Review on Present Status and Future Potential of Renewable Energy in India

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Abstract- **The Sun has been worshiped as a life-giver to our planet since ancient times. The industrial ages gave us the understanding of sunlight as an energy source. India is endowed with vast solar energy potential. About 5,000 trillion kWh per year energy is incident over India's land area with most parts receiving 4-7 kWh per sq. m per day. Solar photovoltaics power can effectively be harnessed providing huge scalability in India. The primary objective for deploying renewable energy in India is to advance economic development, improve energy security, improve access to energy, and mitigate climate change. Sustainable development is possible by use of sustainable energy and by ensuring access to affordable, reliable, sustainable, and modern energy for citizens. Strong government support and the increasingly opportune economic situation have pushed India to be one of the top leaders in the world's most attractive renewable energy markets. Presently, most of India's energy demands are fulfilled by fossil fuels like coal, petroleum, natural gas, etc. Due to such high demand for fossil fuels, these fossil fuels will soon get depleted. India is increasingly adopting responsible renewable energy techniques and taking positive steps towards carbon emissions, cleaning the air and ensuring a more sustainable future. Recently, India achieved 5th global position in solar power deployment by surpassing Italy. Solar power capacity has increased by more than 11 times in the last five years from 2.6 GW in March,2014 to 30 GW in July, 2019. Presently, solar tariff in India is very competitive and has achieved grid parity.**

Keywords: **Renewable energy, Solar energy, Energy**

Introduction

The sources of electricity production such as coal, oil, and natural gas have contributed to one-third of global greenhouse gas emissions. It is essential to raise the standard of living by providing cleaner and more reliable electricity. India has an increasing energy demand to fulfil the economic development plans that are being implemented. The provision of increasing quanta of energy is a vital pre-requisite for the economic growth of a country. The National Electricity Plan (NEP) framed by the Ministry of Power (MoP) has developed a 10-year detailed action plan with the objective to provide electricity across the country, and has prepared a further plan to ensure that power is supplied to the citizens efficiently and at a reasonable cost. According to the World Resource Institute Report 2017, India is responsible for nearly 6.65% of total global carbon emissions, ranked fourth next to China (26.83%), the USA (14.36%), and the EU (9.66%). Climate change might also change the ecological balance in the world. Intended Nationally Determined Contributions (INDCs) have been submitted to the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement. The latter has hoped to achieve the goal of limiting the rise in global temperature to well below 2 °C. According to a World Energy Council prediction, global electricity demand will peak in 2030. India is one of the largest coal consumers in the world and imports costly fossil fuel. Close to 74% of the energy demand is supplied by coal and oil. According to a report from the Centre for monitoring Indian economy, the country imported 171 million tons of coal in 2013–2014, 215 million tons in 2014–2015, 207 million tons in 2015–2016, 195 million tons in 2016–2017, and 213 million tons in 2017–2018. Therefore, there is an urgent need to find alternate sources for generating electricity. Awareness of saving energy has been promoted among citizens to increase the use of solar, wind, biomass, waste, and hydropower energies. It is evident that clean energy is less harmful and often cheaper. Recent estimates show that in 2047, solar potential will be more than 750 GW and wind potential will be 410 GW. A mixture of push policies and pull mechanisms, accompanied by particular strategies should promote the development of renewable energy technologies. The Indian Government has been at work, making a comprehensive policy for compulsory use of renewable energy resources through biomass, hydropower, wind, solar and municipal waste in the country, particularly for commercial establishments, as well as Government establishments. The financial allocation for renewable energy sources vis-a` - vis total allocation, however, remains in the range of 0.1% during Tenth Plan period. The Indian government has also set specific targets for renewable energy by 2012 it expects renewable energy to contribute 10% of total power generation capacity and have a 4–5% share in the electricity mix. This implies that growth in renewable energy will occur at a much faster pace than traditional power generation, with renewables making up 20% of the 70,000MW of total additional energy planned from 2008 to 2012. From 2002 to 2007, there was 3075MW of renewable grid-tied power planned, but the actual capacity addition exceeded 6000MW by 2006. A large share of this was the result of exceptional growth of wind energy in India. Wind energy is expected to add more than 10,000MW of additional capacity by 2012, followed by small hydro (1400 MW), cogeneration (1200 MW) and biomass (500 MW). Ministry of Nonconventional Energy Sources is focused on nation-wide resource assessment, setting up of commercial projects, renovation and modernization, development and up-gradation of water mills and industry-based research and development. The Ministry of New and Renewable Energy has identified renewable energy R&D as an important factor for developing this sector. R&D subsidy is 100% of a project's cost in government R&D institutions, and 50% in the private sector. The R&D subsidy for the

private sector may be enhanced for initial stages of technologies that have longer time-horizons. Renewable sources already contribute to about 5% of the total power generating capacity in the country. During the last two decades, several renewable energy technologies have been deployed in rural and urban areas. Some of the achievements are given in Table 1 along with the estimated potential. In 2016, India's overall energy consumption was 724 million tons of oil equivalent (Mtoe) and is expected to rise to 1921 Mtoe by 2040 with an average growth rate of 4.2% per annum. Energy consumption of various major countries comprises commercially traded fuels and modern renewables used to produce power. In 2016, India was the fourth largest energy consumer in the world after China, the USA, and the Organization for economic co-operation and development (OECD) in Europe. The projected estimation of global energy consumption demonstrates that energy consumption in India is continuously increasing and retains its position even in 2035/ 2040. The increase in India's energy consumption will push the country's share of global energy demand to 11% by 2040 from 5% in 2016. Emerging economies such as China, India, or Brazil have experienced a process of rapid industrialization, have increased their share in the global economy, and are exporting enormous volumes of manufactured products to developed countries. This shift of economic activities among nations has also had consequences concerning the country's energy use.

Material and Method

As it is a revive various books, research papers, Govt. publications, Websites etc. are used for comparative study.

Discussion

How renewable energy sources contribute to the energy demand in India

Energy is a basic requirement for economic development and in every sector of Indian economy. It is thus necessary that India quickly look towards new and emerging renewable energy and energy efficient technologies as well as implement energy conservation laws. Against this background, the country urgently needs to develop a sustainable path of energy development. Promotion of energy conservation and increased use of renewable energy sources are the twin planks of a sustainable energy supply. Fortunately, India is blessed with a variety of renewable energy sources, like biomass, the solar, wind, geothermal and small hydropower and implementing one of the world's largest programs in renewable energy. India is determined to becoming one of the world's leading clean energy producers. The Government of India has already made several provisions, and established many agencies that will help it to achieve its goal. Renewable energy, excluding large hydro projects already account for 9% of the total installed energy capacity, equivalent to 12,610MWof energy. In combination with large hydro, the capacity is more than 34%, i.e., 48,643 MW, in a total installed capacity of 144,980 MW. Fig. 4 is showing installed power capacity (MW) in India. The country has an estimated renewable energy potential of around 85,000MW from commercially exploitable sources, i.e., wind, 45,000 MW; small hydro, 15,000MW and biomass/bioenergy, 25,000 MW. In addition, India has the potential to generate 35MW per square kilometer using solar photovoltaic and solar thermal energy. By March 2007, renewable electricity, excluding hydro above 25MW installed capacity, has contributed 10,243MWrepresenting 7.7% of total electricity installed capacity. There has been phenomenal progress in wind power and, with an installed capacity of over 8757 MW, India occupies the fifth position globally (REN21, Renewables 2009; Varuna SK, Singal.2007; Planning Commission, Govt. of India). According to the 11th new and renewable energy five-year plan proposed by the government of India, from 2008 to 2012 the renewable energy market in India will reach an estimated US $19 billion. Investments of US $15 billion will be required in order to add the approximately 15,000 megawatts (MW) of renewable energy to the present installed capacity. The Indian government has also set specific targets for renewable energy by 2012 it expects renewable energy to contribute 10% of total power generation capacity and have a 4–5% share in the electricity mix. This implies that growth in renewable energy will occur at a much faster pace than traditional power generation, with renewables making up 20% of the 70,000MW of total additional energy planned from 2008 to 2012. From 2002 to 2007, there was 3075MW of renewable grid-tied power planned, but the actual capacity addition exceeded 6000MW by 2006. A large share of this was the result of exceptional growth of wind energy in India. Wind energy is expected to add more than 10,000MW of additional capacity by 2012, followed by small hydro (1400 MW), cogeneration (1200 MW) and biomass (500 MW). Ministry of Nonconventional Energy Sources is focused on nation-wide resource assessment, setting up of commercial projects, renovation and modernization, development and up-gradation of water mills and industry-based research and development. The Ministry of New and Renewable Energy has identified renewable energy R&D as an important factor for developing this sector. R&D subsidy is 100% of a project's cost in government R&D institutions, and 50% in the private sector. The R&D subsidy for the private sector may be enhanced for initial stages of technologies that have longer time-horizons. Renewable sources already contribute to about 5% of the total power generating capacity in the country. During the last two decades, several renewable energy technologies have been deployed in rural and urban areas. Some of the achievements are given in Table 1 along with the estimated potential (Urja Akshay 2008).

Table 1. Renewable energy in India at a glance

Sl. no.	Source/system	Estimated potential	Achievements (as on 30 September 2008)
I	A power from renewables		
A.	Grid interactive renewable power	(MW)	(MW)
1.	Wind power	45,195	9521.80
2.	Biopower (agroresidues and plantations)	16,881	656.60
3.	Bagasse cogeneration	5000	993.83
4.	Small hydro (up to 25 MW)	15,000	2220.99
5.	Energy recovery from waste (MW)	2700	55.25
6.	Solar photovoltaic power	–	2.12 MW
	Sub total (A)	**84.776**	**13,450.59**
B.	Captive/combined heat and power/distributed renewable power		
7.	Biomass/cogeneration (non-baggase)	–	136.70
8.	Biomass gasifiers	–	102.21
9.	Energy recovery from waste	–	31.07
	Sub total (B)	–	**269.98**
	Total (A+B)	**84.776**	**13,720.57**
II	Remote village electrification		**5379 villages/hamlets**
III	Decentralized energy systems		
10.	Family-type biogas plants	120 lakh	40.32 lakh
11.	Solar photovoltaic systems	50 MW/km^2	120 MWp
	i. Solar street lighting systems	–	70,474 nos.
	ii. Home lighting systems	–	434,692 nos.
	iii. Solar lanterns	–	697,419 nos.
	iv. Solar power plant	–	8.01 MWp
	v. Solar photovoltaic pumps	–	7148 nos.
12.	Solar thermal systems		4,78,058 nos.
	i. Solar water heating systems	140 million m^2 of collector area	2.45 million m^2 of collector area
	ii. Solar cookers	–	6.37 lakhs
13.	Wind pumps	–	1342 nos.
14.	Aero generators/hybrid systems		723.00 kW
IV	Awareness programs		
15.	Energy parks	–	516 nos.
16.	Aditya Solar Shops	–	269 nos.
17.	Renewable Energy Clubs	–	521 nos.
18.	Distric Advisory Committees	–	560 nos.

MW = mega-watt; m^2 = square meter; km^2 = kilowatt; MWp = mega watt peak

MNRE (www.mnre.gov.in).

Biomass

India is very rich in biomass and has a potential of 16,881MW (agro-residues and plantations), 5000MW (bagasse cogeneration) and 2700MW (energy recovery from waste) (Subramanian V 2007). Biomass power generation in India is an industry that attracts investments of over Rs. 600 crores every year, generating more than 5000 million units of electricity and yearly employment of more than 10 million man-days in the rural areas.

Hydropower

In India, hydropower projects with a station capacity of up to 25 megawatts (MW) fall under the category of small hydropower (SHP). India has an estimated SHP potential of about 15,000 MW, of which about 11% has been tapped so far. The Ministry of New and Renewable Energy (MNRE) supports SHP project development throughout the country. So far, 523 SHP projects with an aggregate installed capacity of 1705MW have been installed. Besides these, 205 SHP projects with an aggregate capacity of 479MW are under implementation. With a capacity addition, on an average, of 100MW per year and gradual decrease in gestation periods and capital costs, the SHP sector is becoming increasingly competitive with other alternatives.

Wind energy

The availability of wind varies for different regions. Wind resources can be exploited mainly in areas where wind power density is at least 400 W/m2 at 30 m above the ground. The Wind Resource Assessment Program is being implemented by C-WET (Centre for Wind Energy Technology) in coordination with state nodal agencies. An annual mean wind power density greater than 200 W/m2 (watts per square meter) at 50-m height has been recorded at 211 wind monitoring stations, covering 13 states and union territories, namely Andaman and Nicobar Islands, Andhra Pradesh, Gujarat, Karnataka, Kerala, Lakshadweep, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttaranchal, and West Bengal. India's wind power potential has been assessed at 45,000 MW. A capacity of 8757MWup to 31 March 2008 has so far been added through wind (REN21, Renewables 2009). India is surpassed only by Germany as one of the world's fastest growing markets for wind energy. By the mid-1990s, the subcontinent was installing more wind generating capacity than North America, Denmark, Britain, and the Netherlands. The ten machines near Okha in the province of Gujarat were some of the first wind turbines installed in India. These 15-m Vestas wind turbines overlook the Arabian Sea. Now, in 2008, there is an installed capacity of 5310 MW; however, ten times that potential, or 45,000 MW, exists. Different types of Wind Power Generators used in India for Off grip Power generation, i.e., water-pumping windmills, aero-generators (a small wind electric generator having a capacity of up to 30 kW) and wind–solar hybrid systems [Urja Akshay 2007-8).

Solar energy

The total annual solar radiation falling on the earth is more than 7500 times the world's total annual primary energy consumption of 450 EJ. The annual solar radiation reaching the earth's surface, approximately 3,400,000 EJ, is an order of magnitude greater than all the estimated (discovered and undiscovered) non-renewable energy resources, including fossil fuels and nuclear. However, 80% of the present worldwide energy use is based on fossil fuels. Most parts of India receive 4–7 kWh of solar radiation per square

meter per day with 250–300 sunny days in a year. The highest annual radiation energy is received in Western Rajasthan while the North- Eastern region of the country receives the lowest annual radiation India has a good level of solar radiation, receiving the solar energy equivalent of more than 5000 trillion kWh/yr. Depending on the location, the daily incidence ranges from 4 to 7 kWh/m2, with the hours of sunshine ranging from 2300 to 3200 per year.

Geothermal energy

Biofuel program in the country is at nascent stage. The policy measures currently in place include an excise tax reduction for E-5, the obligation to blend all petrol with 5% ethanol in certain regions since January 2003 and government regulation of the ethanol selling price on the basis of ethanol production costs. Subsequently the percentage of ethanol mixture in petrol is planned to be increase to 10%. A new biofuel policy for the country is under construction.

