced by frequency, temperature and dopant.

AC Conductivity without Dopant (0% SA): Frequency Dependence: Fig 1.1 shows the AC conductivity is inversely proportional to frequency, meaning that higher frequencies lead to increased conductivity. This suggests greater charge carrier mobility at higher frequencies, resulting in higher conductivity. Temperature Dependence: Surprisingly, as temperature rises, AC conductivity also increases. This indicates that the undoped PVC-PMMA thin film becomes more conductive at elevated temperatures due to increased thermal energy.

Dielectric Constant without Dopant (0% SA): Frequency Dependence: Fig 1.2 shows the dielectric constant decreases with increasing frequency, signifying a reduced ability to store electrical energy as frequency rises. This behavior is common in dielectric materials and indicates decreased polarization. Temperature Dependence: With rising temperature, the material becomes less viscous, making it easier for dipoles to align with the electric field, resulting in increased dielectric constant values.

. AC Conductivity and Dielectric Constant with Dopant (8% SA): Frequency Dependence: Fig 1.3 and Fig 1.4 shows the behavior of AC conductivity with the dopant follows a similar trend to the undoped sample, increasing with frequency and dielectric constant decreases with increasing frequency Temperature Dependence: The effect of temperature on AC conductivity with the dopant may differ from the undoped sample, as the presence of the dopant influences charge carrier mobility in a unique manner.

Comparison of Dopant vs. without Dopant: AC Conductivity: The doped sample generally exhibits higher AC conductivity at high temperatures, suggesting that the presence of Salicylic Acid enhances conductivity under these conditions. However, at constant frequency, AC conductivity decreases with an increase in dopant percentage, except at high temperatures, where it suddenly increases. Dielectric Constant: The dielectric constant of the doped sample may vary compared to the undoped sample, with an increase in dopant percentage leading to a decrease in dielectric constant due to chemical factors. Overall, these results shed light on the complex interplay of frequency, temperature, and dopant presence in PVC-PMMA thin films, offering insights into their electrical behavior.

V. CONCLUSIONS

In summary, the study investigated the AC conductivity and dielectric constant of PVC-PMMA thin films with and without a dopant of salicylic acid across varying frequencies and temperatures. The results indicated a strong frequency-dependent behavior, where AC conductivity increased with increasing frequency, a typical characteristic of many materials. Additionally, the temperature-dependent behavior showed an unexpected increase in AC conductivity with rising temperature for the undoped sample, likely due to enhanced

charge carrier mobility. Furthermore, in this graph at constant frequency,AC conductivity gradually decrease with increase in the dopant percentage As SA is least interested in making any kind of association with PVC-PMMA blend, its presence becomes unnecessary. This stranger particle may exert its overshadowing impact on the functional sites of poly-blends. This maybe the reason for decrease in conductivity with increase in dopant percentage. But at high temperature ac conductivity suddenly increase with dopant thin film this suggests that the presence of salicylic acid enhances the material's conductivity at high temperature. The data demonstrated that the presence of salicylic acid as a dopant enhanced AC conductivity, as the doped sample exhibited higher conductivity values compared to the undoped sample at High temperature. The dielectric constant exhibited a decrease with increasing frequency and temperature for the undoped sample, while the effect of the dopant if we increase dopant percentage then dielectric constant decreases due to chemical perspectives

Data Availability

The raw data required for ongoing study, hence it cannot be shared.

Conflict of Interest

Authors declare that they do not have any conflict of interest.

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Synthesis of SnO_2 Nanoparticles by Solution Combustion Method

Abstract: - The SnO2 nanoparticles were synthesized by solution combustion method. It is also characterized for their structural and optical properties using various techniques including XRD, UV-Vis spectroscopy and FTIR. SnO_2 nanostructures have a tetragonal rutile structure, as determined by X-ray diffraction studies, with an average crystallite size of 11.47 nm. The bandgap was estimated as 3.72 eV from the UV-Visible spectra. The FTIR spectra provide evidence supporting the crystalline phase of SnO_2.

Keywords: SnO2 nanoparticles, X-ray diffraction, UV-visible spectra, FTIR

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I. INTRODUCTION

Transition-metal oxide nanoscale materials have sparked significant research interest due to their adaptive chemical, physical, and mechanical properties, which provide superior performance when compared to bulk materials [1,2]. The finite size, high surface-to-volume ratio, and possible appearance of quantum effects have a dramatic effect on nanomaterial properties [3]. Tin dioxide (SnO_2), an n-type semiconductor metal oxide, with a wide band gap (E_g=3.65 eV at 300 K) and a high excitation binding energy of 130 eV at ambient conditions [4,5]. With its remarkable physical and chemical characteristics, SnO_2 finds extensive utilization in various fields such as solar cells [6], gas sensors [7], transparent electrodes [8], transistors [9], batteries [10], and more. Several techniques have been used to prepare SnO_2 nanostructures, including sol-gel [11], hydrothermal [12], SILAR [13], precipitation [14], combustion-assisted sol-gel method [15], and microwave [16] among others.

Solution combustion method is a versatile, rapid, cost-effective, self-sustaining, energy efficient and scalable approach for the synthesizing of ultra-fine and uniform nanoscale materials [17,18]. This self-sustaining exothermal process involves the combustion of a uniform mixture of oxidizers (such as metal nitrates, metal sulfates, and carbonates) and fuels organic compounds like carboxylate and aliphatic amines (like urea, glycine, sucrose, and hydrazides) to produce a fine powder [17, 19]. In this study, we present the structural and optical properties of SnO2 nanoparticles synthesized using a rapid and cost-effective solution combustion method.

II. EXPERIMENTAL:

2.1 Synthesis Of SnO_2 Nanoparticles

All the chemical reagents were analytical grade and used as purchased without further purification. Tin chloride pentahydrate ($SnCl_4.5H_2O$) and urea ($CO(NH_2)_2$) was purchases form Sigma Aldrich. Ammonia solution (35%) was obtained from S. D. Fine Chemicals, India. Urea was used as a fuel.

In a typical solution combustion method, 15 ml of 1M solution of $SnCl_2.5H_2O$ were added to 150 ml of distilled water. The solution was stirred with a magnetic stirrer for 30 minutes at room temperature. Next, urea was added in the stoichiometric ratio under continuous stirring to the above solution and stirred for another hour to obtain a homogenous solution. The ammonia solution was used to adjust pH = 7, and the solution was stirred for 4 hours at 100 ^oC. Then, the resulting sol was further heated with magnetic stirring to remove the presence of water in the sol until a viscous gel was formed. The viscous gel was ignited by increasing the temperature up to 200 ^oC, and a brownish-gray powder of the sample was obtained. After cooling the powder to ambient temperature, it was delicately ground using an agate mortar and pestle. Finally, the powder was calcined at 500 ^oC for 5 hours to obtain tin oxide nanoparticles.

2.2 Characterization:

The crystal structure, purity, and phase identification of SnO_2 nanoparticles were examined using X-ray diffraction (XRD) using a Rigaku Miniplex-II instrument operating with Cu-Kα radiation (λ=1.5405 Å) in the 20–80◦ (2θ) range. A UV-visible spectrophotometer (Shimadzu Corporation, Kyoto, Japan) was used to characterize the optical properties of the product. The spectral range used was 200-800 nm. FT-IR spectra of dried samples were acquired with an Affinity-1S IR spectrometer (Shimadzu Corporation, Kyoto, Japan) over the 4000–500 wavenumber

III. RESULT AND DISCUSSION:

3.1 XRD Studies:

The presence of distinct peaks in the XRD pattern of the SnO_2 nanoparticles at 2θ = 26.60, 33.83, 37.97, 51.79, 54.78, 57.81, 61.91, 65.99, 71.27, and 78.74° can be attributed to the (110), (101), (200), (211), (220), (002), (310), (301), (202), and (321) planes respectively [20]. All of the diffraction peaks can be indexed to the tetragonal rutile phase (P42/mnm) of SnO_2 (PDF Card No.: 1000062) [21]. The absence of any additional secondary phases of SnO2 suggests that the synthesized product exhibits a high level of purity. The calculated mean lattice parameters, a = b = 4.7357 $A^o$and c = 3. 1873A^o, exhibit a strong agreement with the standard values [22]. The average crystallite size of nanoparticles (D, nm) was calculated from Debye-Scherrer's equation [23].

$$D = 0.9\lambda / \beta \cos\theta \quad ----------(1)$$

where D is the size of a particle; λ is the wavelength of X-rays, which is equal to 0.154059 nm; β is a full width half maximum (FWHM) of the corresponding peak and θ is a diffracting angle. The average crystallite size of the SnO_2 nanoparticles synthesized in this method was obtained to be 11.47 nm. An overview of the structural parameters associated with the tetragonal SnO_2 lattice is listed in Table 1. These include unit

cell volume [24], lattice strain [25], dislocation density (δ), lattice distortion [26], number of unit cells per unit volume [27], specific surface area [28]. The quality of the synthesized SnO_2 nanoparticles appears to be fine, as δ is small and η is large compared to values reported in the literature [29].

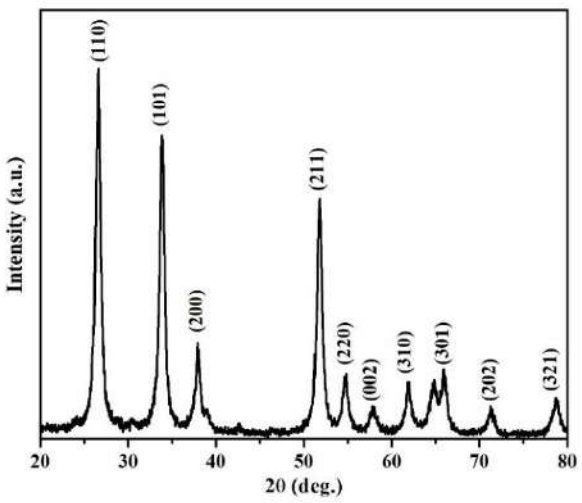

Fig.1: XRD pattern of SnO2 nanoparticles

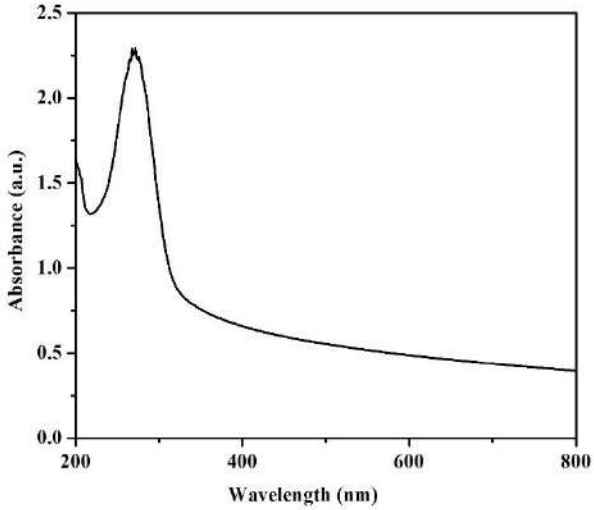

Fig. 2: UV-Vis. absorption spectrum of SnO_2 Nanoparticles

Table 1: Unit cell volume, strain, dislocation density, lattice distortion, number of unit cells per unit volume and specific surface area of SnO_2 nanoparticles.

Lattice Constant		Average Crystaline Size (nm)	Unit Cell Volume $V = a^2c\ (m^3)$	Lattice Strain $\varepsilon = \beta / 4\tan\theta$	Dislocation Density $\delta = 1/D^2$ lines/m^2	Lattice Distortion $U = a/c$	Unit Cells Per Unit Volume $n = pD^3/6V$	Specific Surace Area $S = 6/rD' \ 10^3$ m^2/g
a=b (A^o)	c (A^o)							
4.7357	3. 1873	11.47	71.48	2.156×10^{-3}	7.601×10^{16}	1.485	11.07×10^3	75.27

3.2 UV- Visible Study:

To examine the optical characteristics using UV-Vis. absorption spectroscopy, SnO_2 nanoparticles were dispersed in a solution containing 2-propenol and ethylene glycol in a 3:2 proportion. Fig. 4 shows the UV-Vis absorption spectra for tin oxide nanoparticles. The observed spectrum (Fig.2) exhibited a sharp absorption peak at 272 nm, at a shorter wavelength compared to bulk SnO_2 (344 nm) [30]. The band gap energy was estimated by analyzing the Tauc plot (Fig. 3) and was measured to be 3.74 eV.

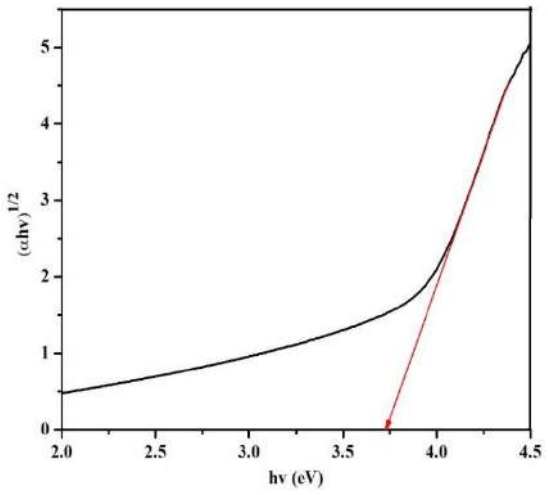

Fig. 2: Optical band gap of SnO2 nanoparticles

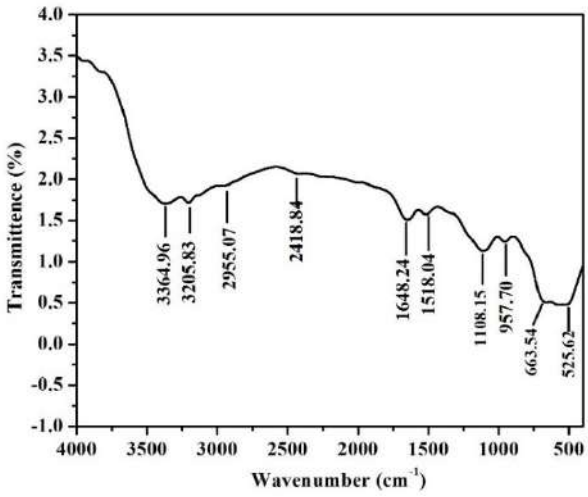

Fig.:4 FTIR Spectra of SnO2 nanoparticles

3.3 Fourier transform infrared spectra (FTIR):

The FTIR spectrum of the dry SnO_2 nanoparticles sample is shown in Fig.4. The band noticed at 3364 and 3205 cm^{-1} are due the O-H stretching O-H bending vibrations of water molecules reabsorbed from the ambient atmosphere by SnO_2 nanoparticles [29]. Bands at 1648 and 1518 cm^{-1} were observed due bending vibration of H-O-H from water molecules entrapped inside the SnO_2 nanostructures [31]. The band area around 2955 and 2418 cm^{-1} indicates the presence of C–H group [30]. The transmission in the region near 525 cm^{-1} and 1108 $cm^{-1}$is related to the vibration of Sn–O and Sn-OH bonds [32]. The O-Sn-O asymmetric stretching of SnO2 appeared at 663 cm^{-1} and ensured the existence of the SnO_2 crystalline phase [33].

IV. CONCLUSION:

SnO2 nanoparticles were synthesized using straightforward solution combustion synthesis. The X-ray diffraction pattern confirms the formation of the tetragonal rutile system of SnO_2. The observed average size of the crystallites is 11. 47 nm. UV-Vis. analysis showed an absorption peak at 272 nm, at a shorter wavelength compared to bulk SnO_2 (344 nm), confirming the blue shift. The band gap calculated using the Tauc relation is 3.74 eV, which is larger than that of bulk SnO_2. The asymmetric stretching vibrations of the O-Sn-O bond at 663 cm-1 in the FTIR spectra ensure the formation of SnO_2. The Fourier transform infrared spectroscopy analysis indicated that water molecules were present on the nanoparticles as a result of reabsorption from the ambient atmosphere.

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Impact of Laser irradiation on seed germination, seed vigour and electric conductivity in Groundnut seeds

Abstract: - In this study, the groundnut seeds (Arachis hypogaea L.) were exposed to He-Ne laser. We had taken four varieties of groundnut seeds(TAG_{24},SB_{11}&G_2), each varieties were divided into four groups. First group was the controlled group and received no radiation. Second, third and fourth group were irradiated 2, 4 and 6 minutes respectively by He-Ne laser with wavelength 632.8nm. from a distance of 45cm. Exposure with He-Ne laser gave significant results in increasing of germination percentages and vigour index but electrical conductivity has been decreased.

Keywords: Laser irradiation, germination rate, vigour index and electrical conductivity.

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I. INTRODUCTION

Light plays a major role in growing of plant. The effect of light during plant growth and germination process is undeniable. Laser can emit a high density of photons at small solid angle. The characteristics of the laser radiation, such as monochromatic, polarization, coherence and high density, can be used not only in all spheres of engineering but also in biology and plant growth [1-3]. The growing need for ecological agricultural products together with the increased demand of crop materials for food production as well as for other branches of industry imposes the necessity for searching new, safer decisions for raising the agricultural production [4-7]. Sustainable agriculture is a management system for renewable natural resource for food production income and livelihood for present and future generations [7-9]. Physical factors such as microwave and laser radiation are useful for plants enable to vegetable at higher energy level. It is based on the fact that physical methods increase the energy account by internal transformation of energy [10]. The germination of seed is dependent on both internal and external conditions. One of the most important external factors is light, which plays vital role in photosynthesis and non-photosynthesis processes involving action of light [11-15].

The previous studies showed that LED light and He-Ne laser presented a positive role in acceleration the plant growth, metabolism and increase their resistance to diseases, which suitable applications of laser irradiation improved germination capacity of plant seeds [4,16,17].

Laser irradiation is considered as a new branch in agriculture. This work aimed to study the effect of laser irradiation and exposure time on germination, vigour index and electric conductivity of groundnut seeds. Groundnut are the most important commercial crop playing a key role in economical and social affects of world continues to be acclaimed as king of oil seed.

II. MATERILAS AND METHOFDS

2.1. Seed materials:

Groundnut seeds (Arachis hypogae L.) used in this work were supplied by college of agricultural engineering and technology, Marathwada Krishi Vidyapeeth, Parbhani, India. The experiment were carried out at the department of physics , Shri Shivaji College, Parbhani.

2.2. Treatments:

Continuous laser irradiation at λ =632.8nm was obtain from He-Ne and intensity of beam is 5mW/mm^2.The groundnut seeds of three verities (TAG_{24}, SB_{11}, G_2), each having 800 seeds were taken. Each varieties of seeds were divided into four groups. The first is the controlled (no irradiation) and rest of were irradiated to 2, 4, 6 minutes to He-Ne laser. The irradiation treatment of the seeds were performed in the dark room to avoid the influence of the Sun rays.

2.3. Germination test:

After the treatments, irradiated and controlled seeds were placed in water saturated towel paper. In each towel paper contained 200 seeds which were treated with time period of 0 min., 2min., 4min. and 6min. Sprayed the distilled water two times in a day to germination of groundnut seeds and count daily the number of seeds were germinated.

2.4. Seed Vigor Index:

Seed vigor index were calculated by determining the germination percentage and seedling length of the same seed lot. We were selected randomly 10 germinated seeds and measured seedling length.

The seed vigor index was calculated by using the formula

Vigor Index=germination % x Average seedling length (in mm)

2.5. Electrical conductivity test:

A seed sample of 10gm was sterilized with distilled water for 2-3 minutes. The clean sample was immersed in 100ml of water at 25±1^{0}C temperature for 10-12hr. After that the seeds were removed by a clean forcep. The steep water left was decanted and was termed as leachate. The conductivity meter was warmed about 30 minutes before testing by deeping in distilled water. First the conductance of distilled water was measured, then leachate was measured. The formula for calculate the electrical conductivity of seed extract was as follows.

E.C.=[Actual E.C. meter reading –E.C. of distilled water]x Cell constant factor.

Ammonia solution ($NH_3 \cdot H_2O$): Used for pH adjustment.

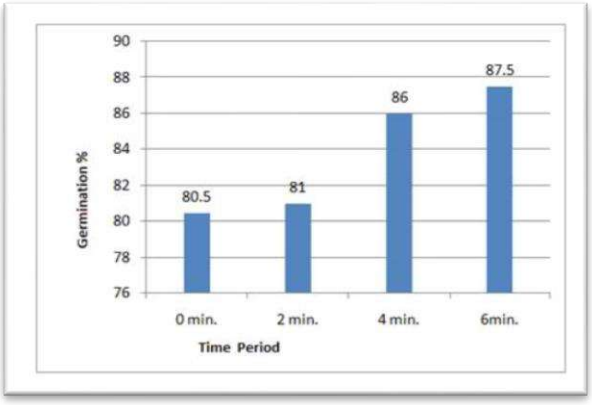
III. RESULT AND DISSCUSSION

3.1: GERMINATION PERCENTAGE

The results of germination test for all varieties based on irradiation time as shown in table.

Table (1) No. of seeds germinated per day for controlled and irradiated seeds of TAG24 variety

No. of Days	No. of seeds germinated per day			
	Controlled	Irradiation time period		
		2 min.	4 min.	6 min.
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	15	22
5	26	32	31	39
6	39	31	45	34
7	47	56	34	33
8	49	49	48	57
Total	161	162	172	175
%	80.5%	81%	86%	87.5%

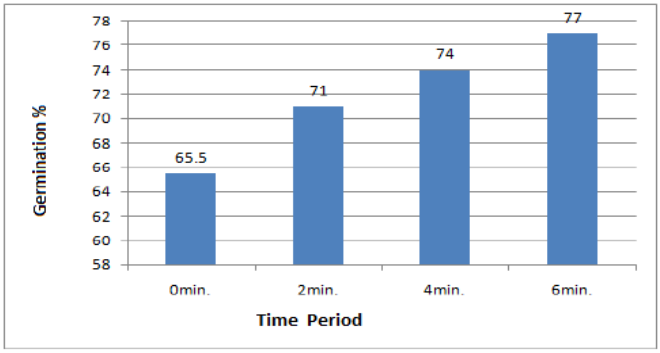


Graph 1) Germination % for TAG $_{24}$ Variety Vs irradiation time

From graph it was seen that as the time period of irradiation increases the germination percentage also increased from 80.5% for controlled seed to 87.5% for 6min. irradiated seed.

Table (2) No. of seeds germinated per day for controlled and irradiated seeds of SB_{11} variety

No. of Days	No. of seeds germinated per day			
	Controlled	Irradiation time period		
		2 min.	4 min.	6 min.
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	12	14
5	19	28	25	26
6	24	25	24	34
7	40	42	41	38
8	48	47	46	42
Total	131	142	148	154
%	65.5%	71%	74%	77%

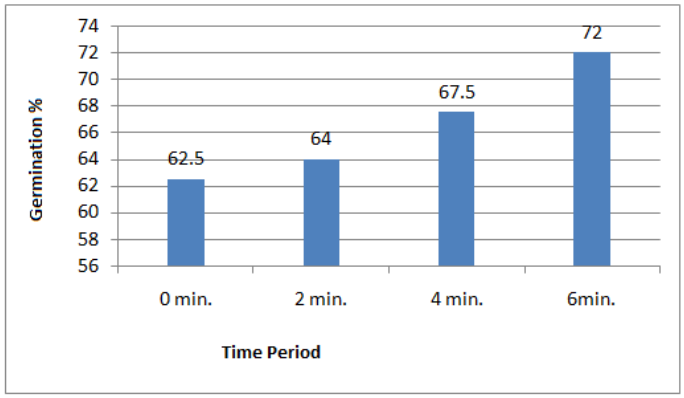


Graph 2) Germination % for SB $_{11}$ Variety Vs irradiation time

From graph it was seen that as the time period of irradiation increases the germination percentage also increased from 65.5% for controlled seed to 87.5% for 6min. irradiated seed.

Table (3) No. of seeds germinated per day for controlled and irradiated seeds of G_2 variety

No. of Days	No. of seeds germinated per day			
	Controlled	Irradiation time period		
		2 min.	4 min.	6 min.
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	9	12	15
5	21	26	32	24
6	26	33	31	30
7	36	34	28	35
8	42	36	32	40
Total	125	128	135	144
%	62.5%	64%	67.5%	72%



Graph 3) Germination % for G2 Variety Vs irradiation time

From graph it was seen that germination % increases from 62.5% for controlled seed to 72% for 6min. irradiated seed. He-Ne laser irradiation enhanced the germination percentage of groundnut seed, after eight days germination % increases 7-11% of irradiated seed as compared to controlled seed. Germination rate of TAG_{24} variety were more than SB_{11} and G_2 varieties.

3.2. Vigour Index

The vigour test of the groundnut seed also shows the deflection in the vigour index of the controlled and irradiated seed. The seeds treated for more time period were more vigours than the controlled seed.

Table 4) Vigour index for TAG_{24} Variety

Seed sample	Controlled (0min.)	2min.	4min.	6min.
Germination %	80.5	81	86	87.5
Seedling Length (mm)	75	80	82	85
Vigour Index	6037.5	6480	7052	7437.5

Table 5) Vigour index for SB_{11} Variety

Seed sample	Controlled (0min.)	2min.	4min.	6min.
Germination %	65.5	70	74	77
Seedling Length (mm)	68	77	76	79
Vigour Index	4454	5467	5624	6083

Table 5) Vigour index for G_2 Variety

Seed sample	Controlled (0min.)	2min.	4min.	6min.
Germination %	62.5	62	67.5	72
Seedling Length (mm)	62	70	73	77
Vigour Index	3875	4340	4927.5	5544

The vigour index in all varieties i.e. TAG24, SB11 and G2 increases with the irradiation time period. For TAG24, the vigour index was increased from 6037.5 to 7437.5. For SB11, the vigour index was increases from 4454 to 6083. For G2, the vigour index was increases from 3875 to 5544. It was seen that as irradiation time increases Vigour index also increases.

3.3. Electrical Conductivity Test of Leachates.

The electric conductivity (E.C.) of the groundnut seed extract was measured by a digital electrical conductivity meter in mu.mhos/cm/gm.

Electrical conductivity of distilled water=3.8 (mu.mhos/cm/gm.).

Cell constant factor=1.28

Table 7) . Electrical Conductivity of Leachates forTAG_{24},SB_{11} and G_2 verities of groundnut seed.

Variety	Sample	Actual meter reading	Calculated E.C.
TAG_{24}	0min.	6.0	2.816
	2min.	5.8	2.56
	4min.	5.2	1.792
	6min.	4.9	1.408
SB_{11}	0min.	5.8	2.56
	2min.	5.5	2.176
	4min.	5.0	1.536
	6min.	4.8	1.28
G_2	0min.	5.9	2.688
	2min.	5.4	2.408
	4min.	5.2	1.792
	6min.	4.7	1.152

Weakening of cell membrane is poor vigour seeds causes leakage of water soluble compounds like suger, amino acids electrolytes etc. when immersed in distilled water. It was seen that irradiation time increases , electrical conductivity goes on decreasing. It means that less water soluble compounds leakage for more time of irradiation.

IV. CONCUSION

In the irradiation process the nucleus cell membrane of the DNA stands break and repairs the DNA stand. Because of reassembling of DNA stand the germination capacity and seed vigour index increases. Many researchers observed that irradiation of laser reduces seed born pathogen. Due to that significant increases in germination percentage and vigour index of all varieties of groundnut seed.

The time period of irradiation increases the electrical conductivity of irradiated seed was decreases. If the electrical conductivity is less the germination capacity of seed is more. The groundnut is one of the important oil seed. The area under groundnut is decreases day by day. To increase the groundnut production the irradiation treatment is used.

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Enhanced Ammonia Sensing Performance of NiO-WO_3 Metal Oxide Composite Gas Sensors

Abstract: - The detection and monitoring of ammonia gas have significant implications in various fields, including agriculture, environmental safety, and industrial processes. This abstract presents a comprehensive study of the utilization of NiO-WO_3 metal oxide composite gas sensors for the detection of ammonia. Nickel oxide (NiO) and tungsten trioxide (WO_3) are promising semiconducting materials known for their high sensitivity to reducing gases. The synergistic combination of these oxides in composite structures has garnered attention due to their enhanced sensing properties, such as improved selectivity, sensitivity, and response/recovery times. This study discusses the synthesis methods employed to fabricate NiO-WO_3 composites and highlights the influence of various parameters on the sensing performance, such as composition, morphology, and operating temperature. Moreover, the mechanisms underlying the gas-sensing behavior of NiO-WO_3 composites, including surface reactions and charge transfer processes, are elucidated. Furthermore, recent advances in nanostructuring and functionalization strategies to further enhance the gas-sensing performance of these composites are explored. Finally, the potential applications and future prospects of NiO-WO_3 composite gas sensors for ammonia detection are discussed, addressing challenges and opportunities for commercialization and widespread deployment in real-world sensing applications.

Keywords: NiO-WO_3 Composite ,Ammonia gas sensor , Sensitivity, Selectivity ,Response time and Recovery time.

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I. INTRODUCTION

The detection and monitoring of ammonia (NH_3) gas are of paramount importance in a wide range of applications spanning agriculture, environmental monitoring, and industrial processes[1- 4]. Ammonia, a colorless and pungent gas, is extensively used in fertilizers, refrigeration, and various chemical industries. However, its release into the atmosphere can pose serious health hazards to humans and animals, contribute to air pollution, and lead to environmental degradation. Therefore, the development of highly sensitive, selective, and reliable gas sensors for the detection of ammonia is crucial for mitigating its adverse effects and ensuring environmental safety.