Estimated renewable energy potential in India

The estimated potential of wind power in the country during 1995 (BSK Naidu 1996) was found to be 20,000 MW (20 GW), solar energy was 5 × 1015 kWh/pa, bioenergy was 17,000 MW, bagasse cogeneration was 8000 MW, and small hydropower was 10,000 MW. For 2006, the renewable potential was estimated as 85,000 MW with wind 4500 MW, solar 35 MW, biomass/bioenergy 25,000 MW, and small hydropower of 15,000 MW (Ashwani Kumar et al 2010). According to the annual report of the Ministry of New and Renewable Energy (MNRE) for 2017–2018, the estimated potential of wind power was 302.251 GW (at 100-m mast height), of small hydropower 19.749 GW, biomass power 17.536 GW, bagasse cogeneration 5 GW, waste to energy (WTE) 2.554 GW, and solar 748.990 GW. The estimated total renewable potential amounted to 1096.080 GW [39] assuming 3% wasteland, which is shown in Table 2.

Table 2. The estimated renewable potential in India

State-wise Renewable Energy Potential (in MW)								
Sl. No.	States/UTs	Wind power (MW)	Small hydro power	Bio-energy			Solar	Total
				Biomass power	Bagasse cogeneration	Waste to energy		
1	Andhra Pradesh	44.229	0.978	0.578	0.3	0.123	38.44	84.648
2	Arunachal Pradesh	0	1.341	0.008	0	0	8.65	9.999
3	Assam	0	0.239	0.212	0	0.008	13.76	14.219
4	Bihar	0	0.223	0.619	0.3	0.073	11.2	12.415
5	Chhattisgarh	0.077	1.107	0.236	0	0.024	18.27	19.714
6	Goa	0.001	0.007	0.026	0	0	0.88	0.914
7	Gujarat	84.431	0.202	1.221	0.35	0.112	35.77	122.086
8	Haryana	0	0.11	1.333	0.35	0.024	4.56	6.377
9	Himachal Pradesh	0	2.398	0.142	0	0.002	33.84	36.382
10	Jammu & Kashmir	0	1.431	0.043	0	0	111.05	112.524
11	Jharkhand	0	0.209	0.09	0	0.01	18.18	18.489
12	Karnataka	55.857	4.141	1.131	0.45	0	24.7	86.279
13	Kerala	1.7	0.704	1.044	0	0.036	6.11	9.594
14	Madhya Pradesh	10.484	0.82	1.364	0	0.078	61.66	74.406
15	Maharashtra	45.394	0.794	1.887	1.25	0.287	64.32	113.932
16	Manipur	0	0.109	0.013	0	0.002	10.63	10.754
17	Meghalaya	0	0.23	0.011	0	0.002	5.86	6.103
18	Mizoram	0	0.169	0.001	0	0.002	9.09	9.262
19	Nagaland	0	0.197	0.01	0	0	7.29	7.497
20	Odisha	3.093	0.295	0.246	0	0.022	25.78	29.436
21	Punjab	0	0.441	3.172	0.3	0.045	2.81	6.768
22	Rajasthan	18.77	0.057	1.039	0	0.062	142.31	162.238
23	Sikkim	0	0.267	0.002	0	0	4.94	5.209
24	Tamil Nadu	33.8	0.66	1.07	0.45	0.151	17.67	53.801
25	Telangana	4.244	0	0	0	0	20.41	24.654
26	Tripura	0	0.047	0.003	0	0.002	2.08	2.132
27	Uttar Pradesh	0	0.461	1.617	1.25	0.176	22.83	26.334
28	Uttarakhand	0	1.708	0.024	0	0.005	16.8	18.537
29	West Bengal	0.002	0.396	0.396	0	0.148	6.26	7.202
30	Andaman & Nicobar	0.008	0.008	0	0	0	0	0.016
31	Chandigarh	0	0	0	0	0.006	0	0.006
32	Dadra & Nagar Haveli	0	0	0	0	0	0	0
33	Daman & Diu	0	0	0	0	0	0	0
34	Delhi	0	0	0	0	0.131	2.05	2.181
35	Lakshadweep	0.008	0	0	0	0	0	0.008
36	Puducherry	0.153	0	0	0	0.003	0	0.156
37	Others	0	0	0	0	1.022	0.79	1.812
	Total	302.251	19.749	17.536	5	2.554	748.99	1096.08

(***Source:*** **Ministry of New and Renewable Energy (2017)**

Current achievements in renewable energy 2017– 2018

1. India doubled its renewable power capacity in the last 4 years. The cumulative renewable power capacity in 2013–2014 reached 35,500 MW and rose to 70,000 MW in 2017–2018.
2. India stands in the fourth and sixth position regarding the cumulative installed capacity in the wind and solar sector, respectively. Furthermore, its cumulative installed renewable capacity stands in fifth position globally as of the 31st of December 2018.
3. As said above, the cumulative renewable energy capacity target for 2022 is given as 175 GW. For 2017 2018, the cumulative installed capacity amounted to 70 GW, the capacity under implementation is 15 GW and the tendered capacity was 25 GW. The target, the installed capacity, the capacity under implementation, and the tendered capacity are shown in Fig. 1.

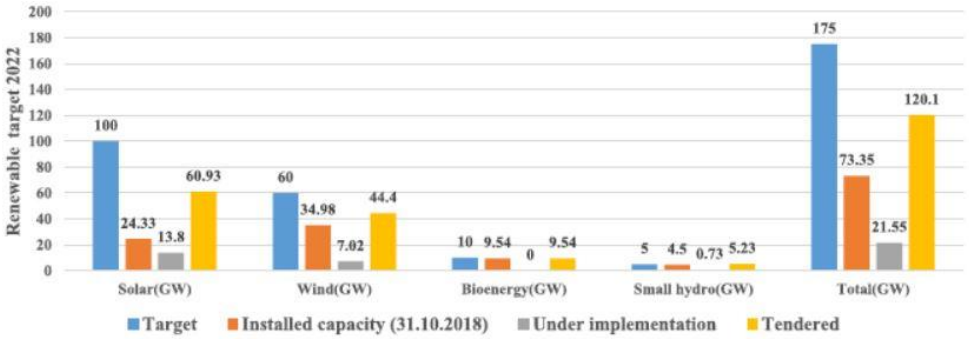

Fig. 1 Renewable energy target, installed capacity, under implementation and tendered (*Source:* Initiatives and achievements, MNRE (2018).)

4. There is tremendous growth in solar power. The cumulative installed solar capacity increased by more than eight times in the last 4 years from 2.630 GW (2013– 2014) to 22 GW (2017–2018). As of the 31st of December 2018, the installed capacity amounted to 25.2122 GW.
5. The renewable electricity generated in 2017–2018 was 101839 BUs. 6. The country published competitive bidding guidelines for the production of renewable power. It also discovered the lowest tariff and transparent bidding method and resulted in a notable decrease in per unit cost of renewable energy.
7. In 21 states, there are 41 solar parks with a cumulative capacity of more than 26,144 MW that have already been approved by the MNRE. The Kurnool solar park was set up with 1000 MW; and with 2000 MW the largest solar park of Pavagada (Karnataka) is currently under installation.
8. The target for solar power (ground mounted) for 2018–2019 is given as 10 GW, and solar power (Rooftop) as 1 GW.
9. MNRE doubled the target for solar parks (projects of 500 MW or more) from 20 to 40 GW.
10. The cumulative installed capacity of wind power increased by 1.6 times in the last 4 years. In 2013–2014, it amounted to 21 GW, from 2017 to 2018 it amounted to 34 GW, and as of 31st of December 2018, it reached 35.138 GW. This shows that achievements were completed in wind power use.
11. An offshore wind policy was announced. Thirty-four companies (most significant global and domestic wind power players) competed in the "expression of interest" (EoI) floated on the plan to set up India's first mega offshore wind farm with a capacity of 1 GW.
12. 682 MW small hydropower projects were installed during the last 4 years along with 600 watermills (mechanical applications) and 132 projects still under development.
13. MNRE is implementing green energy corridors to expand the transmission system. 9400 km of green energy corridors are completed or under implementation. The cost spent on it was INR 10141 crore (101,410 Million INR = 1425.01 USD). Furthermore, the total capacity of 19,000 MVA substations is now planned to be complete by March 2020.
14. MNRE is setting up solar pumps (off-grid application), where 90% of pumps have been set up as of today and between 2014–2015 and 2017–2018. Solar street lights were more than doubled. Solar home lighting systems have been improved by around 1.5 times. More than 2,575,000 solar lamps have been distributed to students. The details are illustrated in Fig. 2.

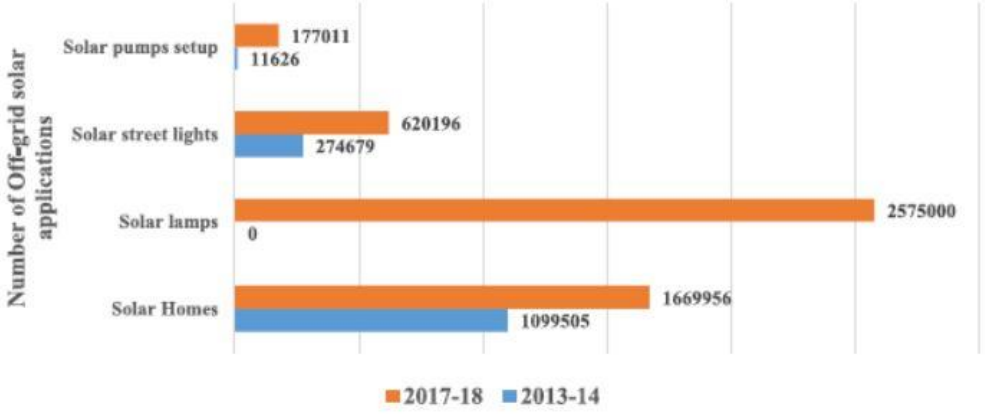

Fig. 2 Off-grid solar applications (*Source:* Initiatives and achievements, MNRE (2018).)

15. From 2014–2015 to 2017–2018, more than 2.5 lakh (0.25 million) biogas plants were set up for cooking in rural homes to enable families by providing them access to clean fuel.
16. New policy initiatives revised the tariff policy mandating purchase and generation obligations (RPO and RGO). Four wind and solar inter-state transmission were waived; charges were planned, the RPO trajectory for 2022 and renewable energy policy was finalized.
17. Expressions of interest (EoI) were invited for installing solar photovoltaic manufacturing capacities associated with the guaranteed off-take of 20 GW. EoI indicated 10 GW floating solar energy plants.

18. Policy for the solar-wind hybrid was announced. Tender for setting up 2 GW solar-wind hybrid systems in existing projects was invited.
19. To facilitate R&D in renewable power technology, a national lab policy on testing, standardization, and certification was announced by the MNRE.
20. The Surya Mitra program was conducted to train college graduates in the installation, commissioning, operations, and management of solar panels. The International Solar Alliance (ISA) headquarters in India (Gurgaon) will be a new commencement for solar energy improvement in India.
21. The renewable sector has become considerably more attractive for foreign and domestic investors, and the country expects to attract up to USD 80 billion in the next 4 years from 2018–2019 to 2021–2022.
22. The solar power capacity expanded by more than eight times from 2.63 GW in 2013–2014 to 22 GW in 2017–2018.
23. A bidding for 115 GW renewable energy projects up to March 2020 was announced.

Current energy policies

The ultimate objective of the renewable energy policy framework is to significantly increase the share of renewable energy source in India's energy mix (Maithani PC 2008). These energy policies are set by government.

1. National Electricity Policy, 2005

The National Electricity Policy aims at achieving the following objectives; access to electricity, availability of power demand (to be fully met by 2012), energy and peaking shortages to be overcome and spinning reserve to be available, supply of reliable and quality power of specified standards in an efficient manner and at reasonable rates, per capita availability of electricity to be increased to over 1000 units by 2012, financial turn around and commercial viability of electricity sector and protection of consumers' interests.

2. The Electricity Act 2003

The Electricity Act contains the following provisions pertaining to non-conventional energy sources. Under Sections 3(1) and 3(2), it has been stated that the Central Government shall, from time to time, prepare and publish the National Electricity Policy and Tariff Policy, in consultation with the state governments and authority for development of the power system based on optimal utilization of resources such as coal, natural gas, nuclear substances or material, hydro and renewable sources of energy. Section 4 states that the Central Government shall, after consultation with the state governments, prepare and notify a national policy, permitting stand-alone systems for rural areas. Section 61, 61(h) and 61(i) state that the appropriate commission shall, subject to the provision of this Act, specify the terms and conditions for the determination of tariff, and in doing so, shall be guided by the following, namely, the promotion, cogeneration and generation of electricity from renewable sources of energy; and the National Electricity Policy and Tariff Policy. Section 86(1) and 86(1)(e) state that the state commissions shall discharge the following functions, namely, promote cogeneration and generation of electricity from renewable sources of energy by providing, suitable measures for connectivity with the grid and sale of electricity to any person, and also specify, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution license.

3. Tariff Policy, 2006

The Tariff Policy announced in January 2006 has the following provisions:
1. Pursuant to provisions of section 86 (1) (e) of the Act, the Appropriate Commission shall fix a minimum percentage for purchase of energy from such sources taking into account availability of such resources in the region and its impact on retail tariffs.
2. It will take some time before non-conventional technologies can compete with conventional sources in terms of cost of electricity. Therefore, procurement by distribution companies shall be done at preferential tariffs determined by the Appropriate Commission.
3. Such procurement by Distribution Licensees for future requirements shall be done, as far as possible, through competitive bidding process under Section 63 of the Act within suppliers offering energy from same type of nonconventional sources.
4. The Central Commission should lay down guidelines within three months for pricing non-firm power, especially from nonconventional sources, to be followed in cases where such procurement is not through competitive bidding.

4. National Rural Electrification Policies, 2006

1. Goals include provision of access to electricity to all households by the year 2009, quality and reliable power supply at reasonable rates, and minimum lifeline consumption of 1 unit/household/day as a merit good by year 2012.
2. For villages/habitations where grid connectivity would not be feasible or not cost effective, off-grid solutions based on standalone systems may be taken up for supply of electricity.
3. State government should, within 6 months, prepare and notify a rural electrification plan, which should map and detail the electrification delivery mechanism.
4. The Gram Panchayat shall certify and confirm the electrified status of the village as on 31st March each year.

5. Integrated Energy Policy Report (Planning Commission) 2006

Suggest a path to meet energy needs of the country in an integrated manner up to 2031–2032. It recommended special focus on renewable energy development.

Initiatives and steps for delivery and outreach

1. District Advisory Committees (DACs)

These Committees have led to the creation of an effective renewable energy promotion network at the grass-root level that will also help in integration of renewable energy schemes with those of other development departments. To date, 550 DACs have been setup in 550 districts of the country.

2. Akshay Urja Shops (renewable energy shops)

Akshay Urja Shops were launched to cover all districts of the country to ensure easy availability of such systems/devices. It is expected that the common man will embrace renewable energy technologies in a big way for augmenting energy needs of cooking, lighting and motive power from these shops.

3. Energy parks

With a view to integrating the activities of State and District Levels Energy Parks was set up at the national level.

4. Rajiv Gandhi Akshay Urja Diwas (Rajiv Gandhi Renewable Energy Day)

The birth anniversary of former Prime Minister, late Sh. Rajiv Gandhi on 20th August 2006 was observed as 'Rajiv Gandhi Akshay Urja Diwas' all over the country is organize to increase awareness on a mass-scale at National, State and District levels.