Metal oxide semiconductor gas sensors[5-7] have emerged as promising candidates for detecting a variety of gases due to their high sensitivity, rapid response, and low cost. Among them, nickel oxide (NiO) and tungsten trioxide (WO_3) have garnered considerable attention owing to their semiconducting properties and affinity towards reducing gases such as NH_3. Individually, NiO and WO_3 exhibit moderate sensitivity towards ammonia gas, but their composite structures have demonstrated enhanced gas-sensing performance attributed to synergistic effects.

The combination of NiO and WO_3 in composite gas sensors offers several advantages over single-component sensors, including improved sensitivity, selectivity, and stability. Moreover, the tunable properties of metal oxide composites enable the optimization of sensor performance for specific applications. Various synthesis methods, including sol-gel, hydrothermal, and co-precipitation techniques, have been employed to fabricate NiO-WO_3 composite gas sensors with tailored morphologies and compositions.

In this paper, we present a comprehensive review of the recent advancements in NiO-WO_3 metal oxide composite gas sensors for enhanced ammonia sensing performance[8-15]. We discuss the synthesis strategies, structural characterization techniques, sensing mechanisms, and factors influencing the gas-sensing properties of these composites. Furthermore, we highlight recent developments in nanostructuring and functionalization approaches aimed at further improving the sensitivity and selectivity of NiO-WO_3 composite gas sensors. Finally, we discuss potential applications and future directions in the field of metal oxide composite gas sensors for ammonia detection, emphasizing the importance of addressing challenges and optimizing sensor performance for real-world applications.

II. MATERILAS AND METHOFDS

2.1 Materials

The following chemicals were used in the synthesis of NiO-WO_3 composite nanomaterials:

Nickel nitrate hexahydrate ($Ni(NO_3)_2 \cdot 6H_2O$): Purchased from Sigma-Aldrich, used as the nickel precursor.

Ammonium tungstate ($(NH_4)_{10}[H_2W_{12}O_{42}] \cdot xH_2O$): Purchased from Sigma-Aldrich, used as the tungsten precursor.

Citric acid ($C_6H_8O_7$): Purchased from Merck, used as a complexing agent.

Ethanol (C_2H_5OH): Analytical grade, used as a solvent.

Deionized water (H_2O): Used in all aqueous solutions.

Ammonia solution ($NH_3 \cdot H_2O$): Used for pH adjustment.

2.2 Synthesis of NiO-WO_3 Composite Nanomaterials

The NiO-WO_3 composite nanomaterials were synthesized using a sol-gel method, followed by calcination.

2.2.1 Preparation of Precursors

Nickel Precursor Solution: Dissolve 0.01 mol of Nickel nitrate hexahydrate in 50 mL of deionized water under contant stirring to form a clear Ni^{2+} solution. Tungsten Precursor Solution: Dissolve 0.01 mol of Ammonium tungstate in 50 mL of ethanol under constant stirring to form a W^{6+} solution.

2.2.2 Mixing and Gel Formation

Gradually add the tungsten precursor solution to the nickel precursor solution under vigorous stirring. Add 0.02 mol of citric acid to the mixed solution to act as a complexing agent and stabilize the mixture. Slowly add ammonia solution dropwise to the mixture until the pH reaches 7-9, promoting the formation of hydroxides. Continue stirring the solution until a gel is formed. This process may take several hours, depending on the temperature and concentration.

2.2.3 Aging and Drying

Allow the gel to age for 24-48 hours at room temperature to enhance network formation. Dry the aged gel at 100-120°C in an oven for several hours to remove solvents and water, resulting in a xerogel.

2.2.4 Calcination

Calcine the dried gel at 500°C in an air atmosphere for 3 hours. This step decomposes the nitrates and converts the hydroxides to oxides, forming the NiO-WO_3 composite nanomaterial. Allow the calcined material to cool to room temperature naturally.

2.3 Characterization

The synthesized NiO-WO_3 composite nanomaterials were characterized using the following techniques:

2.3.1 X-ray Diffraction (XRD)

XRD analysis was performed using a Bruker D8 Advance diffractometer with Cu Kα radiation (λ = 1.5406 Å). Scans were recorded in the 2θ range of 10-80° to determine the crystalline phases and estimate the crystallite size.

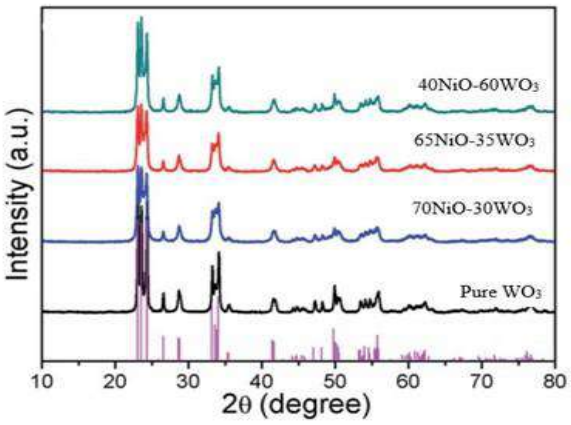


Fig. 1. XRD patterns of pure WO_3 and NiO–WO_3 composite sample

The phase composition and crystal structures of the synthesized pure WO_3 and NiO–WO_3 composite sample were analyzed using X-ray diffraction (XRD), as shown in Figure 1. The XRD patterns exhibit a series of strong diffraction peaks for all samples, which match well with the crystalline monoclinic WO_3 phase (JCPDS no. 43-1035)

The diffraction peaks for all NiO–WO_3 composite sample are broader compared to those of pure WO_3, suggesting smaller crystallite sizes in the composite material. The mean grain sizes were calculated using the Scherrer equation. The mean grain sizes for pure WO_3, 70NiO–30WO_3, 65NiO–35WO_3, and 40NiO–60WO_3 composite sample are 15.2 nm, 9.2 nm, 8.2 nm, and 10.3 nm, respectively. Clearly, the NiO–WO_3 composite sample have smaller grain sizes compared to pure WO_3. This reduction in grain size can be attributed to the NiO phase inhibiting the grain growth of WO_3 during heat treatment. Consequently, the 40 NiO–60WO_3 sample exhibit larger grain sizes than the 70NiO–30WO_3 and 65NiO–35WO_3, sample. Smaller mean grain sizes allow for more oxygen species to be adsorbed on the surface of the thick film.

2.3.2 Scanning Electron Microscopy (SEM)

SEM images were obtained using a JEOL JSM-7500F field emission scanning electron microscope. Samples were sputter-coated with a thin layer of gold to improve conductivity before imaging. The detailed morphology and microstructure of the pure NiO, WO3 , 65 NiO-35 WO3 were investigated by SEM. Fig. 2 (a), (b) and (c) the morphology of the pure NiO shows sand like structure, WO3 shows candy with smooth surface structures, 65NiO-35WO3 appears to be small spherical structure and the average particle size is below 10 nm. 65NiO-35WO3 composite material is more porous and therefore more sensitive to ammonia gas.

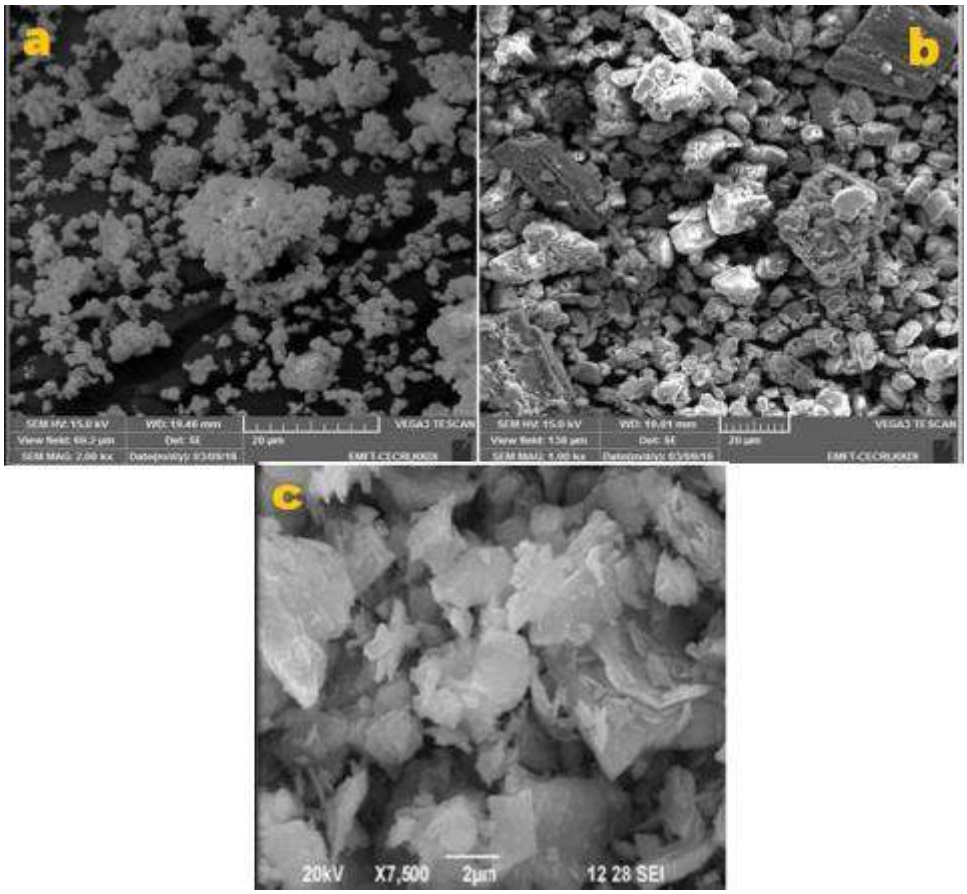


Figure 2: SEM image of (a) Pure NiO (b) Pure WO_3 and (c) 65NiO-35WO_3 composite sample

2.4 Gas Sensing Measurements

The gas sensing performance of the NiO-WO_3 composite nanomaterials was evaluated using a custom-built gas sensing setup.

2.4.1 Sensor Fabrication

Thick films of semiconductor sensors were fabricated using standard screen printing method. So as to prepare these films, inorganic metal oxides was added to organic binder solution in the ratio of 70:30. Binder solution was prepared by using Butyl carbitol acetate (BCA) and ethyl cellulose (EC) in fixed ratio of 8:92. Metal oxides and binder solution were mixed meticulously for 30 minutes using mortar and pestle. This gave us stoichiometric slurry to make stable thick films over glass substrates.

Further small amount of BCA was mixed to above slurry drop wise to get gel like paste. This jelly paste is applied as thick film with dimension of 1 X 0.5 cm over clean and dry glass substrate. After the application of composite coat on glass, these films were dried in air for 20 minutes and subsequently under IR light for 30 minutes. Afterward these composite loaded glass plates were heated in muffle furnace at 100^0 C for approximately 2 hrs. After cooling these thick films were used for the study of its electrical properties using screen printed silver electrode for electrical contact with the circuit.

2.4.2 Gas Sensing Setup

Thick film sensors of metal oxide composites were examined for electrical characterization and gas detection. The gas detection execution was evaluated by a home-made gas sensor system as shown in fig 3.

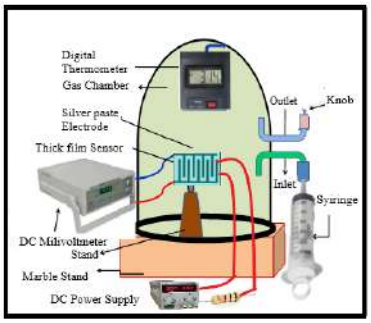


Fig.3.Gas sensor system

DC resistance of these composite sensor was measured, in the atmosphere of various temperatures with fair reliability. The temperature sensed by thermocouple was intentionally recorded by a digital thermometer. The gas is injected at ppm level inside the glass chamber by using a Syringe. The constant DC voltage was applied to the circuit. Sample resistance was measured in the ambient air and also in the presence of testing gas atmosphere at various temperatures. In this method, the resistance of R = 1MΩ was connected in series with the material and used DC Power supply (0-5V).(Fig 4).

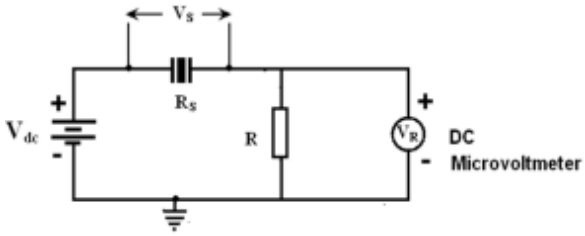


Fig. 4 Measurement of sample resistance

Sensitivity of gas sensor in terms of resistance of sensors can be given by an equation

$$Sensitivity(S) = \frac{R_{NH_3} - R_{Air}}{R_{Air}}$$

Where R_{NH3} is the electrical resistance of thick film in presence of Ammonia gas (NH_3) and R_{Air} is electrical resistance of thick film in ambient air.

III. RESULT AND DISSCUSSION

1. Gas sensitivity

The variations of sensitivity of Pure NiO ,Pure WO_3 and 65NiO: 35WO_3 compositions with concentration of ammonia gas at room temperature are shown in Fig.5.

From Fig. 5, it is observed that for Pure Oxide Samples like Pure NiO and Pure WO_3 sensitivity is less. It is observed from the cure sensitivity increases for composite samples and becomes maximum for 65NiO:35WO_3 composition. From SEM picture, it is found that porosity of 65NiO:35WO_3 composition is large as compared to other Pure NiO and Pure WO_3, thus active surface area is more. Also the average crystallite size of 65NiO:35WO_3 composition is small and it means large active surface area. That's why sensitivity of 65NiO:35WO_3 composition is large as compared to other compositions and pure samples.

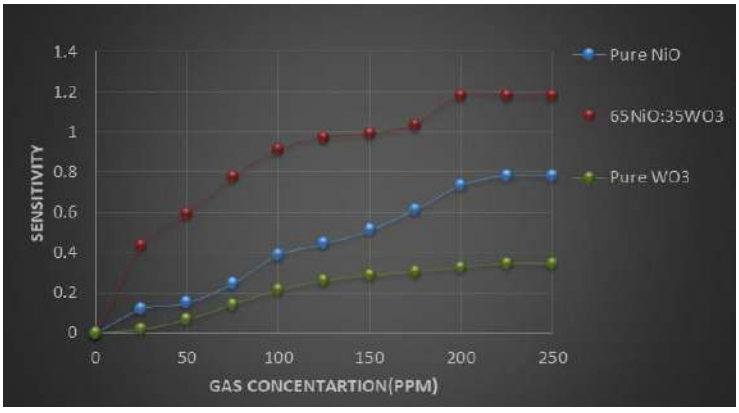


Fig. 5. *Variation of sensitivity of Pure NiO,Pure WO_3 and 65NiO:35WO_3 system with NH_3 gas concentration (ppm) at room temperature (303 K).*

2. Stability of optimise sample

Sensor stability is expressed in terms of measurement of resistance with time. It is defined as the change in resistance of sensor with time [8,9].The resistance values of optimize sensors, measured with time at room temperatures it gives stable response from fig 6.

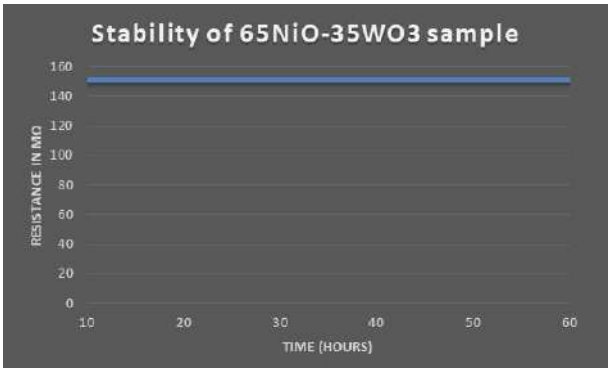
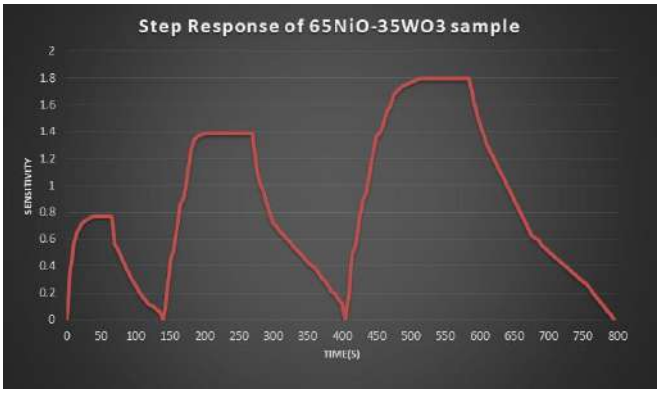


Fig. 6. *Variation of resistance of sensors with time in air*

3. Static response of optimise sample

Fig 7. Static response under static condition, it is observed that response is fast for 65NiO:35WO_3. It is also observed that recovery time for all sensors is very slow than the response time. The response and recovery time for all sensors for 50 ppm Ammonia gas concentration are calculated. Response time for optimize sensor i.e 65NiO:35WO_3 is 75 S and recovery time is 155S



IV. CONCUSION

The gas-sensing properties of NiO:WO_3 films towards Ammonia Gas have been investigated and compared to those of single oxide WO_3 and NiO. The pure thick film of NiO and WO_3 sensors showed low response than the composite films to NH_3.In general, the best performances in terms of response, recovery, sensitivity and low detection limit were found in 65NiO:35WO_3 sensor. This sensor showed higher sensitivity than pure WO_3 and NiO.

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Enhancement in efficacy of gas sensor by doping metal oxide with conducting polymer

Abstract: - Recent uprising in gas sensor research shows substantial transfer to a enormous quantity of sensor devices for biomedical and environmental proficiency. These sensor devices have been made effective by suitable doping of metal oxides with conducting polymer PPy which can be formed by using solid electrolytes, insulators, metals, catalytic materials and classical semiconductors. A majority of polymers are unable to conduct electricity; their insulating properties are applied in the electronic industry. Such metal oxides gas sensors prepared by screen printing method. After validation of its properties viz. sensitivity, stability and characterization from FTIR and SEM etc. It has confirmed that enhancement in efficacy of gas sensor by doping metal oxide such as CuO, ZnO, SnO_2 with conducting polymer PPy.

Keywords: CuO, ZnO and SnO_2 gas sensors, Sensitivity and Stability

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I. INTRODUCTION

The last century has seen increased industrial growth worldwide. A side effect of this development is an exponential increase in pollution of earth, air and water, especially in densely populated areas. While land pollution is locally restricted and great efforts have been made during the last decades to improve the quality of rivers and larger bodies of water, air pollution is not so easily reduced. Recently, there is a great interest in implementing sensing devices in order to improve environmental and safety control of gases. The most used gas sensor devices can be divided in three big groups depending on the technology applied in their development: solid state, spectroscopic and optic. While spectroscopic and optic systems are very expensive for domestic use and sometimes difficult to implement in reduced spaces as car engines, the so called solid state sensors present great advantages due to their fast sensing response, simple implementation and low prices [1-5]. These solid state gas sensors are based on the Change of the physical and /or chemical properties of their sensing materials when exposed to different gas atmospheres. Although the number of materials used to implement this kind of devices is huge, this work was centered in studying the semiconductor properties, in those material using SnO_2 and ZnO as sensing materials.

The main purpose of this paper is to study and develop CO_2 gas sensor with new materials for gas sensing elements starting from the knowledge in thick film production using screen-printing technique.

II. EXPERIMENTAL

2.1 Sensor preparation:

Ammonia solution ($NH_3 \cdot H_2O$): Used for pH adjustment. ZnO , SnO_2 and Al_2O_3 powders (AR grade) were calcinated at about 700 °C for 5-6 h and were crushed in mortal pestle to get fine powder of the samples. ZnO ,SnO_2 were characterized by SEM. The ink or paste of the sample was prepared by using screen-printing (thick film technique) technique. The binder for screen-printing was prepared by thoroughly mixing 8 wt% butyl carbitol with 92 wt% ethyl cellulose. On chemically cleaned glass plate, paste of Al_2O_3 was screen printed and it was kept for 24 hr to dry it at room temperature and then heated at 140^0C for 2.5 h to remove the binder. The Al_2O_3 layer provides mechanical support as well as high thermal conductivity. Paste of ZnO and SnO_2 mixed in proper stiochometry was then screen printed on Al_2O_3 layer. Again plate was dried at room temperature for 24 h and binder was removed by heating it at 150^0C for 2.5 h. Finally film is prepared by screen printing, whole plate was dried and again binder was removed as above. Fabrication of multilayer sensor is shown in following fig. (1)

Finally on the top surface of the sensor, interdigitate electrodes [6,9] were fabricated using conducting silver paste as shown in the Fig.1 (b)To measure the sensitivity, electrical resistance was measured with the help of voltage drop method, best one.

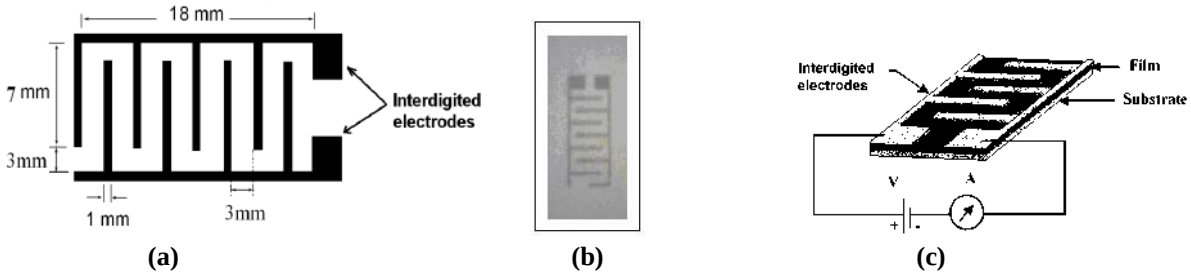

Fig. 1 (a) Fabrication of interdigitate Electrodes (b) Actual photograph of interdigitate electrodes (c) Circuit of resistance measurement using interdigitate electrodes.

III. RESULT AND DISSCUSSION

3.1 Scanning Electron Microscopy (SEM)

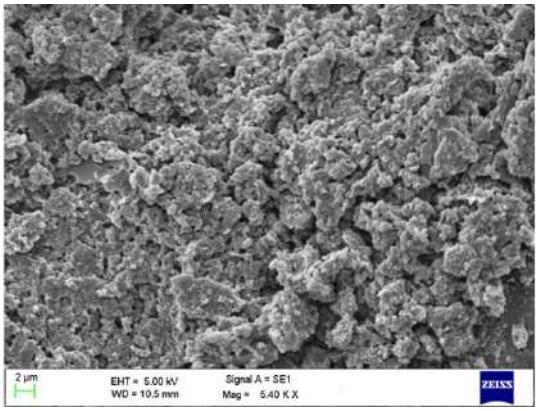

Fig 2 (a). SEM Pure ZnO

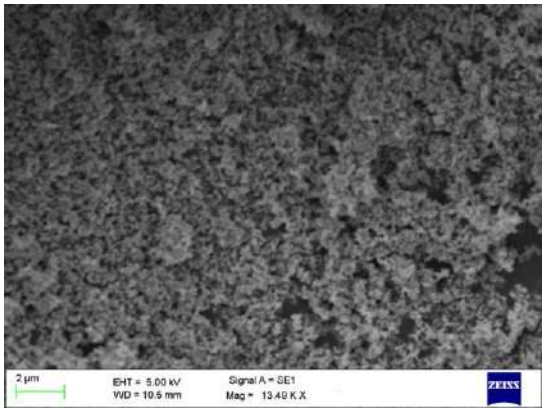

Fig.2 (b) SEM Pure SnO_2

Above SEM images shows some rods with fine voids over them which helps to enhance gas sensing properties.The surface morphologies of ZnO and SnO_2 materials were studied by SEM and the average diameter and number of pores per inch of ZnO and SnO_2 are as under.

Table .1 Average diameter of pore and number of pores per inch of pure samples and their compositions

Sr.No	Pure sample and their composition (mole %)	Average diameter of pore(nm)	No. of pores per inch (in x 2000 Magnification)
1	SnO_2 doped with PPY	780	67
2	SnO_2	740	61
3	ZnO	700	56

From the SEM pictures, it is observed that SnO_2 have maximum pores per inch (calculated for x 2,000 magnification for each composition) than ZnO. Thus SnO_2 have more surface area and exhibit more sensing nature.

3.2. Sensitivity of Sensor:

The sensitivity of the sensor is given by equation (2),

$$S = \left(\frac{R_{air} - R_{gas}}{R_{air}} \right) = \left(\frac{\Delta R}{R_{air}} \right) \quad (2)$$

Where, R_{air} and R_{gas} are the resistances of sensors in air and gas respectively. Maximum sensitivity was recorded for multilayer sensor at 70 ppm concentration of CO_2

Sr. No.	Sample	Codes
1	Pure SnO_2	P1
2	Pure ZnO	P2
3	ZnO Doped with PPY	P3

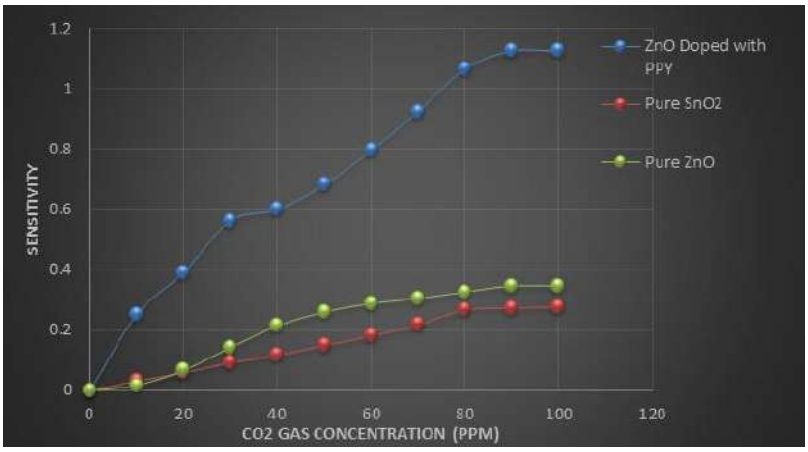

Figure 3: Variation of sensitivity with of CO_2 gas concentration for SnO_2, ZnO and ZnO doped PPY samples

It was observed that, in a typical case,the sensitivity increases gradually with temperature and becomes less gradual at higher temperature values. From linear dependency, it deviates to a maximum value and beyond this point the sensitivity falls rapidly, such behavior is being exhibited by almost all the metal oxide-based gas sensor

3.2. Stability of Sensor:

Rate of change of resistance of the sensor with respect to time defines the stability of the sensor. A sensor should be more stable for its better response. It is observed that resistance of SnO_2 sensor does not change drastically as that in case of ZnO samples.

IV. CONCUSION

From SEM characterization it is concluded that the crystallite size of SnO_2 is smaller, more porus and hence has greater surface area and therefore shows greater response to CO_2 gas. Screen printing technique is the easiest for the preparation of sensor. SnO_2 sensor shows good stability than ZnO samples and dynamic response of SnO_2 is also fast. In present work we prepared a thick film of metal oxides SnO2 and ZnO by using screen printing technique and analyzed by SEM .

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Spectroscopic Studies of Polymethyl Methacrylate (PMMA) and Ethyl Cellulose (EC) Polyblend doped with Oxalic Acid

Abstract: Fourier transform infrared (FT-IR) and X Ray Diffraction (XRD) spectroscopy measurements for Polymethyl Methacrylate (PMMA) and Ethyl Cellulose (EC) polyblends (1:1 and 1:2) doped with different percentages (0%, 5% and 10%) of Oxalic Acid in tetrahydrofuran (THF) at room temperature were prepared using isothermal evaporation techniques. Polymers like Ethyl Cellulose (EC) and Poly Methyl Methacrylate (PMMA) being essentially insulating materials, the number of free charge carriers is very small and their mobility is very low. These measured spectra were then used to evaluate the optical energy gap in relation to blend composition. X-ray diffraction (XRD) was used to identify the molecular interaction arising in the mentioned polymer blend films. The peculiar deviation confirms the structural changes in the prepared samples.

Keywords: EC, PMMA, Oxalic Acid, Tetrahydrafuron, FT-IR, XRD

I. Introduction

Blending between two or more polymers can modify the structural and physical properties of polymers to specific requirements. So,the attention of material researchers has been attracted to polymers blend [1,2]. It involves physical mixing of biopolymers; leading to creation of a new material having some desirable properties that are superior to any one of the component polymers [3-5].Polymer blending is an attractive route for producing new polymeric materials with tailored properties without having to synthesize totally new materials. Other advantages for polymer blending are versatility and simplicity [6]. There are many investigations on polymer blending. The most important of the cellulose ethers is ethyl cellulose (EC). Its electrical, mechanical and weathering properties are good in comparison with other cellulosic's, but not generally outstanding. Poly Methyl Methacrylate) (PMMA) is a hard, rigid, transparent thermoplastic, which has good outdoor weatherability and is more impact resistant than glass. Poly Methyl Methacrylate

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(PMMA) is weakly polar [7]. The interest in organic and polymeric semiconductors has arisen, particularly because of their electro photo graphic and solar cell applications. The changes in the values of the optical energy gaps, dielectric constants, and the refractive index under different frequencies and blending ratio were related to the effects of structural changes in the amorphous domains, impurities, and space charge existing in the interfaces between the mixed phases [8-10].