5. Akshay Urja Newsletter (Renewable Energy Newsletter)

A bi-monthly newsletter titled 'Akshay Urja' was started with a focus on national/international renewable energy developments, technological developments, manufacturer's details, renewable energy education, etc.

6. Renewable Energy Clubs

A scheme has been evolved to promote the study of renewable energy through the setting up of RE Clubs in AICTE recognized/ approved Engineering Colleges/Technology Institutions all over the country to educate and sensitize young and future scientists on various aspects of new and renewable energy.

Future of renewable energy in India

India, faced with twin challenges on energy and environmental front, has no option but to work towards increasing the role of renewable in the future energy systems. Renewable energy technologies vary widely in their technological maturity and commercial status. In India, renewable energy is at the take-off stage and businesses, industry, government and customers have a large number of issues to address before these technologies could make a real penetration. India with large renewable energy resources (solar PV, wind, solar heating, small hydro and biomass) is to set to have large-scale development and deployment of renewable energy projects (Maithani PC 2008). The aim of meeting 10% of the country power supply through renewable by 2012 and also ambitious plans for the distribution of biogas plants, solar PV applications and solar city appears to be within reach. Moreover, introduction of tradable renewable energy certificates (REC) could overcome the existing gap that is hindering the application of quota for renewables and thereby creates a vibrant market. India would also have to look for international cooperation in renewable energy through well-defined R&D projects with proper division of labour and responsibilities for specific tasks with equitable financial burden and credit sharing arrangements.

Renewable energy development is considered in India to be of great importance from the point of view of long-term energy supply security, environmental benefits and climate change mitigation. The Integrated Energy Policy report has recognized the need to maximally develop domestic supply options as well as the need to diversify energy sources. The Committee has placed emphasis on higher use of renewables in all forms of services. It is expected that the contribution from renewables in power generation alone can be of the extent of 60,000MW in the year 2031–2032. By 2031–2032 renewables will be the key driver in social inclusion of the poor in the development process. A modest assessment of investments in the renewable energy sector will be about Rs. 300,000 crores over the next 25 years. MNRE has included in its mission: energy security; increase in the share of clean power; energy availability and access; energy affordability; and energy equity (Chaturvedi P, Garg HP. 2008). A number of government and private organizations such as MNRE, Centre for Wind Energy Technology, Universities, IITs, NITs, Indian Oil Corporation Ltd. (IOCL) and The Energy Resource Institute (TERI) are involved in R&D of renewable energy sources.

Conclusion

The renewable sector suffers notable obstacles. Some of them are inherent in every renewable technology; others are the outcome of a skewed regulative structure and marketplace. The absence of comprehensive policies and regulation frameworks prevent the adoption of renewable technologies. The renewable energy market requires explicit policies and legal procedures to enhance the attention of investors. There is a delay in the authorization of private sector projects because of a lack of clear policies. The country should take measures to attract private investors. Inadequate technology and the absence of infrastructure required to establish renewable technologies should be overcome by R&D. The government should allow more funds to support research and innovation activities in this sector. There are insufficiently competent personnel to train, demonstrate, maintain, and operate renewable energy structures and therefore, the institutions should be proactive in preparing the workforce. Imported equipment is costly compared to that of locally; therefore, generation of renewable energy becomes expensive and even unaffordable. Hence, to decrease the cost of renewable products, the country should become involve in the manufacturing of renewable products. Another significant infrastructural obstacle to the development of renewable energy technologies is unreliable connectivity to the grid. As a consequence, many investors lose their faith in renewable energy technologies and are not ready to invest in them for fear of failing. India should work on transmission and evacuation plans. Inadequate servicing and maintenance of facilities and low reliability in technology decreases customer trust in some renewable energy technologies and hence prevent their selection. Adequate skills to repair/service the as par parts/equipment are required to avoid equipment failures that halt the supply of energy. Awareness of renewable energy among communities should be fostered, and a significant focus on their socio-cultural practices should be considered. Governments should support investments in the expansion of renewable energy to speed up the commercialization of such technologies. The Indian government should declare a well-established fiscal assistance plan, such as the provision of credit, deduction on loans, and tariffs. The government should improve regulations making obligations under power purchase agreements (PPAs) statutorily binding to guarantee that all power DISCOMs have PPAs to cover a hundred percent of their RPO obligation. To accomplish a reliable system, it is strongly suggested that renewables must be used in a hybrid configuration of two or more resources along with conventional source and storage devices. Regulatory authorities should formulate the necessary standards and

regulations for hybrid systems. Making investments economically possible with effective policies and tax incentives will result in social benefits above and beyond the economic advantages.

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Exploring Phytoplankton Diversity and Morphology in Shakkar Lake: A Case Study at Narnala Fort

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Abstract- **Phytoplankton, as primary producers, is integral to the functioning of freshwater ecosystems, profoundly impacting aquatic food webs and water quality. This research investigates the phytoplankton diversity, morphology, and species composition in Shakkar Lake at Narnala Fort, shedding light on its ecosystem dynamics. Plankton samples were collected weekly from four designated sampling sites over a month-long period and preserved in a 5% formalin solution for microscopic analysis. The study identified phytoplankton belonging to the Cyanophyceae, Chlorophyceae, and Bacillariophyceae classes in Shakkar Lake. Within Cyanophyceae, four genera were observed: Anabaena, Nostoc, Microcystis, and Spirulina. Chlorophyceae exhibited three genera: Spirogyra, Cosmarium, and Zygnema, while Bacillariophyceae revealed three genera: Pinnularia, Cymbella, and Ulnaria. These findings provide valuable insights into the phytoplankton community structure of Shakkar Lake, enhancing our understanding of its ecological dynamics and contributing to broader research on freshwater ecosystems.**

Keywords: **Phytoplankton, Freshwater Ecosystems, Shakkar Lake, Narnala Fort, Diversity, Morphology, Species Composition, Cyanophyceae, Chlorophyceae, Bacillariophyceae.**

Introduction

The objective of the current research is to identify the various types of phytoplankton inhabiting Shakkar Lake and to investigate their morphology and diversity. Situated within the Narnala Fort, Shakkar Lake is positioned at coordinates 210 15′ N and 770 4′ E, near Akot, Akola District, Maharashtra, and is currently located within the Melghat Tiger Reserve. This lake serves as a crucial water source for the Maharashtra Jeevan Pradhikaran water supply office. Phytoplankton, being ubiquitous, unicellular, and microscopic, serves as the primary life forms in aquatic environments. They play a pivotal role as the primary producers in the aquatic food chain, thereby significantly contributing to the global fishery resource (Reynolds, 1987; Vajravelu et al., 2018; Boruah and Das, 2001). [1][2][3] Additionally, phytoplankton is fundamental in maintaining the equilibrium between living organisms and abiotic factors within aquatic ecosystems. The distribution of phytoplankton and their variations in different zones of a water body are influenced by various physico-chemical parameters of water. Research indicates that summer is the most conducive season for phytoplankton growth in freshwater lakes due to factors such as extended duration of light exposure, increased salinity, and pH levels (Chaturvedi et al., 1999).[4] Conversely, late summer and monsoon seasons witness a decrease in phytoplankton production due to factors like heavy rainfall, heightened turbidity, reduced salinity, temperature, and pH levels (Saravanakumar et al., 2008).[5] The study of plankton is an invaluable tool for assessing water quality in any water body, contributing significantly to the understanding of the lake's primary nature and overall economy (Pawar et al., 2006).[6]

Material and Method

Study area:

Location: Shakkar Lake is situated within the Narnala Fort, which is positioned in the Akot, Akola District, and Maharashtra, India.
Coordinates: Latitude 21° 15' N, Longitude 77° 4' E.
Closest City: Akot, which is approximately 18 km away from the lake.
Current Status: The area is now part of the Melghat Tiger Reserve.

Sampling:

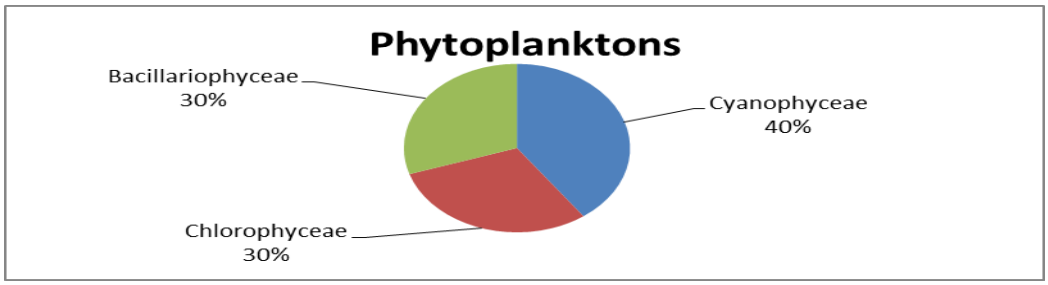
Sampling Period: Plankton samples were collected weekly for the duration of a month in March 2023.
Sampling Sites: Four sampling sites within the lake were selected for plankton sampling.

Sample Collection: Surface water samples, containing phytoplankton, were directly collected from each selected site of the lake.
Handling: Samples were carefully transferred to bottles without disturbance to preserve their integrity.
Transport: Collected samples were brought to the laboratory for further analysis.
Timing: Sampling was conducted during morning hours.

Shakkar Lake

Preservation and Identification of Phytoplankton Samples:
Preservation: Samples were preserved in a 5% formalin solution to maintain their structure for microscopic identification.
Microscopic Identification: Plankton slides were prepared from the preserved samples. Identification was performed using a Magnus digital binocular microscope equipped with a 5-megapixel camera.
Identification Resources: Various resources were utilized for identification, including:
Reference books specifically focused on plankton identification.
Journals and research papers relevant to plankton taxonomy and ecology.
Online resources such as Google Lens, likely used for image-based identification assistance.

Observation and Result



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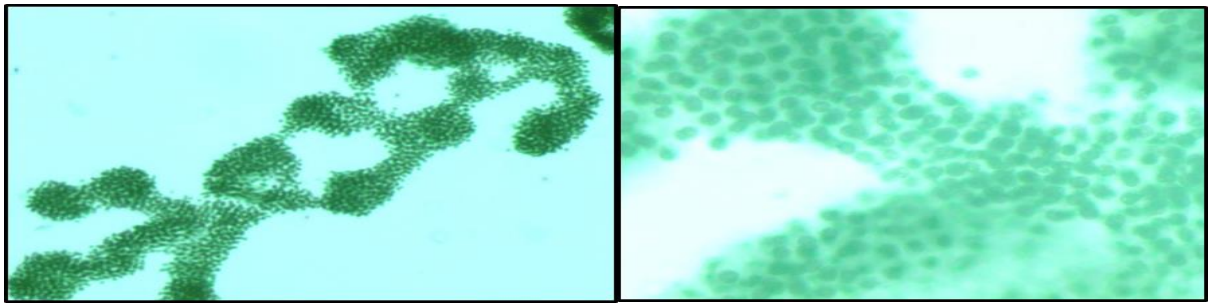
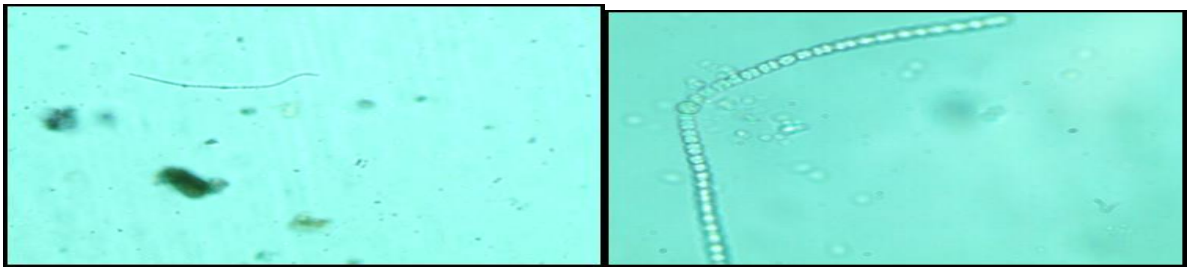


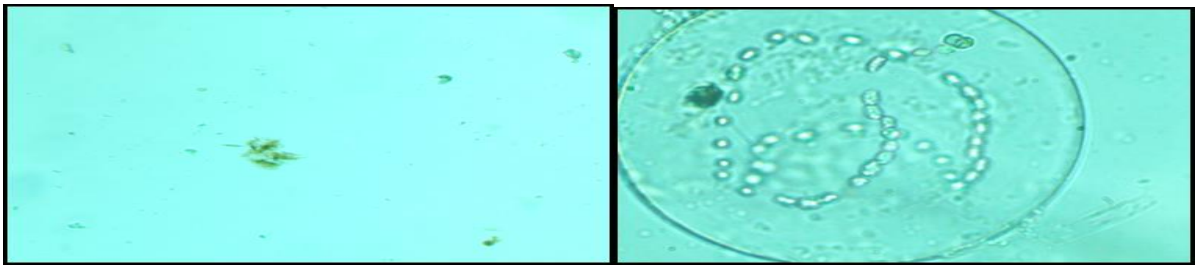
Microcystis

Spirulina

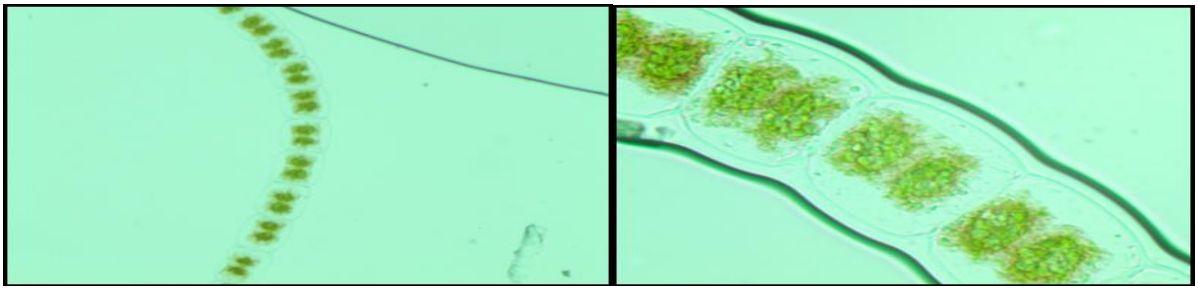
Spirogyra



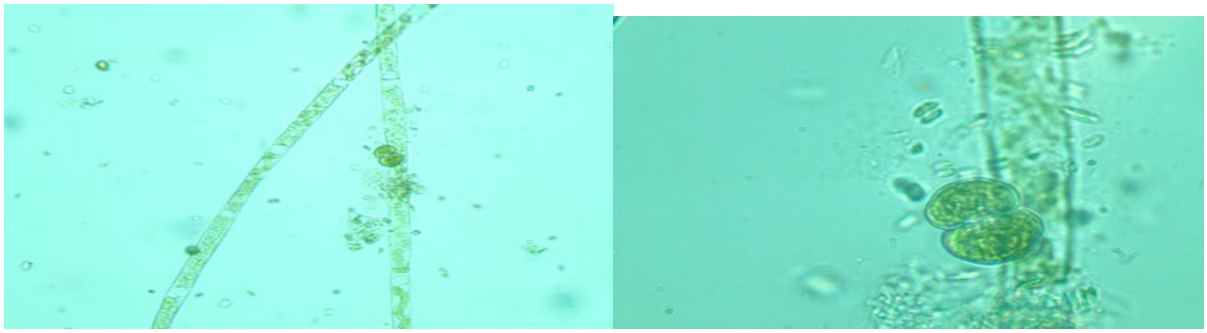
Anabaena



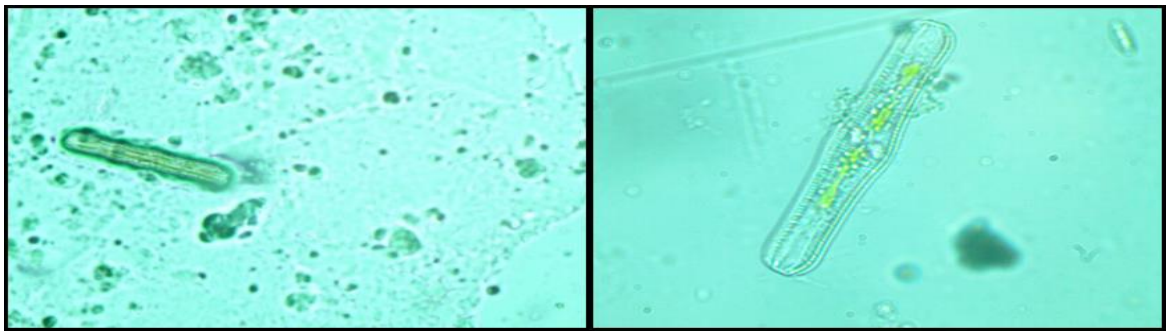
Nostoc



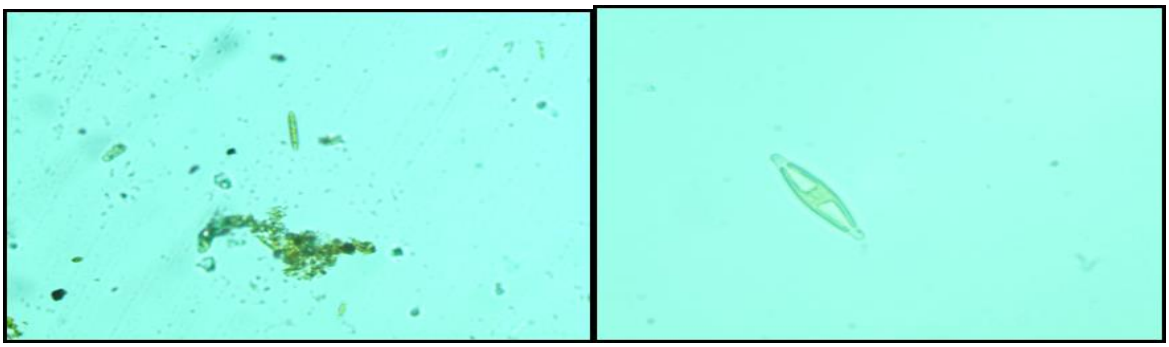
Zygnema



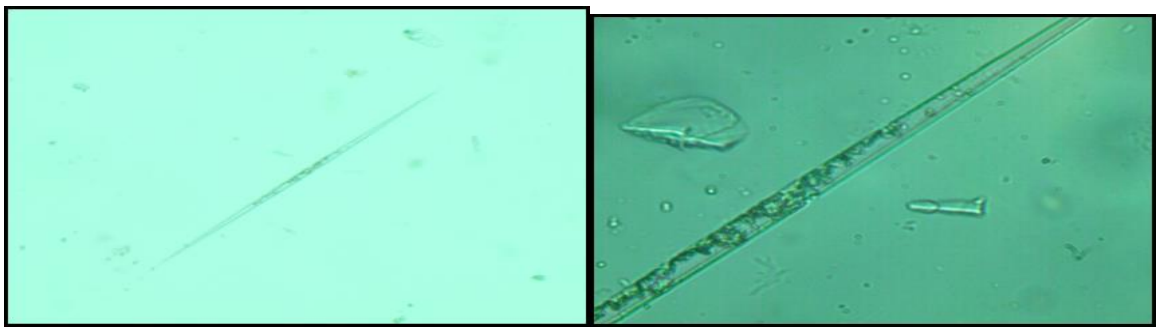
Cosmarium



Pinnularia



Cymbella



Ulnaria

Cyanophyceae Members

Microcystis

Microcystis is known for its small cells that contain gas-filled vesicles. Typically, these cells form colonies, which are visible to the naked eye and initially appear spherical. However, over time, these colonies lose their coherence and develop perforations or irregular shapes. The colonies are held together by a dense mucilage, which consists of various complex polysaccharide compounds such as xylose, mannose, glucose, fucose, galactose, rhamnose, and others (Rohrlack, Henning, & Kohl, 1999).

Spirulina

Spirulina is a multicellular and filamentous blue-green microalgae that forms symbiotic relationships with bacteria capable of nitrogen fixation from the air. It can exhibit rod or fragment shapes, with trichomes forming a regularly spirally curled cylinder. The individual cells within these trichomes can be delicate and challenging to distinguish, with sizes ranging from 1 to 8 µm in the periphery depending on the species. Spirulina is commonly found in both freshwater and brackish environments. Reproduction in Spirulina occurs exclusively through asexual means, primarily by double fission, as it does not engage in sexual reproduction..

Anabaena

Anabaena is a genus of nitrogen-fixing blue-green algae characterized by beadlike or barrel-like cells and interspersed enlarged spores known as heterocysts. These algae are commonly found as plankton in shallow water and on moist soil. There exist both solitary and colonial forms of Anabaena, with the colonial forms resembling those of a closely related genus, Nostoc. In temperate latitudes, particularly during the summer months, Anabaena may undergo prolific growth, leading to the formation of water blooms (Britannica, Editors of Encyclopaedia, 2016).

Nostoc

Nostoc is the most prevalent genus of cyanobacteria, widely distributed across various aquatic and terrestrial environments. These organisms have the ability to form colonies consisting of filaments made up of moniliform cells enveloped in a gelatinous sheath composed of polysaccharides. Additionally, Nostoc has the capability to establish symbiotic relationships within plant tissues, facilitating nitrogen fixation through specialized cells called heterocysts. The genus Nostoc encompasses numerous species exhibiting diverse morphologies, habitat distributions, and ecological functions (Fidor et al., 2019; Sand-Jensen, 2014).

Chlorophyceae Members

Spirogyra

Spirogyra is a genus of filamentous charophyte green algae belonging to the order Zygnematales. It derives its name from the helical or spiral arrangement of chloroplasts, which is a distinguishing feature of the genus. With over 400 species, Spirogyra is commonly found in freshwater habitats. Typically, Spirogyra measures between 10 to 100 µm in width and can grow to several centimeters in length. It is often observed as green slimy patches on the ground near ponds and other stagnant water bodies (Parmentier, 10).

Cosmarium

Cosmarium is a genus of freshwater organisms that belong to the Charophyta division, which is a group of green algae considered to be the ancestors of land plants (Embryophyta). Within this extensive genus, the cells display considerable variability. They are all constricted in the middle, giving them a characteristic bi-lobed appearance, with each half referred to as a semicell. The cells come in various shapes, and their cell walls may exhibit different textures, including smooth surfaces or ornamentation with spines, granules, scrobiculations (pits), or pores. Generally, Cosmarium cells are flattened in structure (Hall & McCourt, 2014).

Zygnema

Zygnema is a genus of freshwater filamentous thalloid algae, encompassing approximately 100 species. Among them is a terrestrial species known as Z. terrestre, which is identified in India. Zygnema typically grows as a free-floating mass of filaments, although young plants may attach to streambeds using a holdfast structure. These filaments form a tangled mat, ranging in color from yellow-green to bright green. Each filament consists of elongated barrel-shaped cells, with two star-shaped (stellate) chloroplasts arranged along the cell's axis (Guiry & Guiry, 2008).

Diatoms

Diatoms are single-celled organisms that exist either individually or in colonies, adopting various shapes such as ribbons,

fans, zigzags, or stars. These organisms exhibit a wide range of cell sizes, spanning from 2 to 200 micrometers in diameter (Hasle et al., 1996).

Pinnularia

Pinnularia are elongated elliptical unicellular organisms characterized by their unique cell structure. Their cell walls primarily consist of pectic substances supported by a rigid silica framework. Each cell is divided into two halves known as thecae, which overlap akin to a Petri dish and its cover. The larger outer valve is termed the Epitheca, while the smaller inner valve is referred to as the Hypotheca. A connecting band called a cingulum covers the margins of the two thecae, collectively forming a structure known as a frustule. Additionally, the entire cell is enveloped by a mucilaginous layer (Vashishta, Sinha, & Singh, 1960).

Cymbella

The cells of this organism exhibit a dorsiventral curvature, resembling the shape of an orange slice, ranging from slight to pronounced. They can exist either as colonial entities, forming branched mucilage stalks, or as individual cells. Within each cell, a single plastid contains two H-shaped plates that connect toward the dorsal side of the girdle, creating an enlarged bridge structure (Round et al., 1990).

Ulnaria

This organism is a pennate diatom, characterized by its elongated to needle-like shape when viewed from the valve, and appearing narrow and rectangular when viewed from the girdle. The valves are identical and lack a raphe, placing the genus within the category of araphid diatoms. Striae, or fine lines, are arranged in parallel rows, separated along the central axis of the cell by a thickened sternum. The central area of the valve lacks striae or may have very faint ones. While similar to Fragilaria, this organism does not form ribbons of cells joined side to side. Cells of this species are frequently attached to surfaces by one end. Furthermore, its chloroplasts are golden brown in color.

Result

The investigatory study conducted in Shakkar Lake has unveiled the presence of a diverse array of phytoplankton genera spanning different classes. The identified phytoplankton species in Shakkar Lake include *Anabaena, Nostoc, Microcystis, Spirulina, Spirogyra, Cosmarium, Zygnema, Pinnularia, Cymbella, and Ulnaria.* These findings highlight the rich biodiversity of phytoplankton in Shakkar Lake, underscoring the significance of further research to elucidate their ecological roles and dynamics within the lake ecosystem.

Conclusion

In conclusion, the phytoplankton community in Shakkar Lake at Narnala Fort comprises species belonging to the classes Cyanophyceae, Chlorophyceae, and Bacillariophyceae. Within Cyanophyceae, four genera were identified: *Anabaena, Nostoc, Microcystis, and Spirulina*. Chlorophyceae exhibited three genera: *Spirogyra, Cosmarium, and Zygnema*, while Bacillariophyceae revealed three genera: *Pinnularia, Cymbella, and Ulnaria*. These findings underscore the rich diversity of phytoplankton in Shakkar Lake and contribute to our understanding of its ecological dynamics. Further research is warranted to elucidate the interactions among these phytoplankton taxa and their impact on the lake's ecosystem health and functioning.

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Qualitative Phytochemical and Antibacterial Screening of *Annona squamosa* L. of Akot tehsil in Akola District (M.S.)

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ABSTRACT –

Plants are one of the most important sources of medicines from ancient time. The importance of herbal medicine is increases day by day. the chemical constituents present in the crude leaf extracts of *Annona squamosa* L. with special emphasis on their pharmacological actions. Qualitative phytochemical screening was carried out using the crude leaf extracts in four different solvents such as water, ethanol, acetone and petroleum ether. Phytochemical screening of the leaf extracts Shows the presence of glycosides, alkaloids, oils, saponins and flavonoids. the dried leaf extracts of *Annona squamosa* L. were evaluated against *Escherichia coli* and *Pseudomonas aeruginosa*. The leaf extracts of *Annona squamosa* L. shows the highly antibacterial activity against *Escherichia coli* and *Pseudomonas aeruginosa*. These results shows that the leaves are a rich source of primary and secondary metabolites exhibiting the antimicrobial activity

INTRODUCTION

From the ancient times, people have been inspecting the plants in search of novel drugs which has resulted in the use of numerous medicinal plants for the cure of various diseases (Verpoorte, 1998).
According to World Health Organization (WHO, 2008) 80% populations living in the developing countries rely exclusively on traditional medicine for their primary health care needs of which most involve the use of plant extracts (Sandhya et al., 2006). *Annona squamosa* L. belonging to the family Annonaceae is a small ever green tree commonly found in India and originates from West Indies and South America. Different parts of *Annona squamosa* L. are used in traditional medicine for the treatment of numerous diseases (Suresh et al., 2006). It is mainly grown in gardens for its fruits and ornamental value. This plant is commonly called custard apple in English, sharifa in Hindi, Shitafal in Marathi and sitaphalam in telungu in india (Raj Sobiya et al., 2009). The discovery of novel secondary metabolites or phytochemicals which are the non-essential nutrients derived from plants exhibiting a number of protective functions for human consumers. It is considered beneficial for cardiac disease, diabetes hyperthyroidism and cancer. The root is considered as a drastic purgative (Raj Sobiya et al., 2009). A leaf decoction was taken in the case of

dysentery (S. Gajalakshmi et al., 2011). Leaves are used as plaster over boils and ulcers. The ripe fruits of this plant are applied to malignant tumors to accelerate suppuration. The dried unripe fruit powder is used to destroy insect. The seeds are pungent and poisonous. Powdered seeds serve as fish poison and insecticides. A paste of seed powder has been applied to the head to kill lice. It is also used for destroying worm in the wound of cattle's (Parvin et al., 2003). Phytochemical screening is a method in which we expose the properties readily available in plants for bio-activity or ethno-medical applications. Thuse it is expected that phytochemicals with adequate antibacterial efficiency can be used for the treatment of bacterial infections (Balandrin et al., 1985). The medicinal plants play an important role in the development of newer drugs because of their effectiveness, less side effects and relatively low cost when compared with synthetic drugs (Raj et al., 2011).
The present study aims in exploring the phytochemical constituents, antibacterial properties of the crude leaf extracts of *Annona squamosa* L.

MATERIALS AND METHODS -

Collection and Identification – The dust and infections free leaves and of *Annona squamosa* L. were collected from its natural habitat in khatkali region of Akot tehsil in District Akola. Maharashtra, India. During January – February of 2023. Taxonomic identification of plants was carried out by using published floras.

Extraction: The leaves and stem of *Annona squamosa* L. were thoroughly washed 3-4 times in running tap water, and then the leaves and stem are shade dried. After complete shade drying, the leaves and stem were grinded in mixer; the powder was stored in small polyethene bags. 30 gm of powder was taken for preparation of plant extract in solvents like acetone (300 ml), Petroleum ether (300 ml) and Ethanol (300 ml) by using Soxhlet extractor. Then the extracts become concentrated by evaporating solvent and stored in sterile bottle in deep freezer at 5ºC for further use. For the preparation of aqueous extract, the powdered material of 5 gm was taken by weighing balance and crushed in 50 ml of distilled water then boiled at 50-60˚ C for 30 – 40 minutes in water bath and filtered through Whatman No. 1 filter paper. The filtrate was centrifuged at 2800 rpm for 10 minutes then the filtrate was stored in sterile bottle in deep freezer at 5ºC for further use.