In the past decades much effort has been devoted to investigating metal-polymer system, by the attachment of inorganic components and the performance of polymer matrix will be greatly enhanced with respect to electrical, mechanical, thermal and especially optical properties [11-13]. They have wide range of application in various sectors such as electronic devices, conductive composites, non-liner optical materials and so on [14]. Poly (methyl methacrylate) (PMMA) is one of the important transparent polymeric materials and it is used in various applications as dielectric in organic thin films, opto-elctronic devices, optical lenses in cameras, optical fibers and advanced electronic devices [15, 16]. Several researchers are focused on thermal and electrical properties of heterogeneous materials have gained momentum in recent years [17].

In the present work samples of different mass fractions (PMMA/EC) were prepared and their physical properties were studied by ordinary FT-IR and XRD with different glimpse. A new route for inquest the degree of miscibility was introduced depending on a spectroscopic quantitative measurement.

II. Experimental

A. Sample Preparation

In the present work, Isothermal Evaporation Technique has been used, as it is best suited to the laboratory. Polymers of Ethyl Cellulose (EC) and Poly Methyl Methacrylate (PMMA) were obtained from S.d. Fine Chem Ltd, Mumbai, India. The different quantities of given substances have been used for preparing film of thickness. The two polymers PMMA, EC were taken in pure form and in the ratio 1:1 were dissolved in the common solvent Tetrahydrofuran (THF).The solution was kept for 3-4 days to allow polymers to dissolve completely to yield uniform solution. A glass (15 cm X 15 cm) thoroughly cleaned with water and later with was used as a substrate. To achieve perfect levelling (and uniformity in thickness of the film), a pool of mercury was used in a plastic tray. The solution was poured on the glass plate and was allowed to spread uniformly in all directions on the substrate. The whole assembly was placed in a dust free chamber at room temperature. The solvent in the solution was thus allowed to evaporate completely and get air-dried. The film on the glass substrate was then removed and cut into small pieces of suitable sizes. In this way the films were prepared by isothermal evaporation technique. Further it was dried for 3 days to remove any traces of solvent. The dry film was removed from the plate and cut into pieces (samples) of desired size. The films of

other samples were prepared by the same method.The 0 %, 5 % and 10% of oxalic acid (doping) were taken and dissolved in the pure PMMA and EC and mixture of (1:1and 1:2) PMMA/ EC solution.

B. Characterization

1. FT-IR analysis:

The FT-IR spectrum introduces information about the molecules present in the Specimen**.** The infrared (IR) spectra of the polymer were recorded on IRAffinity 1 model FTIR spectrophotometer in the region 400–4000 cm^{-1}.

2. X-Ray Diffraction:

In order to study the constitutional properties, the structure is resolve with a Rigaku Miniflex 600 model X-ray diffractometer used in this present work for identification and conformation of the compounds formed.

III. Results and Discussion

A. FT-IR Spectra:

FTIR spectra of PMMA and EC doeped with different concentration of Oxalic Acid are depicted in Figure 1-6. From the figures it is apparent that the synthesized polymer blend contains characteristic transmittance vibration bands of polyblends PMMA/EC appear at range 1700 cm^{-1} (C=O) and 1400 cm^{-1} (C–O). The bands at 3000 and 2900 cm^{-1} correspond to the C–H stretching of the methyl group (CH_3) while the bands at 1300 and 1450 cm^{-1} are associated with C–H symmetric and asymmetric stretching modes, respectively. The 1200 cm^{-1} band is assigned to torsion of the methylene group (CH_2) and the 1100 cm^{-1} band corresponds to vibration of the ester group C–O, while C– C stretching bands are at 1000 and 800 cm^{-1} [18] The PMMA/EC with dopant 5%, 10% FTIR spectrum variation showed similar absorption peaks of functional groups, namely –CH Sp3, C=O ester, and C-O-C (ether). And other details of functional group are shown in table 1.

B. XRD

Figures 7-12 show the XRD pattern of the prepared pure PMMA/EC thin film and with dopant PMMA/EC films at Oxalic Acid concentration 5% and 10 wt%. From Figure 7 and 10 it seems clear that Pure PMMA/EC thin film possesses no crystalline structure therefore, we can say that amorphous structure. Some new peaks were observed in XRD patterns by doping with Oxalic Acid as shown in figures 8,9,11 and 12.

The 5% of oxalic acid in PMMA and EC polyblends in 1:1 and 1:2 proportions show microcrystalline nature but 10% of Oxalic Acid in PMMA and EC polyblends in 1:1 and 1:2 proportions show sharp peaks. And in 10% of 1:2 sample refraction provided by the three main peaks at 2θ = 14.99, 24.33 and 28.79◦ which are assigned to the lattice planes (1 0 1), (1 1 0) and (0 2 1). Oxalic Acid has crystalline nature and in present investigation by adding dopant the new peaks obtained this peak confirms the presence of Oxalic Acid and this behavior agrees with reference [19].

Acknowledgements

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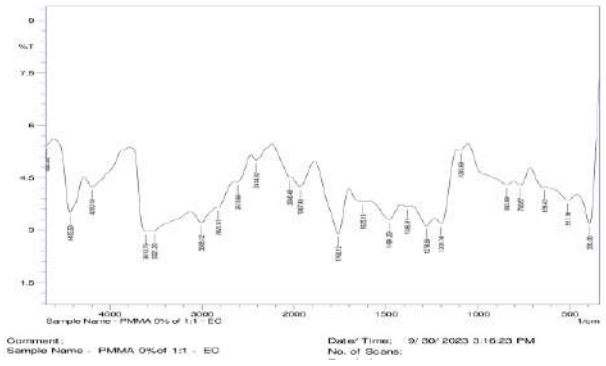
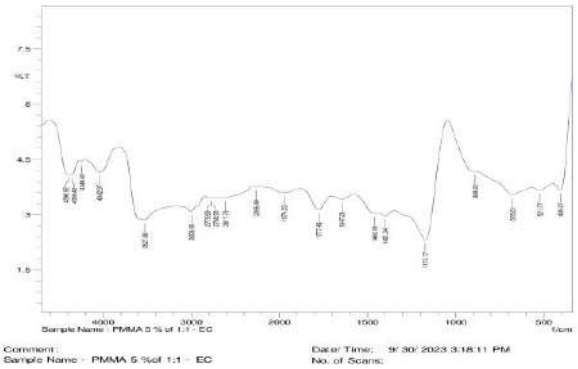
Figures and table:

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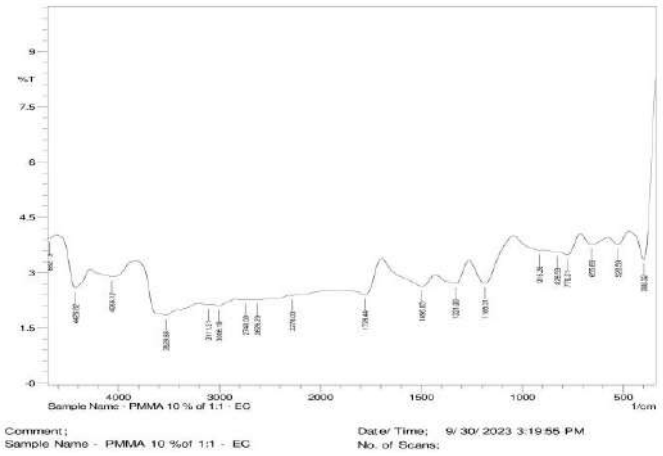
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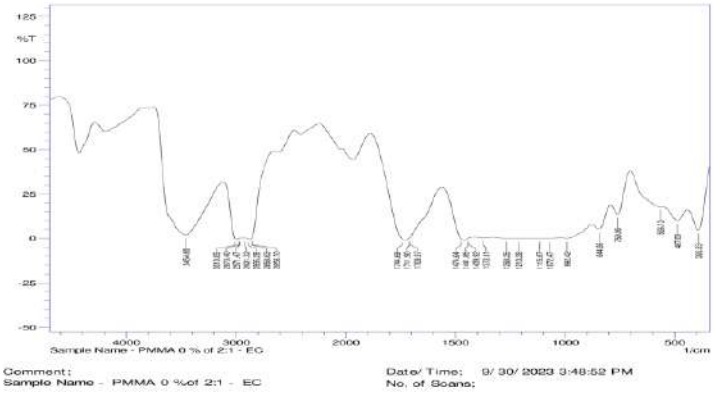
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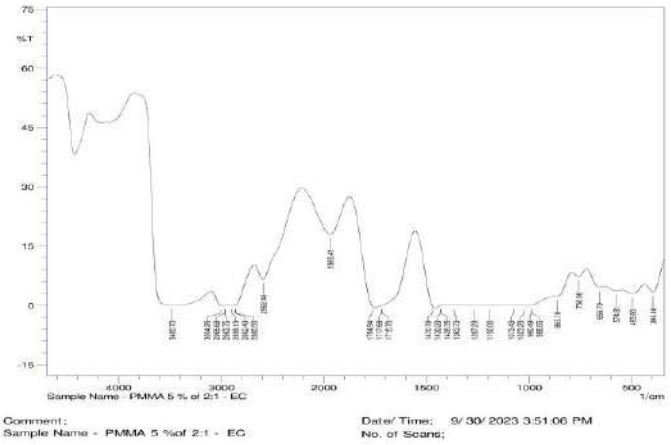
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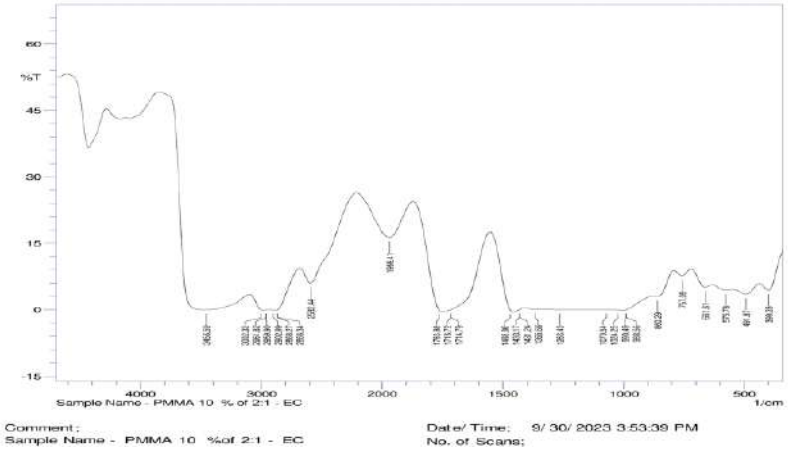
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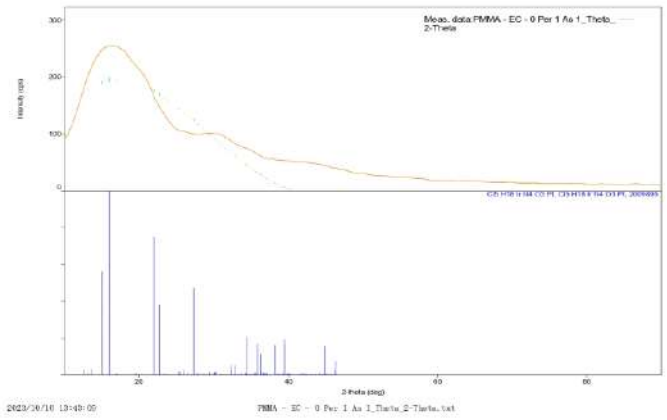
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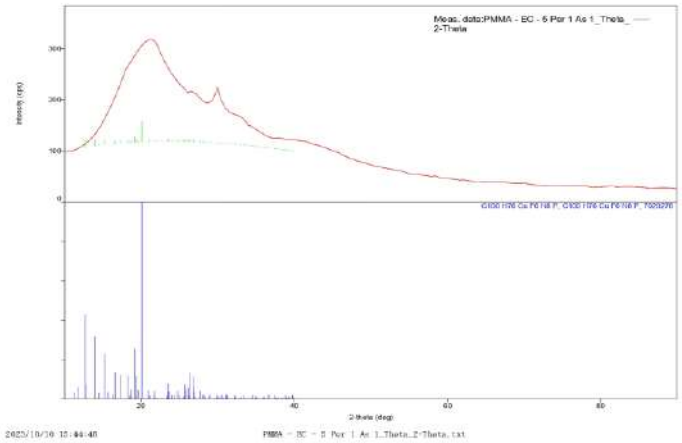
2-Theta
Intensity (cps)
2-theta (deg)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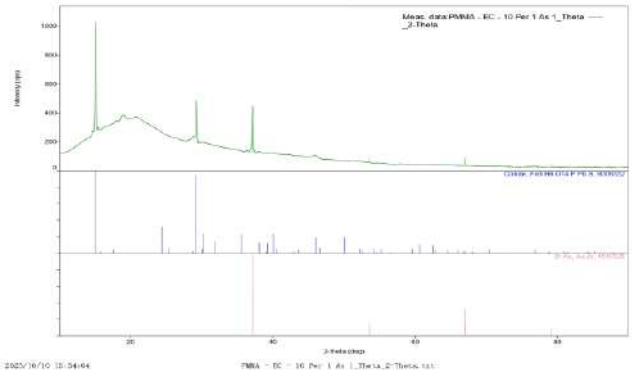
2-Theta
Intensity (cps)
2-theta (deg)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Intensity (cps)

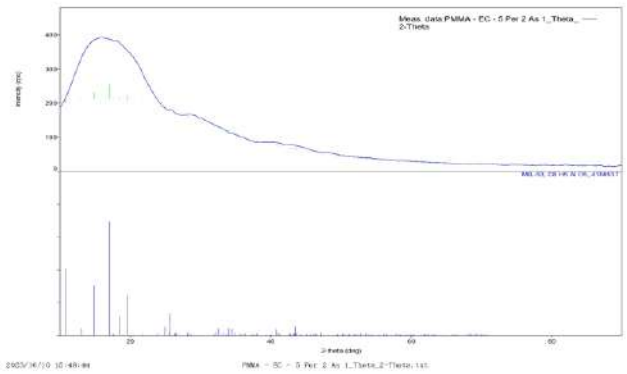

Fig.11. X- ray diffraction scans of 5% of PMMA/EC (1:2)

Vibrational modes	Peak No.	Wave Number (Cm^{-1}) PMMA/EC with Oxalic Acid					
		1:1			1:2		
Sample Code		0%	5%	10%	0%	5%	10%
$-CH_3$ stretching	1	3008	3000	3006	3010	3004	3002
$-CH_3$ stretching + $-CH_2$ symmetric stretching	2	2961	2965	2973			
$-CH_2$ antisymmetric Stretching	3	2823	2775	2740	2858	2862	2868
C=O stretching	4	1760	1777	1778	1744	1764	1763
C-H antisymmetric stretching	5	1484	1460	1496	1474	1470	1468
C-H deformation	6	1434	1401	1439	1430	1433	1433
C-H symmetric stretching	7	1385	1371	1372	1363	1365	1365
$-CH_2$ twist	8	1200	1233	1213	1267	1237	1263
C-O-C stretching	9	1190	1172	1192	1192	1192	1190
C-O stretching	10			1115			
C-C stretching	11			992	988	990	990

Table1. Vibrational Modes observed in the PMMA/EC blends with dopant

[1*]R.N.Zade
[2]B.M.Mude
[3]K.M.Mude
[4]S.M.Yenorkar
[5]K.B.Raulkar
[6]R.R.Mistry
[7]S.M.Warbhe
[8]S.K.Mude
[10]A.N.Patange
[5]G.T.Lambdhade
[9]P.S.Bodkhe

Coupling Reactions of Active Methylene Group for synthesis of 3(P-Methylphenyl)1-Phenylprop-2-en-1-one [Chalcone] using nanocomposite of Ceria embedded on zeolite

Abstract: **-** Chalcones are prominent secondary metabolites and precursors of flavonoids and isoflavonoids in plants. The 'enone' moiety is present in many biologically active molecules and it is considered to be primarily responsible for eliciting the biological response in such molecule. Chalcones in general are reported to exhibit various pharmacological activities such as anticancer, antimalarial, anti-inflammatory, immunomodulatory, antibacterial, immunosuppressive, antiprotozan, trypanocidal, and leismanicidal properties. Though there are many methods for preparation of chalcone, there is need to explore its synthesis using a simple, cheaper yet efficient method based on heterocatalytic embedded system. Here we have prepared chalcone using ceria embedded zeolite using cheaply available base compounds and allowed to undergo Michael addition at ambient temperature using very less amount of solvent and extraneous material. This provides a new route to prepare chalcone vide simple, cheaper, minimum solvent yet efficient synthesis at ambient temperature. This confirms the stability, nontoxicity and cost effectivity of ceria-zeolite nanocomposite for preparation of chalcone.