Phytochemical screening –
Preliminary phytochemical screening (qualitative) for to detect the bioactive compounds like phenols, alkaloids, glycosides, tannins, flavonoids, steroids, saponins, was carried out by using following methods (Mirge et al., 2022):
Test for proteins – Take 2 ml of protein solution 1ml of 40% NaOH solution and 1 to 2 drops of 1% CuSO4 solution was added. A peptide linkage in molecules is indicated by the violet color.
Test for amino acids - Take 2 ml of sample was added to 2 ml of Ninhydrin reagent and kept in water bath for 20 minutes. Appearance of purple color indicated the presence of amino acid in the sample.
Test for reducing sugars - Take 2 ml of extract 2 drops of Molisch's reagent was added and shaken well. 2ml of conc. H2SO4 was added drop by drop on the sides of test tube. A reddish violet ring form at the junction of two layers which indicated the presence of carbohydrates.
Test for Alkaloids - Solvent free extracts, 50 mg was stirred with few ml of dilute HCL and filtered. The filtrate is tested with various alkaloidal reagents as follows:
Mayer's test- Few ml of filtrate and a drop or two of Mayers reagent were added by the side of the test tube. A white or creamy ppt indicates the presence of alkaloids.
Wagner's test - Take a few ml of filtrate, few drops of Wagner's reagent were added by the side of the test tube. A reddish- brown ppt confirms the presence of alkaloids.
Hager's test - Take a few ml of filtrate, 1 or 2 ml of Hager's reagent (saturated aqueous solution of picric acid) were added. A prominent yellow ppt indicates the presence of alkaloids.
Test for phenolic compound - Lead acetate test - The extract (50mg) was dissolved in distilled water and to this; 3ml of 10% lead acetate solution was added. A bulky white precepted indicates the presence of phenolic compounds.

Test for Tannins - Take a 0.5g of the plant extract was added in 10 ml of water in test tube and filtered. A few drops of 0.1% ferric chloride were added and observed for brownish green or blue- black coloration

Test for glycoside - Each extract was hydrolyzed with HCL and neutralized with NaOH solution. A few drops of Fehling's solution A and B were added to each mixture. Formation of red precepted indicates the presence of glycosides.

Test for Flavonoids

(a) 0.2 g of each extract was dissolved in diluted NaOH and few drops of HCL were added. A yellow solution that turn colorless indicates the presence of flavonoids

(b) To 2 ml of test solution, 0.5ml alcohol was mixed. Then a bit of magnesium and 1 or 2 drops of con. HCL were added and heated. The mixture was analyzed for reaction

Test for Phenols - To 2 ml of test solution, alcohol and then few drops of neutral ferric chloride solution was added. A dark green color indicated the presence of phenolic compound.

Terpenoids: 2ml of leaf extract was added to 2ml of acetic anhydride and concentrated H_2SO_4. The blue, green ring is form which shows the presence of terpenoids.

Steroids: 1ml of leaf extract was dissolved in 10ml of concentrated sulphuric acid and equal volume of chloroform was added by sides of the test tube. The upper layer turns red in color and sulphuric acid layer showed the yellow with green fluorescence. Which shows the presence of steroids

Test for Resins - To the 0.2 g of each extract, 10 ml of glacial acetic acid was added then heated and cooled. A drop of conc. H_2SO_4 was added. Purplish red color shows the presence of resins

Saponins: 5ml of leaf extract was mixed with 20 ml dist. water and continuously shake it for 15 min. the foam is form which shows the presence of saponins.

Antibacterial Activity –

Antibacterial activity was carried out against *Escherichia coli* and *Pseudomonas aeroginosa*. In order to access the biological significance and ability of the plant part, the minimal inhibitory activity was determined by well diffusion method. Petriplates containing 20ml of Nutriant agar medium were seeded each with 24hr old culture of bacterial strains such as *E. coli* and *P. aeroginosa*. Wells of approximately 10 mm diameter was bored using a well cutter and 25 µl, 50 µl and 100µl of the extracts were added to the well from a stock concentration of 0.1g /1ml. The plates were then incubated at 37 °C for 24 hours. Antibacterial activity was assayed by measuring the diameter of the zone of inhibition in millimeters formed around the wells.

Sr. No.	Phytochemical Component	Acetone	Petroleum ether	Ethanol	Aqueous
01	Protein	+	-	+	-
02	Amino Acid	-	-	-	-
03	Reducing Sugar	+	+	-	+
04	Alkaloids				
	Mayer's	-	-	-	+
	Wagner's	+	+	+	-
	Hager's	+	+	+	+

05	Phenolic compounds Lead acetate	-	+	+	+
06	Tannins	+	+	-	-
07	Glycosides	+	-	+	+
08	Flavonoids	+	-	+	+
09	Phenol	-	+	+	+
10	Terpenoids	+	-	-	+
11	Steroid	+	+	-	-
12	resins	-	-	-	+
13	saponins	+	-	-	+

Table 1: Phytochemical analysis of *Annona squamos*a L. leaf extracts

Table 2 - Qualitative antimicrobial activity of different solvent extract of *Annona squamosa* L. **against test organisms**

Sr. No.	**Test organism**	**Acetone**	**Petroleum ether**	**Ethanol**	**Aqueous**
01	*E. Coli*	+	-	+	-
02	*P. aeroginosa*	+	-	-	+

Table 3: Zone of inhibition of acetone leaf extract of *Annona squamosa* L.

Test organism	**Zone of inhibition**		
	Concentration of leaf extracts		
	25 µl	50 µl	100 µl
E. Coli	-	-	12 mm
P. aeroginosa	-	15mm	18 mm

Table 4: Zone of inhibition of ethanol leaf extract of *Annona squamosa* L.

Test organism	**Zone of inhibition**		
	Concentration of leaf extracts		
	25 µl	50 µl	100 µl
E. Coli	-	12 mm	17 mm

Table 5: Zone diameter of inhibition of Aqueous leaf extract of *Annona squamosa* L.

Test organism	**Zone of inhibition**		
	Concentration of leaf extracts		
	25 µl	50 µl	100 µl
P. aeroginosa	-	-	18 mm

Results and Discussion

Phytochemical Analysis - Table 1 represent the various phytochemical constituents present in the leaf extracts of *Annona squamosa* L. The phytochemical studies of extract in all the four solvent are as follows acetone shows positive result for protein, reducing sugar, alkaloid, tannin, glycoside, flavonoid, steroid, terpenoids and saponin. Petroleum ether shows positive result for reducing sugar, alkaloid, phenolic compound, tannin, phenols, and steroids. Ethanol shows positive for protein, alkaloid, phenolic compound, glycoside, flavonoid, and phenol. Aqueous extract shows positive result for reducing sugar, alkaloid, phenolic compound, glycoside, flavonoids, phenols, terpenoids, resin and saponins. From the above result it is concluded that the acetone and aqueous shows more positive results.

Antibacterial activity- Table – 2 represent the qualitative antibacterial activity of leaf extract against *E. coli* and *P. aeroginosa* which show positive and negative result. In table 3 shows the zone of inhibition in acetone leaf extract exhibited no activity in 25µl and 50µl but produced 12mm zones of inhibition in 100µl concentrations for E.coli. and for the *P. aeroginosa* showed no activity in 25µl but produced a 15mm &18mm inhibition zone in 50µl and100µl concentration respectively. In table 4 shows the zone of inhibition in ethanol leaf extract exhibited no activity in 25µl but shows 12mm and 17 mm zone of inhibition in 50µl and 100µl respectively for E.coli. In table 5 shows the zone of inhibition in Aqueous leaf extract exhibited no activity in 25µl and 50µl but show 18mm zone of inhibition in 100µl for *P. aeruginosa.*
Antibacterial activity was expressed at varying degrees with the difference in concentration. Higher concentration of the leaf extract shows highest antibacterial activity.

Conclusion - Medicinal plants were the potent source of human health due to the presence of active phytochemical compounds that is responsible for its various pharmacological activities. On the basis of the results obtained in the present study conclude that *Annona squamosa L.* is rich in phytochemical constituents and showed antibacterial properties. The results of the phytochemical screening of the leaf extracts of samples varied, while some of the components were present, some were absent. It was observed that most of the components were present in acetone and aqueous extracts. The present study highlights the possible use of *Annona squamosa* L. leaf extracts as a source of antioxidants and antibacterial agents that can be used to prevent gastrocolic diseases.

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Unveiling Nature's Treasures: Analyzing Phytochemicals in *Argemone mexicana* and *Trichodesmum indicum*

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Abstract: ***This study investigates the phytochemical composition of Argemone mexicana and Trichodesmum indicum, two medicinal plants known for their therapeutic potential. Leaves from these plants were collected, processed, and subjected to qualitative phytochemical analysis using various extraction methods and screening tests. The results revealed the presence of bioactive compounds such as alkaloids, phenolic compounds, steroids, resins, saponins, and terpenoids in different extracts of both plant species. Notably, flavonoids, glycosides, and phenols were absent in the extracts. The findings underscore the importance of further research to isolate, characterize, and evaluate the pharmacological properties of these bioactive constituents for potential therapeutic applications. Additionally, considerations for safety and drug interactions are essential for the development of novel therapeutics from these botanical sources.***

Keywords: Phytochemicals, *Argemone mexicana*, *Trichodesmum indicum*, Medicinal plants, phytochemical analysis, bioactive compounds

1. Introduction

Phytochemicals, natural compounds found in plants, have gained attention for their medicinal potential (Junaid R Shaikh et al., 2020; Soloman Charles et al., 2013). These bioactive substances, produced by plants as secondary metabolites, offer diverse pharmacological benefits. Plants like *Argemone mexicana* and *Trichodesmum indicum* are notable for their traditional healing properties (M.S. Saranya et al., 2012; Manani Lata et al., 2015). However, understanding their phytochemical composition and therapeutic potential remains limited. Our research aims to fill this gap by analyzing the bioactive compounds in these plants, exploring their antioxidant properties, and contributing to their pharmacognostical characterization (K. Anushka et al., 2014; T. Arun et al., 2012; Lokeshwar T, 2023). Through this study, we seek to bridge traditional knowledge with modern scientific inquiry, uncovering the therapeutic potential of these botanical treasures while ensuring safety and efficacy in promoting human health.

2. Materials and Methods

Leaves of *Argemone mexicana* and *Trichodesmum indicum* were collected from a farm in Bambarda Bk, Akot, District Akola, Maharashtra, India.

Preparation of Plant Extracts:

1) Washed leaves with running tap water 2-3 times.
2) Rinsed leaves with distilled water.
3) Shade-dried for seven days.
4) Powdered using a mixer and grinder.
5) Weighed 20 grams of powdered plant material for each sample.
6) Subjected powdered material to extraction using acetone, alcohol, and water in a Soxhlet extractor.
7) Extraction conducted for 72 hours.
8) Solvent extracts collected and concentrated using a rotary evaporator.

Phytochemical Screening Tests:

1) **Test for Protein:** Mix 2 ml of protein solution with 1 ml of 40% NaOH and 1-2 drops of 1% CuSO4. Presence of a violet color indicates peptide linkage.
2) **Test for Amino Acid:** Add 2 ml of sample to 2 ml of Ninhydrin reagent; incubate in a water bath for 20 minutes. Purple color indicates presence of amino acids.
3) **Test for Reducing Sugar:** Mix 2 ml of extract with 2 drops of Molish's reagent, then add 2 ml conc. H2SO4 drop wise. Reddish-violet ring at the junction indicates presence of carbohydrates.
4) **Test for Alkaloids (Mayer's, Wagner's, Hager's tests):** Solvent-free extracts stirred with dilute HCl, then filtered and tested with respective reagents.
5) **Test for Phenolic Compounds (Lead Acetate Test):** Dissolve 50 mg of extract in distilled water, add 3 ml of 10% lead acetate solution. Bulky white precipitate indicates presence of phenolic compounds.
6) **Test for Tannins:** Add 0.5 g of plant extract to 10 ml of water in a test tube, filter, then add a few drops of 0.1% ferric chloride.
7) **Test for Glycosides:** Hydrolyze each extract with HCl, neutralize with NaOH, then add Fehling's solution A and B. Formation of red precipitate indicates presence of glycosides.
8) **Test for Flavonoids: a.** Dissolve 0.2 g of each extract in diluted NaOH, and then add a few drops of HCl. A yellow solution that turns colorless indicates the presence of flavonoids. **b**. Mix 2 ml of the test solution with 0.5 ml of alcohol. Add a small amount of magnesium and 1-2 drops of concentrated HCl, then heat the mixture. Analyze the reaction for characteristic indications.
9) **Test for Phenols:** Add alcohol and neutral ferric chloride solution to test solution.

10) **Test for Terpenoids:** Mix leaf extract with acetic anhydride and concentrated H2SO4.
11) **Test for Steroids:** Dissolve leaf extract in conc. sulphuric acid, add chloroform, and observe color change.
12) **Test for Resins:** Heat plant extracts with glacial acetic acid, and then adds conc. H2SO4.
13) **Test for Saponins:** Mix leaf extract with distilled water and shake vigorously for 15 minutes.
14) This outlines the methodology employed for plant material collection, extraction, and phytochemical screening of *Argemone mexicana* and *Trichodesmum indicum* leaves.

Figure: Argemone mexicana

Figure: Trichodesmum indicum

3. Observation Tables

Table 1: Phytochemical screening of leaf extract of *Argemone mexicana.*

Sr. No.	Constituents tests	Acetone	Alcohol	Aqueous
1	Protein	-	-	-
2	Amino Acid	-	-	-
3	Reducing Sugar	+	+	+
4	*Alkaloids* *Mayer`s* *Wagner`s* *Hager`s*	 + + +	 - + +	 + + +
5	Phenolic compounds Lead acetate	+	+	+
6	Tannins	-	+	+
7	Glycosides	-	-	+
8	Flavonoids	-	+	-
9	Phenol	-	-	-
10	Terpenoids	+	+	+
11	Steroid	+	+	+
12	Resins	+	+	+
13	Saponins	+	+	+

4. Result and Discussion

The qualitative analysis of phytochemical compounds in the leaves of *Argemone mexicana* and *Trichodesmum indicum* provides valuable insights into the potential bioactive constituents present in these medicinal plants.

Understanding the phytochemical composition is crucial for elucidating their pharmacological properties and therapeutic potential.

For Argemone mexicana:
The acetone extract showed the presence of alkaloids, phenolic compounds, steroids, resins, saponins, and terpenoids. Amino acids, tannins, glycosides, flavonoids, and phenols were absent.

The alcohol extract exhibited the presence of reducing sugar, phenolic compounds, alkaloids, tannins, flavonoids, steroids, resins, terpenoids, and saponins. Amino acids, glycosides, and phenols were not detected.

The aqueous extract displayed the presence of reducing sugar, alkaloids, phenolic compounds, tannins, glycosides, terpenoids, steroids, resins, and saponins. Amino acids, flavonoids, and phenols were absent.

For Trichodesmum indicum:
The acetone extract demonstrated the presence of reducing sugar, alkaloids, phenolic compounds, tannins, terpenoids, steroids, resins, and saponins. Amino acids, glycosides, proteins, flavonoids, and phenols were not found.

The alcohol extract revealed the presence of alkaloids, phenolic compounds, flavonoids, terpenoids, steroids, resins, and saponins. Amino acids, reducing sugar, tannins, glycosides, and phenols were absent.

The aqueous extract indicated the presence of alkaloids, phenolic compounds, tannins, terpenoids, steroids, resins, and saponins. Amino acids, reducing sugar, glycosides, flavonoids, and phenols were not detected.

5. Conclusion

The qualitative analysis of phytochemical compounds in the leaves of *Argemone mexicana and Trichodesmum indicum* reveals the presence of various bioactive constituents with potential therapeutic properties. Further studies focusing on the isolation, characterization, and pharmacological evaluation of these compounds are warranted to harness the full medicinal potential of these plants. Additionally, investigations into the safety profiles and potential drug interaction of these phytochemicals are essential for their development as novel therapeutic

Table 2: Phytochemical screening of leaf extract of *Trichodesmum indicum.*

Sr. No.	Constituents tests	Acetone	Alcohol	Aqueous
1	Protein	-	-	-
2	Amino Acid	-	-	-
3	Reducing sugar	+	-	-
4	Alkaloids Mayer`s Wagner`s Hager`s	 + + +	 + + +	 + + +
5	Phenolic compound Lead Acetate	+	+	+
6	Tannins	+	-	+
7	Glycosides	-	-	-
8	Flavonoids	-	+	-
9	Phenol	-	-	-
10	Terpenoids	+	+	+
11	Steroid	+	+	+
12	Resins	+	+	+
13	Saponins	+	+	+

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INVESTIGATING THE IN VITRO REGENERATION POTENTIAL OF COMMERCIAL CULTIVARS OF BRASSICA

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***ABSTRACT*:** In vitro regeneration is a pre-requisite for developing transgenic plants through tissue culture-based genetic engineering approaches. The genus Brassica necessitate the identification of a set of regeneration conditions for a genotype, which can be reliably used in transformation experiments. In this study, we evaluated the morphogenesis potential of four commercial cultivars. The explants namely cotyledons, hypocotyls, petioles and roots on three different Brassica regeneration protocols, BRP-I, -II and -III. The regeneration efficiency was observed in the range of 6–73%, 4–79.3%, 0–50.6%, and 0–42.6% from cotyledons, petioles, hypocotyls, and roots, respectively, whereas, the regeneration response in terms of average shoots per explant was found to be 0.76–10.9, 0.2–3.2, 0–3.4 and 0–2.7 from these explants. its regeneration frequency from cotyledons was up to 7.5-fold higher on BRP-I, while it produced up to 21.9-fold more shoots per explant. Our data show that the explant has strong influence on the regeneration response, ranging from 24% to 92%. While the growth of commercial cultivars was least elected by the regeneration conditions provided, the erect on Westar was twice that of the commercial cultivars. Inhibit the growth of untransformed cells for these cultivars. successfully grown to maturity within 16–18 weeks, with no altered phenotype noted and normal seed yields obtained. Therefore, the commercial variety, Aari canola, would be a good candidate for future genetic transformation studies.

Keywords: in vitro regeneration; tissue culture; commercial cultivars; Brassica Sp.

INTRODUCTION

Brassica, from the family Brassicaceae, is an economically important genus. It includes several species that are often used as oilseed crops, vegetables, fodder crops as well as condiments. Brassica oilseed varieties producing oil low in anti-nutritive aliphatic glycosylates and acid as well as rich in unsaturated fatty acids are generally termed as ‘canola’ Conventionally, the term ‘canola’ was more often used for B. napus but now some canola quality varieties of B. rapa and B. juncea are also available. The development of stress tolerant Brassica is possible by transferring genes from the plant species that are adapted to harsh environmental conditions. These species present a rich reservoir of the traits that enable them to grow under stressful conditions. However, transferring these traits to salt or drought sensitive crops is only possible by genetic transformation, as they cannot be cross bred through conventional breeding approaches for example, a plant species must be responsive to in vitro regeneration protocols, and a robust regeneration system is one of the key pre-requisites for successful genetic transformation. Several indigenous Brassica varieties developed locally have canola characteristics. Being stress-sensitive, these varieties are unable to grow on marginal lands. Although transformation of Brassica species has been reported in several studies, several Brassica genotypes remain recalcitrant to genetic transformation. Several factors including susceptibility to Agrobacterium infection, choice of explant and tissue culture conditions mainly responsible for these variations have been identified. These factors vary from genotype to genotype, indicating a strong genetic control on in vitro regeneration and transformation of Brassica

genotypes. The information generated in this study will be useful for developing stress-resilient Brassica varieties by directly transforming the commercial cultivars.

Results

Shoot Regeneration from Cotyledons

All the explants, including cotyledons, normally regenerated multiple shoots and occasionally a single shoot per explant. Regenerates formed from the cut end of the 2 mm petiole attached to the cotyledon. The highest regeneration efficiency was observed for Aari canola on all the three protocols with 70.6% on BRP-I, 69.3% on BRP-II, and 73.3% on BRP-III Faisal canola showed the lowest regeneration efficiency on BRP-I (6.0%) which showed the lowest regeneration on BRP-II and BRP-III with 13.3% and 10.0% efficiency, respectively. The regeneration efficiency of on BRP-I, 3.8-fold higher on BRP-II and 2.5-fold higher on BRP-III. In terms of total shoots regenerated, the highest shoot formation was observed. All the three protocols with 548 shoots on BRP-I (average 10.96 shoots/explant), 436.3 on BRP-II (8.72 shoots/explant) and 366.3 on BRP-III (7.3 shoots/explant) from a total of 50 explants. The least regeneration responsive was (25 shoots/50 explants; 0.50/explant) BRP-I, and BRP-II (38.3 shoots/50 explants; 0.76 shoots/explant) and BRP-III (25 shoots/50 explants; 0.50/explant). In terms of average number of shoots per explant, it was in the range of 0.50–10.9, 0.76–8.7 and 0.5–7.3 from cotyledons on BRP-I BRP-II and BRP-III, respectively. Overall, the regeneration response of Aari canola, in terms of total shoots formation, was 21.9-fold higher than Westar on BRP-I, 7.0-fold higher on BRP-II and 2.3-fold higher on BRP-III.

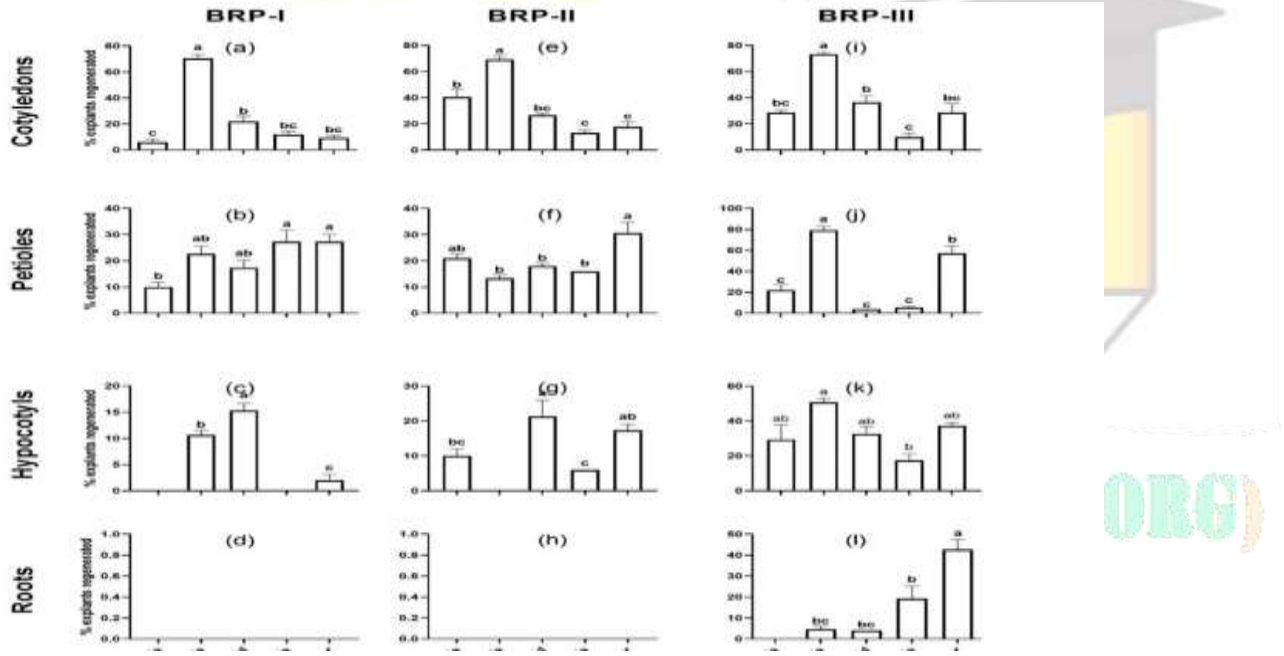

Figure 1. Regeneration efficiency of five Brassica cultivars

Shoot Regeneration from Detached Petioles

Petiole explants regenerated shoots along the middle rib after 3 weeks on SIM. The highest regeneration efficiency from detached petioles was observed for on BRP-III (79.3%), BRP-I and BRP-II with a regeneration of 27.3% and 30.6%, respectively (Figure 1b,f,j). The lowest regeneration efficiency was observed for Faisal canola on BRP-I (10.0%), followed by BRP-II (13.3%), and Nifa Gold on BRP-III (4.0%). The regeneration efficiency and 2.3-fold lower on BRP I and BRP-II, respectively, while 1.3-fold higher on BRP-III. The highest number of shoots on BRP-I and BRP-II with 137 and 164.33 shoots from 50 explants the highest number of shoots (129 shoots) on BRP-II (Figure 2b,f,j). least number of shoots on BRP-I (14.3 shoots/50 explants) and BRP-III (15.6 shoots) while it was Westar, which showed the lowest response on BRP-II with 24.6 shoots from 50 explants. The average number of shoots per explant was in the range of 0.2–2.7, 0.4–2.5 and 0.3–3.2 on BRP-I, BRP-II and BRP-III, respectively. The number of shoots produced by Aari canola was 1.7-fold, 5.2-fold and 1.0-fold on BRP-I, BRP-II and BRP-III respectively.

Shoot Regeneration from Hypocotyls

Regeneration from hypocotyl segments usually started after 3 weeks on SIM although callus formation started in the second week. The upper end of the hypocotyl cut 2 mm below the epicotyl region showed more swelling and calli formation, ultimately producing higher number of shoots as compared to the other end of the explant. Shoot regeneration was rarely observed from the middle rib portion. The highest regeneration efficiency from hypocotyls was observed on BRP-III (50.6%) followed by Brassica with 37.3% and 32.6%, respectively (Figure 1k). The highest regeneration efficiency on BRP-I and BRP-II was of Brassica with 15.3% and 21.3%, respectively, as compared to the other cultivars, suggesting the suitability of these protocols for Brassica for obtaining regeneration from hypocotyls sections. it was 5.3-fold higher on BRP-I, 17.3-fold lower on BRP-II and 1.3-fold higher on BRP-III. The highest number of shoots on BRP-I (60.3 shoots from 50 explants) and BRP-II (170 shoots/50 explants) while the highest shoots on BRP-III (121 shoots/50 explants) (Figure 2c, g, k). The hypocotyl segments of respond to BRP-II, BRP I. Regeneration on all three protocols, with highest shoot count on BRP-III (82 shoots/50 explants), followed by BRP-II with 61.6 shoots and BRP-I with 15 shoots. The average number of shoots generated from hypocotyls were in the range of 0–1.2, 0–3.4, and 0.4–2.4 per explant on BRP-I, BRP-II and BRP-III, respectively.

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Effect of Explant, Regeneration Conditions, and Their Interaction on In Vitro Regeneration

The data obtained was analysed for the significance and the degree of erect of the explant type, the growth regimes, as well as their interaction on the regeneration of all the cultivars. A standard analysis of variance was applied to analyse the regeneration data. Table 1 shows the summary of the analyses. The explant had a highly significant erect on regeneration (p _0.0001). The erect of regeneration conditions was less significant. other cultivars (p _ 0.001),whereas, it was highly significant (p _ 0.0001). The effect of explant regeneration conditions was statistically non-significant. The erect of replication was non-significant on all cultivars except. In terms of percentage contribution of these erects to the regeneration efficiency, the erect of explant type was highest from all the other factors except (Table 2). It was highest in (91.87%) while lowest in (24.13%). The effect of regeneration conditions was much more pronounced on regeneration (57.21%) compared to that of the commercial varieties. It was highest for Brassica (27.12%) and Brassica (31.44%) while lowest for (4.95%).

Table 1. Mean square and significance levels from analysis of variance of data from the regeneration of five Brassica cultivars.

Sourse of Variation	DF	Brassica I	Brassica II	Brassica III	Brassica IV	Brassica V
Explant (E)	3	6552 ****	368,487 ****	26,280 ***	6644 ****	10,035 ****
Regeneration Conditions (RC)	2	8297 ***	11,116 ***	1026 NS	8261 ****	35,692 **
Interaction (ExRC)	6	2540 ****	9938****	1762 NS	3202 ****	2323 **
Replicate	8	115.9 NS	795.6 NS	891.1 NS	318.7 ***	302.9 NS
Residual Error	16	236.1	596.7	769.1	180.1	432.5

*, **, ***, **** Significant at p = 0.05, 0.01, 0.001 and 0.0001, respectively; NS, non-significant

Table 2. Percent contribution of explant type, growth conditions, and their interaction on the regeneration frequencies of five Brassica cultivars.

Percent Contribution of a Treatment to the Total Experimental Variations					
Source of Variation	**Brassica I**	**Brassica II**	**Brassica III**	**Brassica IV**	**Brassica**
Explant Type (E	34.98	91.87	71.09	32.62	24.13
Regeneration Conditions (RC)	29.53	1.848	1.850	27.04	57.21
Interaction (E x RC)	27.12	4.956	9.533	31.44	11.17
Replicate	1.650	0.529	6.428	4.173	1.942
Residual Error	6.720	0.797	11.09	4.727	5.548
Total	100.0	100.0	100.0	100.0	100.0

Materials and Methods

Plant Material and Growth Conditions Five different cultivars (four local and one model) belonging to Brassica napus and B. juncea wereobtained from different

Table 3. List of cultivars with their sources used in this study.

Sr.No.	Cultivar Species	Source
	Brassica juncea	oil seed are used
	Brassica napus	oil seed are used
	Brassica napus	oil seed are used
	Brassica napus	oil seed are used
	Brassica napus	oil seed are used
	Brassica napus	oil seed are used

Sterilization and Sowing

Seeds were stratified at 4°C for 48 h before sowing to ensure uniform germination. Seeds were surface sterilized by immersing in 100% ethanol for 2 min followed by immersing in commercial bleach (sodium hypochlorite solution) containing 4–6% available chlorine plus 2–3 drops of 10% bettween-20 for 10 min. The seeds were then rinsed four times with sterile distilled water in a laminar flow and placed on sterile filter paper to dry and germinated on seed germination media (MS salts, 3% sucrose, 1 mg/L pyridoxine, 1 mg/L nicotinic acid, 10 mg/L thiamine-HCl, 100 mg/L myo-inositol, 4 g/L phytagel, pH 5.7–5.8) at a density of 20 seeds per 90 30 mm petri dish in a growth room maintained at 23°C at 16 h light/8 h dark cycles under a light intensity of 50 mol m2 s1 provided by cool fluorescent bulbs.