Keywords:Chalcone, active methylene group, ceria, zeolite, nanocomposite

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I. INTRODUCTION

Synthetic organic chemistry has its own charm in simulation of natural products synthesis and creating new fantastic molecules. Both the ways it is providing platform for other fields like agriculture, pharmaceutical, petroleum etc. It has gained pace after the use of catalysts enormously. Though organic synthesis has it's place in classical and applied research, it is constantly encountered with certain problems of separation of materials other than desirable products, huge organic volatile solvent usage, protection and deprotection of functional groups, low absolute yield etc. These limitations are amplified enormously in synthesis of fine and specialty chemicals [1,2]. So, there is a growing need for more environmentally acceptable processes in the chemical industry. This trend towards what has become known as 'Green Chemistry'. After considerable literature survey we find Ceria embedded zeolite very useful in various organic transformation involving reaction between active methylene group for formation of chalcone.

Limitations of classical organic synthesis have been overcame by green chemistry approach especially in terms of reducing waste by replacing stoichiometric reagents with recyclable solid acid and bases, preferably in catalytic amounts[1]. Bio catalysis has many attractive features in the context of green chemistry such as mild reaction conditions (physiological pH and temperature), an environmentally compatible catalyst (an enzyme) and solvent (often water) combined with high activities and chemo-, regio- and stereoselectivities in multifunctional molecules[1,2,10]. Solid acids, such as zeolites, acidic clays and related materials, have many advantages in this respect They are often truly catalytic and can easily be separated from liquid reaction mixtures, obviating the need for hydrolytic work-up, and recycled. Zeolite-catalysedFriedel-Crafts acylation by Rhône-Poulenc (now Rhodia) may be considered as a benchmark in this area [1,6,9].

II. MATERIALS AND METHODS

Synthesis of Chalcone Derivative

1,3-Diaryl-2-propen-1-ones, commonly known as chalcones are prominent secondary metabolites and precursors of flavonoids and isoflavonoids in plants. Structurally in such compounds two phenyl rings are flanked by 2-propenone moiety and this arrangement makes them 'privileged structure' The 'enone' moiety is present in many biologically active molecules and it is considered to be primarily responsible for eliciting the biological response in such molecule.

Chalcones in general are reported to exhibit various pharmacological activities such as anticancer, antimalarial, antiinflammatory, immunomodulatory, antibacterial, immunosuppressive, antiprotozan, trypanocidal, and leismanicidal properties. Licochalcone-A, a natural product, isolated from the licorice root, is known to have a wide variety of anticancer effects. They have recently been reported as antiproliferative and antitumor agents and interest in this class of molecules in identifying potent anticancer agents is renewed. These molecules with enone moiety inhibit several enzymes which render them the therapeutic potential. The ease of preparation, the potential of oral administration, and safety also support the feasibility of chalconebased compounds to be used as chemotherapeutic agents. Tremendous amount of work is reported on the synthesis, bio-evaluations, and mechanism of action of these compounds including their interference in microtubule formation1and many cellular signaling pathways.

A number of chalcones with hydrophobic moieties and hydrophilic substituents attached to the aromatic rings such as adamantanyl and steroidal substituents were prepared and showed potent anticancer activity against different cancer cell lines. Chalcone undergo Buchwald- Hartwig Coupling /Michael Addition reaction with primary amine and with aldehyde to give 4-Quinolones. It is highly biologically active molecule [5].It can undergo Multicomponent Stereoselective Synthesis of 3-Amino-2(1*H*)-pyridinones Using CeCl3·7H2O/NaI, primary amine and oxozolonone. Heterocycles incorporating a 2(1*H*)-pyridinone framework constitute an extensively studied class of compounds owing to their diverse biological activities ranging from anti-HIV, antibacterialand antifungal to free radical scavenger [3,4].A Ce(III)-catalyzed expeditious multicomponent stereoselective synthesis of 3-mercapto-2(1H)-pyridinones [12] is achieved using chalcone, primary amine and oxathiolanone. One of the drug namely Cycloproxalamine (Loprox) is approved by the FDA as a broad spec- trum antifungal drug and is presently in clinical use for the treatment of various skin diseases. Polysubstituted 2(1H)-pyridinones are of special interest due to their anxiolytic activity with improved side effect profiles. In addition, dihydro and tetrahydro derivatives of 2(1H)-pyridinone have been applied as scaffolds for the construction of constrained amino acids [5].Synthesis of benzylaminocoumarin derivative was catalyzed by surfactant Triton X-100 using water as solvent [7].

The basic structure of chalcone [8]include following nucleus. R & R1 can be –OH, CH_3, C_2H_5Cl, NH_2, and many complicated groups.

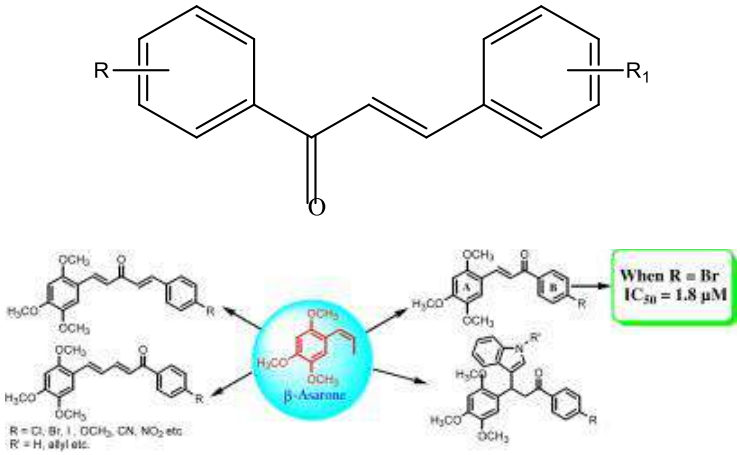

Figure.1. Basic structure of chalcone

Active Methylenes:

These are compounds in which methylene group (CH2) is attached to electron withdrawing group such as CN. COOEt, NO2 as shown in the following compounds.

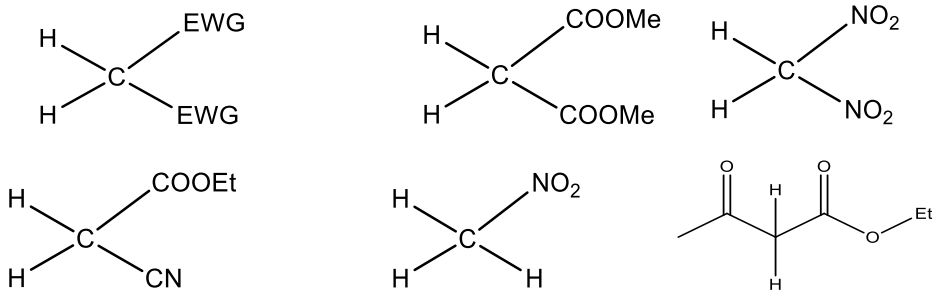

Figure2. Active Methylenes

These compounds are having acidic methylene hydrogens. These can be abstracted by base, forming a carbanion. These carbanions are stabilized due to resonance by EWG group. These also form enolate ion. These enolates are able to give nucleophillic addition over carbon double bond.

Synthesis of Ceria:

Cerium is a rare earth element belonging to the lanthanide series. Even if is a rare earth element, the earth crust is relatively rich in this element, being the most abundant from the lanthanides. After europium, cerium has the highest reactivity among the rare earth metals, passing easily into oxidized stage at room temperature. While most of the rare earths exist in trivalent state, cerium also occurs in 4+ state and may alternate between the two in a redox reaction. cerium oxide nanoparticles prolong cellular longevity by scavenging free radicals generated during their lifetime. The distinct structure of ceria nanoparticles, regarding the valence, support cell longevity as benefit of its antioxidant properties. Antioxidant behaviour is strongly influenced by the co-existence of both Ce^{3+} and Ce^{4+} oxidation states in CeO_2 nanoparticles.

The synthesis of CeO_2nps was achieved by precipitation method by using an aqueous cerium nitrate solution (0.2 M) as the cerium precursor and excess of ammonia solution (0.2 M) as precipitating reagent. The reaction was carried out at room temperature under continuous magnetic stirring. A stream of O_2 was bubbled into the reactor to oxidize Ce^{3+} to Ce^{4+}. Firstly, a white precipitate came out in the solution. Subsequently, the colour of precipitate turned into purple, and gradually became light yellow. The post-precipitation stage consisted of a 24 hrs. aging, separation by filtering and drying. The sample was washed with ethanol for three times.

III. Result and Disscussion

Structural Analysis

FT-IR spectra

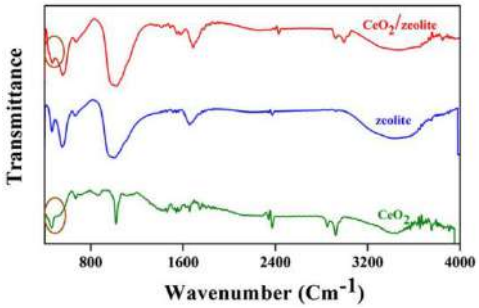

Figure 3. FT-IR Spectra of CeO_2, zeolite and CeO_2/zeolite

FT-IR spectra in the 400–4000 cm^{-1} range were shown in Fig. 3 for CeO_2, zeolite, and CeO_2/zeolite nanocomposite. O-H stretching and bending vibrations of adsorbed water are responsible for the broad peak located at 3437 and 1646 cm^{-1}, respectively. The peak at 1013 cm^{-1} in the zeolite spectrum is indicative of the Si–O–Si stretching vibration. The weak peaks correspond to Si–O–Si bending vibration and are located between 460 and 800 cm^{-1}. The signal at 426 cm^{-1} in the FT-IR spectra of CeO_2 is indicative of the Ce–O bond. Because of the interaction between CeO_2 and zeolite, the Si–O–Si peaks are located at 1013 and 1032 cm^{-1}, respectively, and are associated with zeolite and CeO_2/zeolite nanocomposite.

XRD

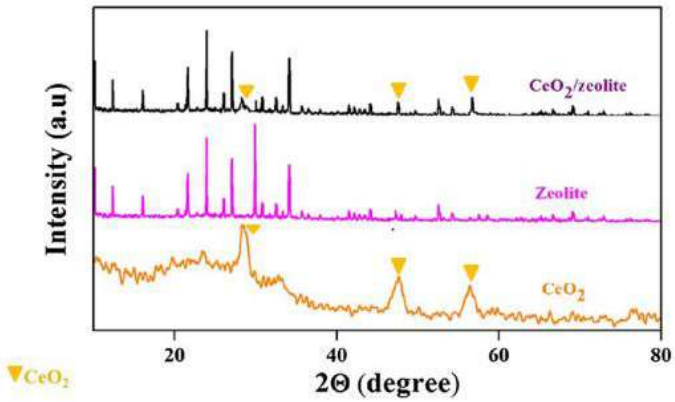

Figure 4. XRD pattern of pure CeO_2, Zeolite and CeO_2 embedded on Zeolite

Figure 4 displayed the XRD patterns of the zeolite, CeO_2, and CeO_2/zeolite. Zeolite's XRD pattern andJCPDS card No. 37-0072 agree well. The characteristic peak of CeO_2 is typically found at 2h = 28.56 (111), 47.4(220), and 56.58 (311) (JCPDS card No. 89-8436). The CeO_2/zeolite XRD pattern showed the presence of both CeO_2 and zeolite peaks, indicating the entry of CeO_2 nanoparticles into the zeolite framework.Scherrer'sformula was used to determine the average crystallite size.

$$D = 0.9\lambda/\beta\cos\theta$$

where D is the average diameter, θ is the Bragg angle in degrees, λ is the breadth line of the diffraction peaks in radians, and is the X-ray wavelength. For CeO_2/zeolite, the average CeO_2 size is determined to be 10.53 nm.

Zeolites are effective materials for segregation, adsorption, and catalytic activity. This immense focus is due to their extraordinary properties, which include a characteristic fluorite-type structure, a stable framework, and the versatile ability of cerium's tetravalent (Ce^{4+}) and trivalent (Ce^{3+}) valence states to undergo reduction and oxidation processes. Rare earth oxides like ceria have a wide range of applications, including electrocatalysis, solar and fuel cells, and photocatalysis. Although, CeO_2 is abundant with oxygen vacancies the drawback of limited surface area, lower visible-light harvesting capability, and high recombination of electron-hole pair has limited its independent application. Various strategies have been employed such as doping with metals and non-metals, support material, and fabricating over support materials. However, to the best of our knowledge, the application of zeolite and CeO_2 photocatalyst composite for the removal of endocrine disrupting compound like caffeine is unexplored. In this study, we developed a CeO_2 decorated zeolite nanocomposite

To prepare various pharmaceutical intermediates such as chalcones derivatives of various active methylene groups, cleaved epoxide, indole derivative, benzothiazepine, using various coupling reactions, C-C, C-N, C-O, C-X bond formation methodologies. All these reactions will be carried out in minimum solvent Ceria embedded zeolite as efficient catalyst. Along with core reaction, effect of temperature, solvent, concentration of catalyst, synergistic effect of various factors also is studied.

IV. CONCUSION

Though classical organic synthetic methods are rampant for synthesis of chalcone derivatives of active methylene groups, we felt the need to develop green protocol using an efficient catalyst. So, we attempted to develop ceria embedded zeolite as a green catalystfor preparation of chalcone derivative which are biologically active intermediates. It also helps in expediting the steps in preparation of drugs which are potentially anticancer, antimalarial, anti-inflammatory, immunomodulatory, antibacterial, immunosuppressive, antiprotozan.

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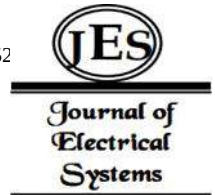
Synthesis and Characterization of Stannic Oxide Nanoparticles by the Sol–Gel Method



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PVC-PMMA Electrolyte System Tailoring with Different Dopants: A Comprehensive Study

Journal of Electrical Systems

Abstract: - Polyvinyl chloride (PVC) and polymethyl methacrylate (PMMA) are types of plastic materials widely used in various scientific and technological fields. In this study, we prepared thin films of PVC and PMMA by doping them with oxalic acid (OA) and cinnamic acid (CA) adopting the isothermal evaporation method. The thickness of the thin films was calculated using a digital micro-meter screw gauge. We characterized the thin films using analytical techniques including Fourier transform infrared (FT-IR) spectroscopy, scanning electron microscopy (SEM), and X-ray diffraction (XRD). FT-IR spectrum analysis confirmed the successful formation of homogeneous 1:1 (PVC: PMMA) thin films by observing characteristic peaks resulting from the addition of oxalic acid and cinnamic acid. XRD analysis revealed that all thin films had an amorphous nature. The scanning electron micrograph images of the samples supported the results obtained from FT-IR and XRD analyses.

Keywords: PVC-PMMA Electrolyte, ($C_2H_2O_4$), $C_9H_8O_2$, Analytical Techniques

I. INTRODUCTION

Polymers and their mixtures are a diverse class of materials that have wide applications in various industries [1–5]. The way these materials are synthesized has a major influence on their molecular structure and, consequently, their properties. Understanding these synthesis methods is crucial to adapting polymers to specific requirements. In addition, the electrical conductivity and dielectric properties of polymers are of the utmost importance, especially in areas such as electronics and energy storage. The ability to modify these properties through doping, the integration of nanomaterials, and the design of structures opens up opportunities for innovation.

Polymer electrolytes, a type of plastic material, have garnered significant attention due to their versatile uses in different scientific and technological sectors. The unique characteristics and versatile nature of polymer electrolytes make them a valuable material for numerous applications, driving ongoing research and technological advancements in this area. Hence, a polymer electrolyte, defined as a membrane made of salts dissolved polymer matrix which having in a high-molecular-weight, is known as a polymer electrolyte [6]. These ionic conduction-friendly, solid, solvent-free systems find extensive use in a range of electrochemical tools, such as lithium-ion batteries and solid-state and rechargeable batteries.

Fenton *et al.* originally introduced the notion of preparing polymer electrolytes in 1973 [7], but S. Rao et al. [8] realized and understood their technological relevance a few years later. The first polyelectrolyte to be suggested and investigated for solid polymer electrolyte (SPE) Li rechargeable batteries was poly (ethylene oxide) [9, 10]. The majority of solid polymer electrolytes (SPEs) are made either by dispersion in the solid state. Additionally, an effort is made to use covalent bonding or another chemical or physical technique to block the anion in the polymer medium [11].

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Polymer electrolytes comprise a wide range of substances that are specially designed to fulfill particular needs and uses in electrochemical devices. These electrolytes are generated by complexing low-lattice energy

salts with solvent polymers [12-13]. Chemical and physical methods are the two main types of polymer film production technology. The flexibility is provided by the electrolytes of solid polymers, which can be easily produced as soft films with a thickness of only a few microns. This allows continuous contact with solid electrodes throughout the operation, facilitating the creation and deployment of various electrochemical devices. The preparation of polymer films is the main topic of this research. Many techniques for producing high-quality polymer films have been described in literature and some really good reviews are available [14-16].

The characteristics, compositions, and ion transport methods of these materials differ, giving rise to several types of polymer electrolytes. Typical polymer electrolyte types include [17-18]. Poly(ethylene oxide), Poly(vinyl alcohol), Poly(methyl methacrylate), Poly(caprolactone), Poly(chitosan), Poly(vinyl pyrrolidone), Poly(vinyl chloride), Poly(vinylidene fluoride), and Poly(imide) are a few typical polymers utilized in these electrolytes. These polymers can all be customized for certain uses and have distinctive qualities.

Polymer electrolytes are fundamental components in many fields, including biomedical engineering, energy storage, electrochemical conversion, sensing, and actuation [19-22]. They are essential for tackling societal issues and promoting technological innovation in a variety of sectors due to their special set of properties.

Also, dopants play vital role in changing electrical parameters like electrical conductivities, which includes ac as well as dc, and dielectric constant. Values of these parameters will determine which applications the desired material will be used. In this study, the same polymer electrolyte system has two different types of dopants. If these dopants completely miscible in polymer electrolyte then it will definitely causes electrical parameters of casting thin films [23-25]. Only the idea of dopant miscibility in specific polymer electrolytes will be examined in this thorough investigation.

II. MATERIAL AND EXPERIMENTAL

All chemicals were of AR grade. Polyvinyl chloride (PVC) and Polymethyl methacrylates (PMMA) were supplied by SIGMA –ALDRICH, Co., USA having purity 99.99%. . While, oxalic acid and cinnamic acid by Merck specialties private limited, India and Tetrahydrofuran by E-Merck India Ltd., India is being used as a solvent for mixing process of two base materials PVC and PMMA. . In this work, the isothermal evaporation process was used to cast thin films [26-29].

A. Preparation of Thin Films

1) Preparation of a 1:1 (PVC-PMMA) Base Polyblend Thin Film

In this work, the isothermal evaporation technique has been used due to the rapid and easy mixing process. The two polymers, PVC and PMMA, have been taken with different weight ratios (i.e. 1:1) as required, and dissolved in the same solvent, tetrahydrofuran (THF). To create a homogeneous solution, the solution was let to stand for three to four days, allowing the polymers to fully dissolve. A glass plate (10 cm x 10 cm) was thoroughly cleaned with water and later with acetone as the substrate. In order to achieve a perfect level (and uniform thickness of the films), a pool of mercury was used in a plastic tray. After being placed onto the glass plate, the solution was given time to evenly spread across the substrate in all directions. The complete assembly was kept at ambient temperature in a dust-free environment. As a result, the solvent in the mixture was left to totally evaporate and turn into dried air. After removing the film from the glass substrate and splitting it into small, appropriate-sized pieces, the surface contaminants were eliminated by acetone rinsing. In this way, the films were prepared with the isothermal evaporation process.

2) Preparation of 1:1 (PVC-PMMA) Polyblend Thin Films Using Dopant Oxalic Acid (OA)

The two polymers PVC and PMMA were taken in weight ratio 1:1, and dopant oxalic acid was taken in doping percentage 5%. All three were dissolved separately in a 10 ml THF solution. After allowing them to completely dissolve, all three solutions were mixed together. A glass plate (10 cm x 10 cm) was cleaned with hot water and then used as a substrate with acetone. To achieve a perfect leveling and uniformity in the thickness of the film, a pool of mercury was used in the plastic box in which the glass plate was placed. After being placed onto the glass plate, the solution was given time to evenly spread across the substrate in all directions. The complete assembly was kept at ambient temperature in a dust-free environment. As a result, the solvent in the mixture was left to totally evaporate and turn into dried air. After removing the film from the glass substrate and splitting it into small, appropriate-sized pieces, the surface contaminants were eliminated by acetone rinsing. In this way, the films were prepared with the isothermal evaporation process.

3) Preparation of 1: 1 (PVC-PMMA) Polyblend Thin Films Using Dopant Cinnamic Acid (CA)

The 5 % of cinnamic acid (dopant) was taken and soluble in the mixture of PVC-PMMA solutions. After attainment homogenous solution, the above mentioned above (2) procedure was repeated to prepare the film using isothermal evaporation technique.

B. Measurements and Analytical Characterizations

The thickness of film is crucial for their structural and electrical properties. Various techniques can be used to measure film thickness. In this study, the thickness of all the samples was calculated using a Digital micrometer provided by Mitutoyo Corporation in Japan. This micrometer has a precision of 0.001 mm and a measurement range of 0 to 25 mm. It can be operated between 50°C and 400°C, with an instrumental error of +2 μm at 20°C. Additionally, it features a digital display with 6 digits and a minus sign for easy and clear readings.

Three samples were chosen for further investigation from a series based on optimization study results. Table 1 contains a list of optimized samples along with their weight percentage, sample codes, and thicknesses.

Table 1 Sample codes and thickness of 1:1 (PVC-PMMA) composite thin films doped with oxalic acid and cinnamic acid

Sr. No	Sample description	Sample code	Thickness
1	1:1 (PVC-PMMA)	S_1	0.041 mm
2	1:1 (PVC-PMMA) OA 5%	S_2	0.024 mm
3	1:1 (PVC-PMMA) CA 5%	S_3	0.073 mm

The films' ultraviolet (UV) absorption spectra were obtained at ambient temperature. FT-IR measurements were conducted using the Bruker Model: Vertex 70, which has a wide wave number range (50 cm to 15,000 cm^{-1}). This equipment allows recordings in both transmission and reflection geometries, with a high resolution scale of 0.5 cm^{-1}. The FT-IR spectra of all samples fall within the range of 500-4000 cm^{-1}.

XRD is analytical technique that provides valuable insights into the lattice structure of a material. It provides details on the phases, average grain size, crystallinity, and crystal flaws, among other structural characteristics. In this study, X-Ray Diffraction (XRD) of the samples was performed by the Bruker D8 Advance XRD system, obtained from the UGC-DAE Consortium for Scientific Research, Indore. Scanning electron microscopy was also carried out at the Department of Physics; RTM Nagpur University, by the Philips Model: XL-30. This analysis aimed to examine the surface structure, identify defects and how much miscibility of dopant presents in the samples.

III. RESULTS AND DISCUSSION

A. FT-IR Spectroscopic Analysis

In current study, FTIR Bruker Model: Vertex 70 was use in the transmittance mode from 500 cm^{-1} – 4000 cm^{-1}. To get the FTIR profiles, the final scan was recorded by averaging 100 scans at a resolution of 8.0. The measurements obtained a resolution of 4 cm^{-1}.

In our case, we have studied the FTIR of samples having 1:1 (PVC: PMMA), 1:1 (PVC: PMMA) OA 5%, 1:1 (PVC: PMMA) CA 5%. Fig. 1, 2 and 3 shows FTIR spectra of sample S_1, S_2 and S_3 respectively.

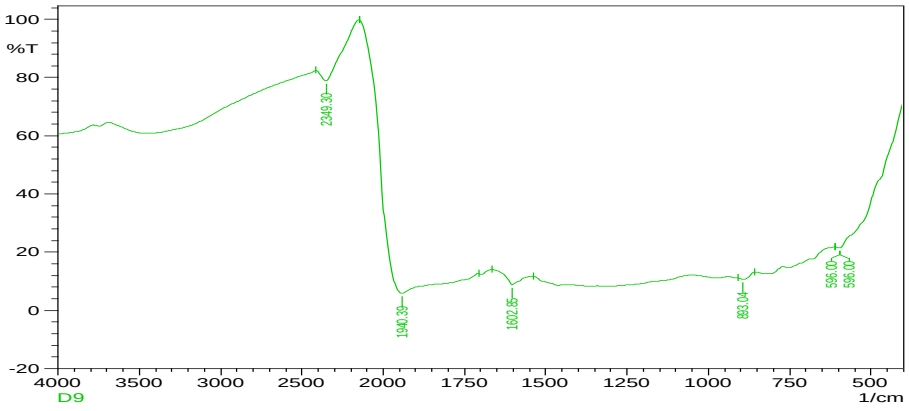

Figure 1 FT-IR of S_1 Sample

Fig. 1 shows 1:1 (PVC: PMMA) spectra. The PMMA carbonyl band has slightly shifted to a lower wave number, according to the spectra. The shift of peak is about 4-6 cm^{-1} within the domain of miscibility of the two polymers. The miscibility of 1:1 (PVC: PMMA) is due to a specific interaction of the hydrogen bonding type between Carbonyl (C = O) of PMMA and hydrogen (from CHCl) group of PVC [30].

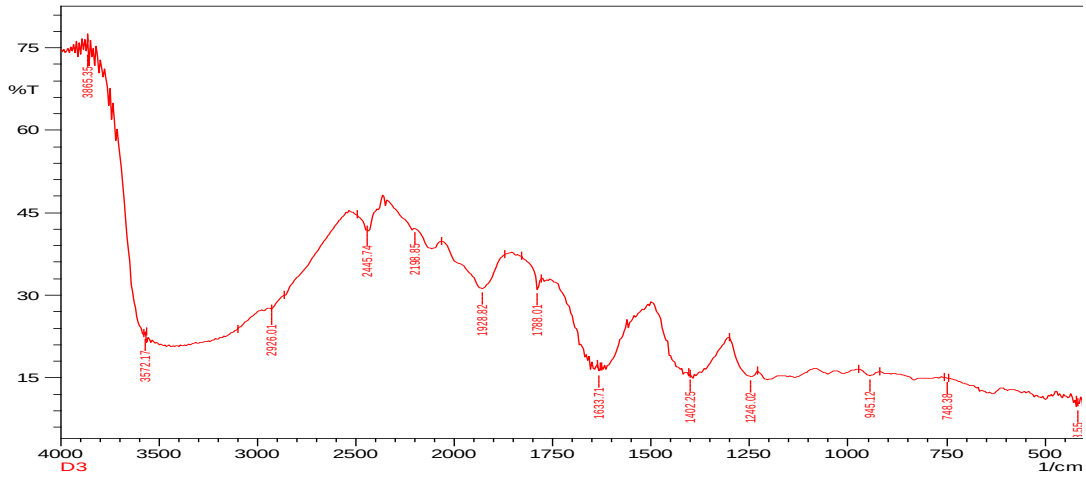

Figure 2 FT-IR of S_2 Sample

Fig. 2 shows 1:1 (PVC: PMMA) OA 5% spectra. The peak location for C = O stretching (i.e. 1732.08 cm^{-1}) in thin film shows minor shifting for the blend within the domain of miscibility.