Explant Isolation and Shoot Induction

Four different explants intact cotyledons with approximately 2 mm of petiole, hypocotyls (Approximately 3–4 mm), petioles (approximately 2 mm, with the 'leaf of the cotyledon removed', and roots (3–4 mm) sections were subjected to in vitro regeneration conditions. Four-day old seedlings were used for explant isolation. A pair of long, sterile forceps were used to remove the seedlings from the germination media and placed in sterile petri dishes. Explants were cut and separated using a sharp scalpel blade and transferred to either shoot induction media (SIM)or callus induction media (CIM) (see Table 4 for composition). Cotyledons were excised with a sharp scalpel blade with 2 mm petiole avoiding any part of meristem. Explants were placed on the medium in such a way that the petiole was embedded in media and the cotyledonary lamella was clear of the media. 10 explants were established on each plate and transferred to a growth room at 23°C under scattered light. Cultures were transferred to fresh medium every two weeks. The explants were subjected to regeneration under three different regeneration protocols termed as Brassica Regeneration Protocols, BRP-I , BRP-II and BRP-III

Table 4. Composition of different mediums used in the study.

Reagent	BRP-I		BRP-II			BRP-III			
	SIM	GRM	CIM RIM		SIM	CIM	SIM	SOM	RI
MS salts (mg/L)	4.43		4.43 4.43		4.43	4.43	4.43	4.43	2.215
Gamborg's salts (mg/L)		3.1				4.43	4.43	4.43	2.215
Sucrose (mg/L)	30	10	30	30	30	20	20	20	10
Vitamin Stock (ml/L	1	1	1	1	1	1	1	1	1
Phytagel (g/L)	4	4	4	4	4	4	4	4	4
BAP (mg/L)	2			6	1	0.75 0.00125			3
NAA (mg/L)						0.1		0.2	0.2
IBA(mg/L)									1
AgNO3 (mg/L)								5	5
GA3 (mg/L)						0.01		0.01	
CaCl2 (mg/L)							435	435	435
KI (mg/L)						05	0.75	0.75	0.75
Adenine hemisulphate (mg/L)						40			
PVP 40,000 (mg/L)						500			

BRP, Brassica regeneration protocol; SIM, shoot induction medium; GRM, Gamborg's rooting medium; CIM, Callus induction medium; RIM, Root induction medium; SOM, Shoot outgrowth medium.

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THERMAL & SPECTROSCOPIC INVESTIGATIONS OF NOVEL SCHIFF BASE LIGAND [1-(2-HYDROXY-1-NAPHTHYL)ETHANONE-4- NITROBENZENAMINE] &THEIR METAL COMPLEXES

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Abstract— Certain metal complexes exhibit different characteristic properties depending on the nature of the metal as well as the type of ligand. A novel schiff base ligand was prepared by condensation of [1-(2-Hydroxy-1-naphthyl)ethanone**](HNET) and 4-Nitrobenzenamine(NBA).** Its metal complexes of **Cr(III), Mn(II), Co(II), Ni(II), Cu(II), Zn(II) and Cd(II) was characterised and invested by physical and spectral techniques, namely, elemental, electrical conductance, molecular weight, IR, electronic spectra, magnetic susceptibility measurements and thermogravimetric analysis.**

Thermal properties and decomposition possibilities of all complexes are suggested. Detailed studies of the thermal properties of the complexes were investigated by thermogravimetric techniques. The interpretation of all thermal decomposition stages has been evaluated. The complexes are found to be colored and stable in air at room temperature.

Index Terms— azomethine linkage, **decomposition possibilities, Spectral techniques**, thermal studies.

INTRODUCTION

From more than last one decade, there has been a dramatic growth of interest in inorganic complexes based materials that exhibit unusual properties [1]. Schiff bases derived from an amine and aldehyde/ketones are an important class of ligands that coordinate to metal ion via azomethine nitrogen and have been studied extensively [2]. Schiff base complexes have been found to be important precursor for semi conducting materials [3, 4]. Various studies have shown that Schiff base derived from substituted acetophenone containing nitrogen/sulphur and/or oxygen as ligand atoms are of interest as simple structural models of more complicated biological systems application such as biochemical, analytical, industrial [5-6] and their metal complexes shown wide spectrum of antimicrobial agents. In the present paper, we report the synthesis and thermal studies of complexes derived from [1-(2-Hydroxy-1-naphthyl)ethanone**](**HNET) and 4-Nitrobenzenamine(NBA)

MATERIALS AND METHOD

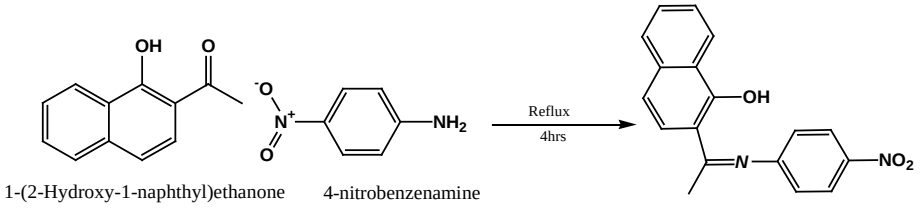
Manganese(II), cobalt(II), nickel(II), chromium(III), copper(II), zinc(II), and cadmium(II) acetate salts used were of Merck and BDH make. Organic solvents such as absolute ethanol, methanol, petroleum ether, dimethyl formamide (DMF) and dimethylsulfoxide (DMSO) were of AR grade from **[**1-(2-Hydroxy-1-naphthyl)ethanone**]** was prepared by known methods. The solvents were purified by standard methods. Elemental microanalysis was performed on a (C.H.N.) analyser from heraeus (Vario EL). IR spectra of the compounds were recorded on Perkin Elmer 842 spectrophotometer in the region 400-4000cm^{-1}. ^{1}H-NMR spectrum of the ligand was recorded in DMSO-d6 on a Bruker DRX-300 FTNMR spectrometer. The diffuse reflectance spectra of the complexes were recorded on Varian Cary-5000 UV-visible

spectrophotometer. The magnetic moment measurement were made on a Gouy balance at room temperature using [$HgCo(SCN)_4$] as the calibrant.

EXPERIMENTAL TECHNIQUE

Synthesis of Schiff base ligand [1-(2-Hydroxy-1-naphthyl) ethanone-4Nitrobenzenamine] (HNETNBA)

The experimental procedure involved mixing of [1-(2-Hydroxy-1-naphthyl)ethanone]**(**HNET) 1 mmol (1.86gm) and 4-Nitrobenzenamine(NBA) 1 mmol (1.38g) dissolve in ethanol, dissolve in ethanol, mix in 250 ml round bottom flask. And the reaction mixture was refluxed on water bath for about 4 hour. Product is filtered and dry. Yellowish white solid obtained having melting point 175 ^{0}C.



1-(2-Hydroxy-1-naphthyl)ethanone 4-nitrobenzenamine HNETNBA

Fig.1 [1-(2-Hydroxy-1-naphthyl)ethanone-4Nitrobenzenamine] (HNETNBA)

Synthesis of Schiff base metal complexes

The Mn(II), Co(II), Ni(II), Cr(III), Cu(II), Zn(II) and Cd(II) complexes have been prepared by mixing the methanolic-ethanolic solution of corresponding metal acetates to the ethanolic solution of HNETNBA in 1 : 2 molar ratio. The precipitated complexes were recrystallized twice with ethanol, finally washed with petroleum ether (60– 80 ^{o}C), and dried under reduced pressure over anhydrous $CaCl_2$ in a dessicator.

RESULTS AND DISCUSSION

The synthesized complexes are colored, stable and non-hygroscopic solids and are insoluble in water, ethanol and methanol but soluble in DMF and DMSO. The analytical data indicate 1:2 metal to ligand stoichiometry for all the complexes**.** All the complexes are found to be non-electrolytes [7-9]. The colors, magnetic susceptibilities as well as the percentage composition of the constituent elements are reported in Table 1.

Table 1: Analytical Data of HNETNBA and its Complexes

S.N.	Compounds	Color	Time of Reflux (hrs.)	Elemental analyses % found (calcd.)				
				M	C	H	N	Cl
1.	HNETNBA	Pale Yellow	4	--	54.21 (54.91)	4.24 (4.07)	3.22 (3.77)	--
2.	[$Mn(HNETNBA)_2(H_2O)_2$] (H_2O)	Light Brown	9	14.98 (14.19)	52.12 (52.72)	3.60 (3.87)	3.52 (3.61)	--
3.	[$Co(HNETNBA)_2$]	Off Brown	5	15.59 (15.04)	52.46 (52.18)	3.95 (3.87)	3.41 (3.58)	--
4.	[$Ni(HNETNBA)_2(H_2O)_2$]	Pale Orange	5	15.12 (15.02)	52.48 (52.21)	3.98 (3.83)	3.45 (3.58)	--
5.	[$Cr(HNETNBA)_2(H_2O)_2$] (H_2O)$_2$	Apple Green	5	13.50 (13.53)	53.35 (53.12)	3.56 (3.90)	3.20 (3.64)	--
6.	[$Cu(HNETNBA)_2$] (H_2O)	Raven Song	8	16.28 (16.06)	51.42 (51.57)	3.86 (3.97)	3.42 (3.79)	--
7.	[$Zn(HNETNBA)_2$]	Pale Yellow	7	16.70 (16.45)	57.72 (57.33)	3.80 (3.77)	5.38 (3.52)	--
8.	[$Cd(HNETNBA)_2$] (H_2O)	Yellow	7	25.13 (25.29)	45.72 (45.90)	3.56 (3.37)	3.00 (3.15)	--

FT-IR (KBr, in cm^{-1})

The characteristic infrared spectral assignment of ligand and its complexes have been reported in Table 2. The presence of broad band at 3587 cm^{-1} in the infrared spectra may be due to the –OH group. All the above evidences were further supported by the emergence of new bands at 516-519 cm^{-1} due to the metal–oxygen vibrations. These new bands were only observed in the spectra of the transition metal complexes only.

Selected IR spectral bands for the ligand and its complexes are given in Table 2. The IR spectrum of the free ligand is characterized mainly by the strong bands at 1698cm^{-1} 3587cm^{-1}, and 1247 cm^{-1} which are attributed to the stretching frequencies of C=N (azomethine), O-H and C-O respectively[10]. The band at 1698 cm^{-1} due to C=N stretching in the spectrum of the ligand shifts to lower wave numbers in all the metal complexes by 7-10 cm^{-1} indicating that the azomethine nitrogen is co-ordinated to metal ion [11]. Further the IR spectra of the complexes of Co(II),Ni(II), Zn(II) and Cd(II) exhibit new bands at 519 and 459 cm^{-1} and 516 and 443cm^{-1}which may be assigned to M-O and M-N (terminal) stretching modes respectively [12]. IR spectra of the Schiff base showed a band at around 1610 cm^{-1} assignable to azomethine group.

Table 2: FT - IR spectral frequencies of selected metal complexes.

Sr. No	Compounds	Assignment (cm^{-1})	Observed Value (cm^{-1})	Expected Value (cm^{-1})
1)	Ligand HNETNBA	V(C=N) V(O-H)/v(OH-N)H_2O	1583.56 1211.30	1777-1600 1330-1063
2)	Co(II) HNETNBA	(C-O) (M-O) (M-N) (O-H) (O-CH_3) (Ar-C-H)	1251.80 530.42 426.27 3286.70 1749.44 3147.83	1330-1063 524-420 524-410 3600-3300 1725-1745 3200-3000
3)	Ni(II) HNETNBA	(C-O) (M-O) (M-N) (O-H) (O-CH_3) (Ar-C-H) (C=N)	1301 528.50 435.91 3307.92 1747.51 3147.83 1749.44	1330-1063 524-420 524-410 3600-3300 1725-1745 3200-3000 1777-1600
4)	Zn(II) HNETNBA	(C-O) (M-O) (M-N) (O-H) (O-CH_3) (Ar-C-H) (C=N)	1254 528.50 435.91 3307.92 1747.51 3147.83 1745.44	1330-1063 524-420 524-410 3600-3300 1725-1745 3200-3000 1777-1600
5)	Cd(II) HNETNBA	(C-O) (M-O) (M-N) (O-H) (O-CH_3) (Ar-C-H) (C=N)	1312 550.50 435.91 3307.92 1747.51 3005.50 1749.44	1330-1063 524-420 524-410 3600-3300 1725-1745 3200-3000 1777-1600

Thermal study and Magnetic study

The presence of water molecule suggested from IR spectra is confirmed by TG analysis [13]. Thermal decomposition results reveal that all the metal complexes decompose gradually. The TG curve of Mn(II) show stable plateau upto 62^{o}C then weight loss is observed indicating the presence of one lattice water molecule [% wt loss obs./cal. 4.00:4.07]. The observed weight losses of Mn(II), Ni(II), Cr(III) complexes between 140-240^{o}C corresponds to removal of three coordinated water molecule [% wt loss obs./calc. 12.10/12.21, 12.34/12.64, 11.25/11.79]. The observed magnetic moment of Mn(II), Ni(II) and Cr(III) complexes found to be 5.67, 3.1 and 4.81 B.M., indicating octahedral environment around central metal ion. Cu(II) and Zn(II) complex loss its weight upto 130 ^{o}C and 110 ^{o}C respectively corresponding to one lattice water [% wt loss obs./calc. 4.21/4.33, 4.60/4.51] and further upto 250 ^{o}C and 241^{o}C corresponding to one coordinated water molecule [% wt loss obs./calc. 4.40/4.33, 4.50/4.51]. The TG curve of Co(II) and Zn(II) complexes show stable plateau upto 77 ^{o}C and 80 ^{o}C respectively indicating absence of lattice water molecule from the metal complexes. The magnetic moment value of Cu(II) complex is found to be 1.78 B.M which is well within the expected range of square planar complexes. For Co(II) complex the magnetic moment value i.e. 2.44 B.M. is lower than those expected for square planar geometry. This lowering in magnetic moment value shows subnormal character of complex due to antiferromagnetic exchange [14]. The complexes of Zn(II) and Cd(II) were found to be diamagnetic, confirmed tetrahedral geometry. Complete decomposition of metal takes place in two steps. In the first step of decomposition in the temperature range 220-380 ^{o}C, indicate the decomposition of free part of ligand. In the second stage, major loss occurs between 410-600 ^{o}C, due to complete elimination of organic ligand molecule and subsequent slow oxidation. The remaining residue of the complexes at 600-710 ^{o}C corresponds to respective metal oxides [15].