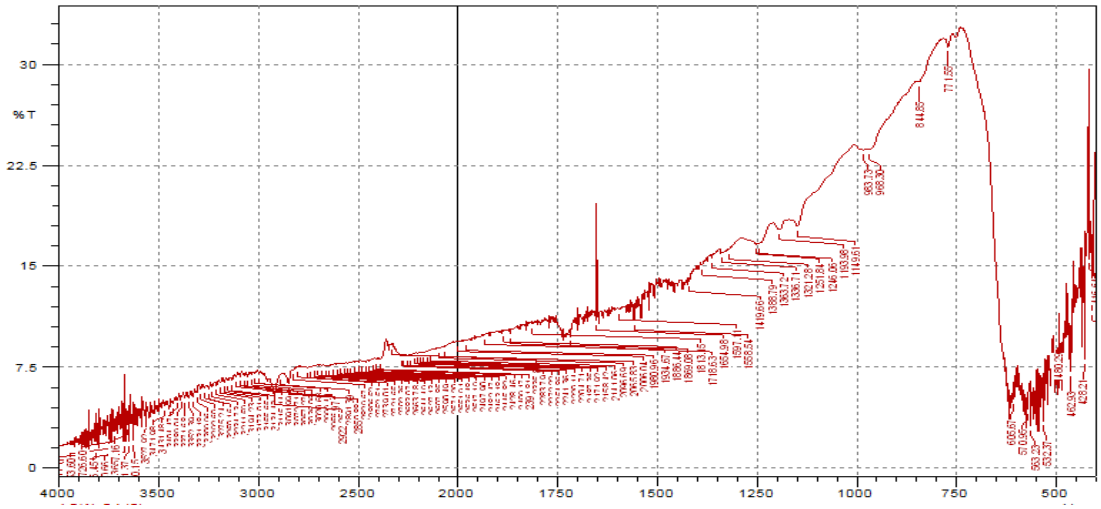

Figure 3 FT-IR of S_3 Sample

While Fig. 3 shows 1:1 (PVC: PMMA) CA 5% spectra. It shows large number peaks at different positions, so it may causes to shift for the blend within the domain of immiscibility [31.32].

B. XRD Analysis

XRD patterns of all samples were taken, and all the sample spectra show a similar nature. So for simplicity only three XRD spectra are shown here. XRD pattern of 1:1 (PVC: PMMA), 1:1 (PVC: PMMA) OA 5%, 1:1 (PVC: PMMA) CA 5% are shown in Fig. 4, 5 and 6 respectively.

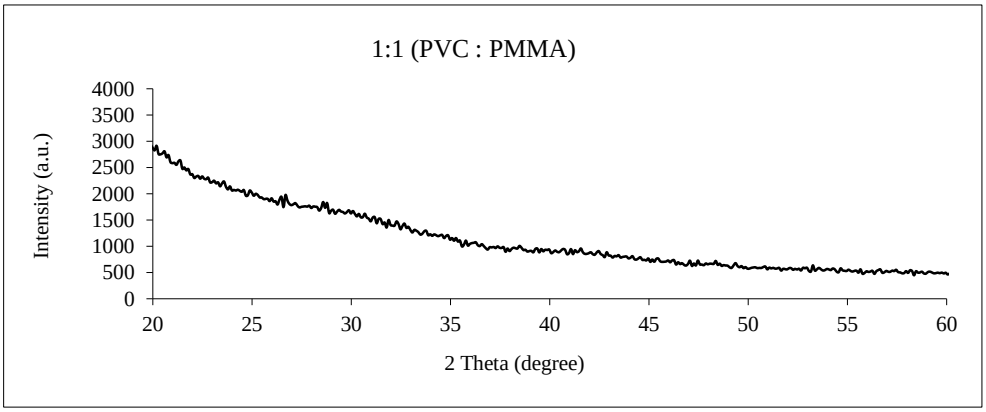

Figure 4 XRD of S_1 Sample

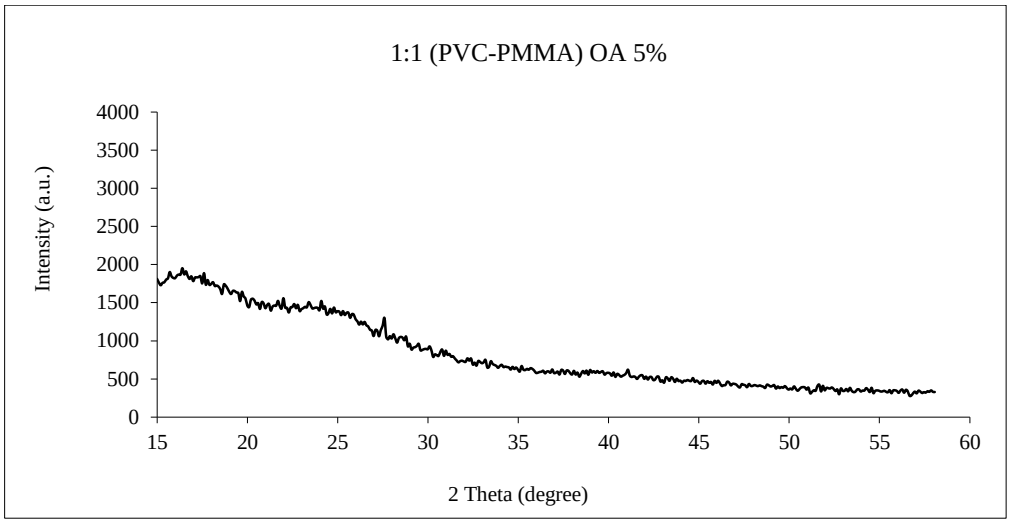

Figure 5 XRD of S_2 Sample

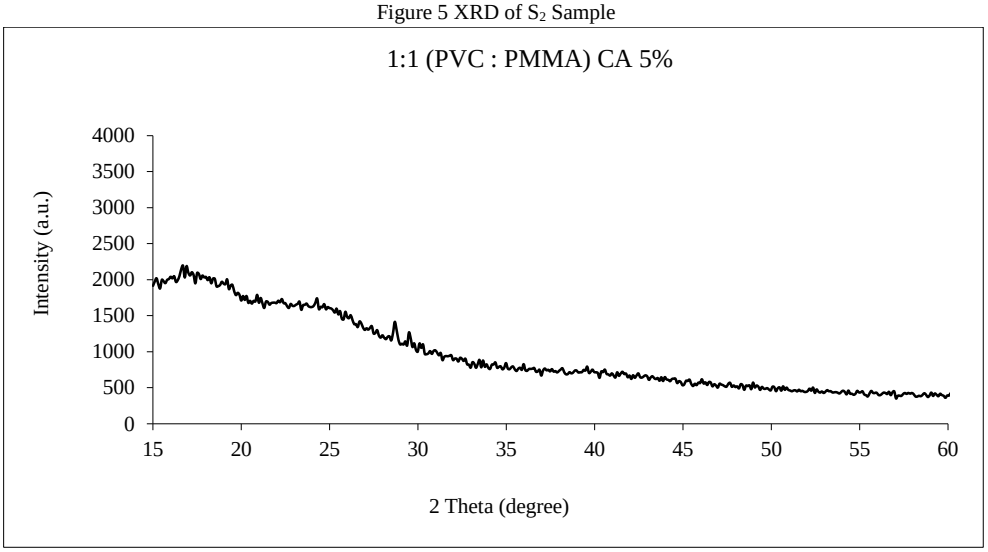

Figure 6 XRD of S_3 Sample

Generally, a polymer consists of both a crystalline region and an amorphous region. The conductivity parameter of the polymeric materials is characterized by their amorphous nature.

From Fig. 4, 5, and 6, it can be observed that the sample exhibit noisy spectra. A peak was observed around 25°, which is attributed to the amorphous nature [33, 34]. Therefore, the X-ray diffractograms of all the samples confirm the amorphous nature, showing large diffraction maxima that decrease at larger diffraction angles. The first main maximum shape indicates the order of the polymer chain packaging. The intensity and shape of the second maximum are related to the order effect within the main chain. The large humps observed in the XRD spectrum indicate the existence of very small crystallites. The absence of any prominent peak in the films demonstrates the mainly amorphous nature of the films. This is in agreement with many reports [35, 36].

C. Scanning Electron Microscopy

Scanning electron micrographs of blended materials were taken across composition for the 1: 1 (PVC: PMMA) blends are shown Fig. 7, 8 and 9. Micrographs show a heterogeneous structure of two base materials i.e. PVC and PMMA, but the size of the dispersed phase changes with composition.

As expected, the pore size maximums for the sample S_1 polymer blend. The tendency of PVC and PMMA to combine is revealed by the change in shape of particles from a spherical shape. As a result, PMMA coordinates with PVC and forms a complexation. In a literature survey, it was found that a higher pore size leads to less phase separation and forms a more homogeneous polymer electrolyte system [37, 38].

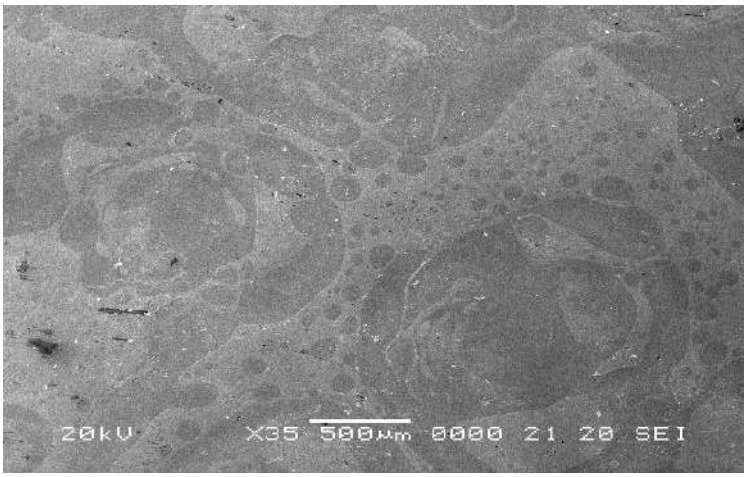

Figure 7 SEM Micrograph of S_1 Sample

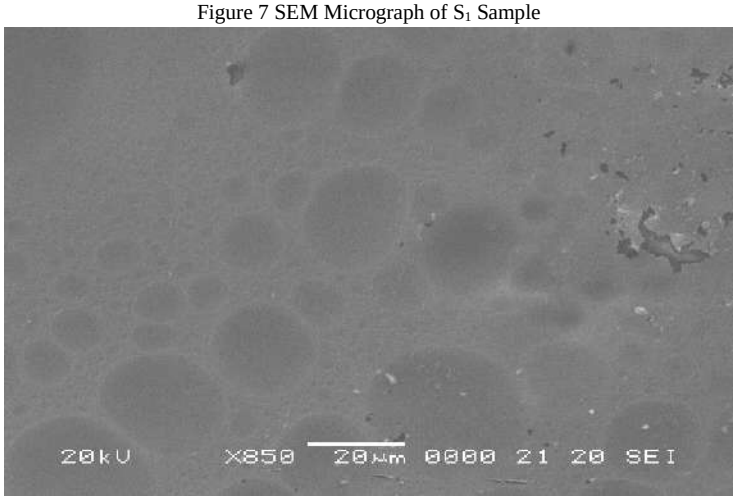

Figure 8 SEM Micrograph of S_2 Sample

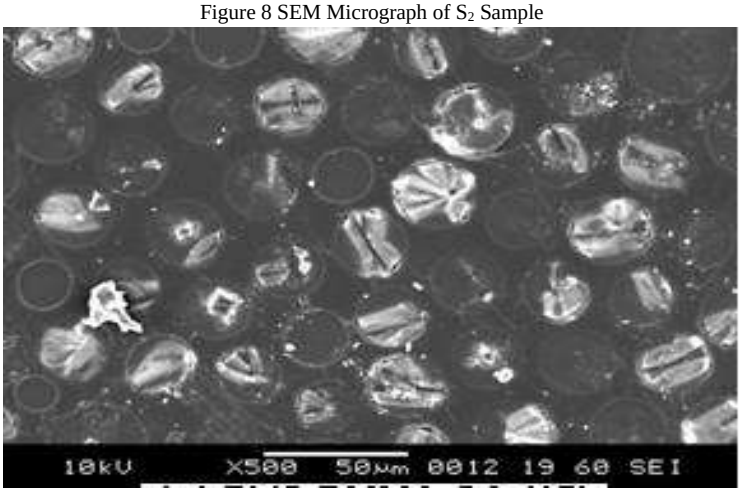

Figure 9 SEM Micrograph of S_3 Sample

Additionally, the morphology of the blends shows a phase-separated region, as shown in Fig. 7. Therefore, at the same concentration of PVC and PMMA, the phase split-up ultimately leads to the miscibility of the blend.

Fig. 8 and 9 clearly show that the 1:1 (PVC: PMMA) blend contains some impurities compared to Fig. 7. From, a comparative study of Fig. 8 and 9, it is also observed that the dopant oxalic acid is more miscible as compared to cinnamic acid in 1:1 (PVC:PMMA) solution. Therefore, it can be concluded that the 1:1 (PVC: PMMA) blend with 5% oxalic acid forms a more homogeneous mixture, leading to the formation of a homogeneous thin film of PVC: PMMA with oxalic acid as a dopant. On the other hand, in the case of the 1:1 (PVC: PMMA) blend with 5% cinnamic acid, a homogeneous mixture was not formed, resulting in a thin film that was not homogeneous. This is because the thin film of the 1:1 (PVC: PMMA) blend with 5% cinnamic acid still shows some crystal particles of cinnamic acid, indicating that cinnamic acid was not completely miscible, i.e., immiscible with the 1:1 (PVC: PMMA) solution. This can also be explained by the fact that immiscible mixes show several glass transition temperature areas, whereas miscible blends only show one [39].

IV. CONCLUSIONS

It was found that 1:1 (PVC: PMMA) CA 5% show maximum thickness among other samples. In short, in given study successfully casted the composites thin films of 1:1 (PVC: PMMA) with dopant oxalic acid (OA) and cinnamic acid (CA). The FT-IR spectrum study agrees us to conclude that successful formation of 1:1 (PVC: PMMA) homogenous thin films with OA and CA as dopant and characteristic peaks shows with addition of oxalic acid and cinnamic acid. XRD analysis shows amorphous nature all thin films. SEM micrographs of samples attribute FTIR and XRD's results. Also, the thin film of the 1:1 (PVC: PMMA) blend with 5% cinnamic acid still shows some crystal particles of cinnamic acid, indicating that cinnamic acid was not completely miscible, i.e., immiscible with the 1:1 (PVC: PMMA) solution. This can also be explained by the fact that immiscible mixes show several glass transition temperature areas, whereas miscible blends only show one [39]. As miscibility of dopant in polymer electrolyte system increase which cause to change in electrical parameters like electrical conductivities (AC and DC) and dielectric constant [40, 41].

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