TABLE 3: Thermal decomposition data of the complexes of HNETNBA

S.N.	Compound	DH (^{o}C)	μeff. (B.M.)	E (kJmol^{-1})		Z (S^{-1})	-ΔS (JK^{-1} mol^{-1})	ΔF (kJ mol^{-1})
				F-C	S-W			
1.	HNETNBA	260	---	5.50	4.35	85.20	229.45	110.52
2.	[Mn(HNETNBA)$_2$(H$_2$O)$_2$] (H$_2$O)	410	5.67	17.50	15.10	225.44	240.12	310.25
3.	[Co(HNETNBA)$_2$]	430	2.44	8.55	7.50	171.14	201.32	165.23
4.	[Ni(HNETNBA)$_2$(H$_2$O)$_2$]	380	3.1	5.25	3.35	156.11	226.30	123.65
5.	[Cr(HNETNBA)$_2$(H$_2$O)$_2$] (H$_2$O)$_2$	550	4.81	12.90	10.85	214.71	200.00	193.32
6.	[Cu(HNETNBA)$_2$] (H$_2$O)	490	1.78	10.20	9.15	198.13	201.34	164.28
7.	[Zn(HNETNBA)$_2$]	400	---	9.60	7.90	189.28	240.26	153.89
8.	[Cd(HNETNBA)$_2$] (H$_2$O)	420	---	16.05	14.65	226.69	211.89	269.60

F-C = Freeman-Carroll, S-W = Sharp-Wentworth, DH - Half Decomposition temp.

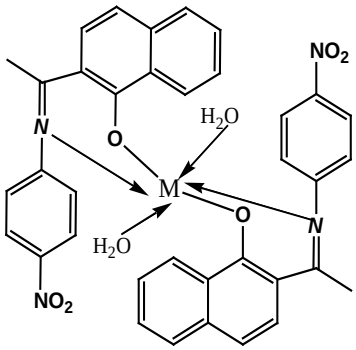
Various kinetic and thermodynamic parameters such as activation energy (E), half decomposition temperature (DH), frequency factor (Z), entropy change (ΔS) and free energy change (ΔF) were calculated from TG data as shown in the Table 3.The kinetic parameter i.e. energy of activation has been calculated by Freeman–Carroll and sharp-Wentworth methods. Generally with decreasing the value of

E the value of *Z* increase and the higher value of activation energy suggest the higher stability. Higher value of *E* (activation energy) and lower values of *Z* (frequency factor) favors the reaction to proceed slower than normal. The large negative values of entropy change and small *Z* suggest that the transition state is in highly ordered state than the individual reactants and the reactions are slower than normal.

Thermal stability of complexes follows the order Cr(III) >Cu(II) >Co(II)>Cd(II) >Mn(II) >Zn(II)>Ni(II).

CONCLUSION

The coordination complexes of Mn(II), Co(II), Ni(II), Cr(III),Cu(II), Zn(II) and Cd(II) with new tridentate Schiff base ligand, *i.e.*, [1-(2-Hydroxy-1-naphthyl)ethanone -4Nitrobenzenamine] (HNETNBA) , was synthesized and characterized. The ligands coordinated with the metal ions through N or O donors (ONO type). From the analysis it can be concluded that the complexes have an octahedral structures for $[Mn(HNETNBA)(H_2O)_3](H_2O)$, $[Ni(HNETNBA)(H_2O)_3]$ and $[Cr(HNETNBA)(H_2O)_3](H_2O)_2$, square planar for $[Co(HNETNBA)(H_2O)]$, $[Cu(HNETNBA)(H_2O)](H_2O)$metal and tetrahedral structure for $[Zn(HNETNBA)(H_2O)]$ and $[Cd(HNETNBA)(H_2O)](H_2O)$. The suggested geometrical structure is shown below:



Where , M = Mn(II), Co(II), Ni(II), Cr(III), Cu(II), Zn(II) and Cd(II)
for Co(II), Cu(II), Zn(II) and Cd(II) ; H_2O=0

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A Review of the Physicochemical Approach to the Analysis of 2-Thiohydantoin

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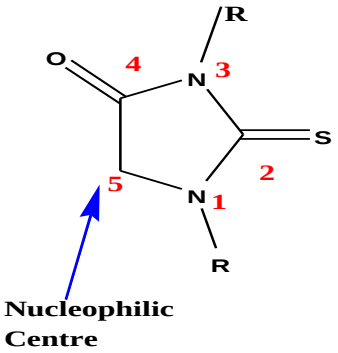
ABSTRACT
Thiohydantoins and their derivatives are the most important sulfer anolog, which acts as a intermediate to making various drugs. Thiohydantoin attracted enormous attention of all researchers in the worldwide. In this review article, we focused our interest on the most important methods for the synthesis of 2-thiohydantoin derivatives, determine spectral data of them. We explored their physicochemical properties like density, viscosity, ultrasonic velocity, intermolecular free path, adiabatic compressibility etc.
Key words; *Thiohydantoin, density, physicochemical parameter etc*

Date of Submission: 07-09.2023 Date of acceptance: 20-09-2023

I. INTRODUCTION

Thiohydantoin is a sulfur analog, which having most important feature. In general, 2-thiohydantoin molecules contribute to drug discovery as they possess attractive features of their structures by owning a stereogenic center at position 5 as well as the feasibility of their synthesis. The number of groups like phenyl, benzyl etc. are attached to position 5 which increases the reactivity of thiohydantoin. [1-4]



2-Thiohydantoins are important class of compounds within pharmaceutical industries and exist in various pharmacologically active molecules that possess important bioactivities like antimicrobial [5], antiviral [6], fungicides [7], antiparasite, [8] and anticancer [9].
In 2017, Zuo and coworkers reported indoline thiohydantoin as a potent androgen receptor (AR) antagonist [10].
Buchynskyy *et al.* prepared the thiohydantoins 1-benzyl-3-aryl-2-thiohydantoins which acts as a anti-Trypanosoma brucei agents [11].
These molecules contribute to drug discovery and the importance of these compounds in bioactive, we have decided to synthesize the thiohydantoin and investigated its physicochemical properties because these properties explain the nature and reactivity towards drugs.

II. METHODS AND MATERIALS

2.1 General

The purity of resultant compound was check by using TLC. The IR spectra were recorded in KBr by using FT-(IR Perkin Elmer - Spectrum RX-IFTIR).Mass spectra were recorded on mass spectrometer while ^{1}HNMR were recorded on FT NMR Spectrometer (Bruker Avance Neo 500 MHz). Data are reported as

chemical shifts in parts per million downfield from TMS, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet), coupling constant and assignment, respectively.

2.2 Synthesis

Aurone is a starting material was prepared from Chalcone. A mixture of aurone (0.01 M) and N-substituted thiourea (0.01 M) were taking in round bottom flask along with 10% KOH and Ethanol as a solvent. A reaction mixture was reflux about 3 hr. After 3 hr. cool the mixture and poured in to ice cold water and filter it by using suction pump. The final product recrystallized with Ethanol.

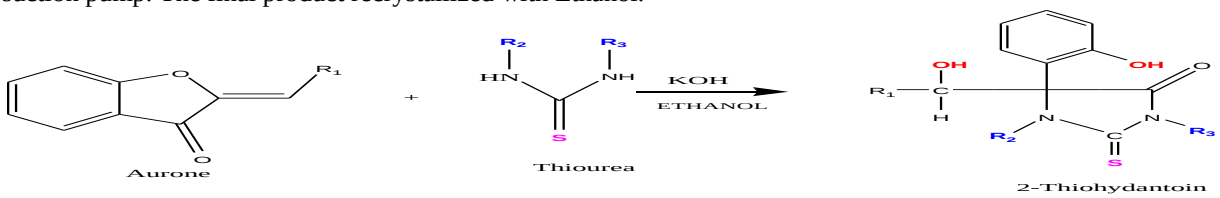


Table-01

Sr. no.	Compounds	R_1	R_2	R_3
1.	1a	C_7H_7	H	C_6H_5
2.	1b	C_4H_3O	C_6H_5	C_6H_5

2.2.1 Preparation of 5-(hydroxyl (p-tolyl)methyl)-5-(2-hydroxyphenyl)-3-phenyl-2-thioxoimidazolidin-4-one (1a)

2-(4-methylbenzylidene)benzofuran-3(2H)-one (0.01M) reflux with N-phenyl thiourea (0.01M) in presence of 10% KOH and appropriate ethanol solvent up to 3 hours. After completion of reaction, cooled the mixture and poured in to ice cold water. The solid product obtained which was filter and washed with dilute HCl and water. The product was crystallized by using ethanol.

Mol. Formula $C_{23}H_{20}O_3N_2S$: yellowish Crystalline solid, m.p 246^oC , yield 71%, Elemental analysis (%):C,68.30; H,4.98; N,6.93; O,11.87; S,7.93; IR (KBr cm-1) 3551.78 (O-H), 3414.58 (N-H), 1711.05 (C=O), 1638.5 (Ar C-H),ESI-MS[M+H]+ Calculated for $C_{23}H_{20}O_3N_2S$ *m/z* 404.12, 405.12.406,14, 407.12 ; ^{1}H-NMR (500 MHz, DMSO): δ 2.27 (3H, s), 5.50 (1H, s), 6.64 (1H, m, *J* = 8.3, 1.3, 0.5 Hz), 7.03 (1H, m, *J* = 8.0, 7.7, 1.3 Hz),

2.2.2 Preparation of 5-(furan-2-yl(hydroxy)methyl)-5-(2-hydroxyphenyl)-1,3-diphenyl-2-thioxoimidazolidin-4-one (1b)

2-(furan-2-ylmethylene)benzofuran-3(2H)-one (0.01M) reflux with N,N dIphenyl thiourea (0.01M) in presence of 10% KOH and appropriate ethanol solvent up to 3 hours. After completion of reaction, cooled the mixture and poured in to ice cold water. The solid product obtained which was filter and washed with dilute HCl and water. The product was crystallized by using ethanol.

Mol. Formula $C_{26}H_{20}O_4N_2S$: faint red Crystalline solid, m.p 238^oC, yield 73%, Elemental analysis (%):C,68.41; H,4.42; N,6.14; O,14.02; S,7.02, IR (KBr cm-1) 3616.5 (O-H), 3368.1 (N-H), 1720.42(C=O), 1436 (Ar C=C), ESI-MS[M+H]+ Calculated for $C_{26}H_{20}O_4N_2S$: *m/z* 456.10, 457.14, 458.16. ^{1}H-NMR (500 MHz, DMSO) : δ 5.86 (1H, s), 6.18-6.34 (2H, 6.24 (dd, *J* = 3.4, 1.1 Hz), 6.28 (dd, *J* = 3.4, 1.8 Hz)), 6.72 (1H, m, *J* = 8.3, 1.3, 0.5 Hz), 6.97-7.14 (2H, 7.04 (m, *J* = 8.0, 7.7, 1.3 Hz).

2.3 Physicochemical Properties of Thiohydantoin Derivatives*:*

Physico-chemical properties are essential indicators used in hazard, exposure and risk assessments, hence in this experiments the physico-chemical parameters were studied in different solvents, and different concentrations**,** with temperature 20 degree.

Density and Viscosity:

In fluid dynamics, viscosity is useful parameter to determine the thickness or thinness of any given fluid. It also useful to find out the intermolecular interaction between solute and solvent. Density is useful to measure the distance between two particles in a given fluid. Viscosity and density are the most important characteristics of a fluid. The density and viscosity were taken in different solvent like DMSO and DMF with different concentration and temperature at 20 degree. Densities of the solutions were measured using a 25 mL specific gravity bottle and the weight of the liquid was measured using an electronic balance (Model Shimadzu

AX200).The viscosity were measured by Ostwald viscometer and time by digital stop watch. The formula for viscosity, .

$$\eta_y = \eta_w \frac{d_y \times d_y}{d_w \times d_w}$$

Acoustic parameters:

The acoustic parameters were studied as follows.

Ultrasonic velocity was useful to determine the strength of material that is elastic moduli (measures the resistance of the material to elastic) as well as particle interaction in solution hence most of the scientist are attracted toward these parameters. Here ultrasonic parameters was measured using a single-crystal Interferometer (Mittal Enterprises) operating at 1MHz with an accuracy of ±1.0m/s.
The acoustic parameters were determine using fallowing formulae

a) Adiabatic compressibility (β):
In compression the heat is not absorb or release but the internal energy increases which effects on work done.

$$\beta = \frac{1}{\rho v^2}$$

b) Intermolecular free path length (L_f):
The mean free path or average distance between collisions for a molecule. In the liquid the mean free path is much probably less than one molecular diameter. There are 750 times more molecules in a given volume than there were in the gas state.

$$L_f = K\beta^{1/2},$$

Where K is the temperature dependent Jacobson's constant

c) Acoustic impedance (Z):
The acoustic impedance is the ratio of sound pressure to volume flow. Acoustic impedances explain, how much resistance an ultrasound beam encounters as it passes through a liquid.

$$Z = \rho V,$$

d) Relative association (RA):
It is a property which explain the interaction of molecules in liquid as well as measure extent of association in molecules.

$$RA = \left(\frac{\rho}{\rho_0}\right)\left(\frac{v_0}{v}\right),$$

e) Ultrasonic attenuation (α/f^2):
Ultrasound intensity is continuously reduces by the cohesive forces present in liquid molecules.

$$\alpha/f^2 = \frac{8\pi^2\eta}{\rho v^3}$$

f) Relaxation time (τ):
It is related to both the elasticity and viscosity of the material. Relaxation time means rate of relaxation.it is inversely proportional to velocity.

$$\tau = \frac{4\eta}{3\rho v^2}$$

III. RESULTS AND DISCUSSION

The physico-chemical properties of thiohydantoin derivatives were given below

3.1 Compound 1a

Solvent: DMF Temp. 20^0 C

Conc. (M) Mol/dm^3	Density(ρ) Kg/m^{-3}	Viscosity(η) ×10^3 NSm^{-2}	Ultasonic velocity(v) m/s	Refractive Index
0.000	970.76	0.94577	1415.0	1.4305
0.001	971.04	1.22993	1513.92	1.4306
0.002	971.84	1.29764	1592.82	1.4308
0.003	972.24	1.34708	1600.28	1.4309
0.004	972.92	1.48921	1648.72	1.4310

0.005	973.68	1.62742	1704.81	1.4314

Ultrasonic parameters in DMF

Conc. (M) Mol/dm^3	Adiabetic compressibility (β) $\times 10^{-10}$	Intermolecular Free path (L_f) $\times 10^{-11}$	Acoustic impedances (Z) $\times 10^{6}$	Relative Association (RA)	Ultrasonic Attenuation $(\frac{\propto}{f^2})$ $\times 10^{-14}$	Relaxation Time (τ) $\times 10^{-13}$
0.000	5.14488	4.62265	1.37362	1.00000	2.71240	6.48780
0.001	4.49320	4.32011	1.47007	0.93492	2.87928	7.36845
0.002	4.05574	4.10443	1.54796	0.88934	2.60620	7.01720
0.003	4.01636	4.08445	1.55585	0.88556	2.66674	7.21384
0.004	3.78119	3.96307	1.60407	0.86014	2.69393	7.50798
0.005	3.53371	3.83118	1.65994	0.83250	2.66074	7.68355

Solvent: DMSO Temp. 20^0 C

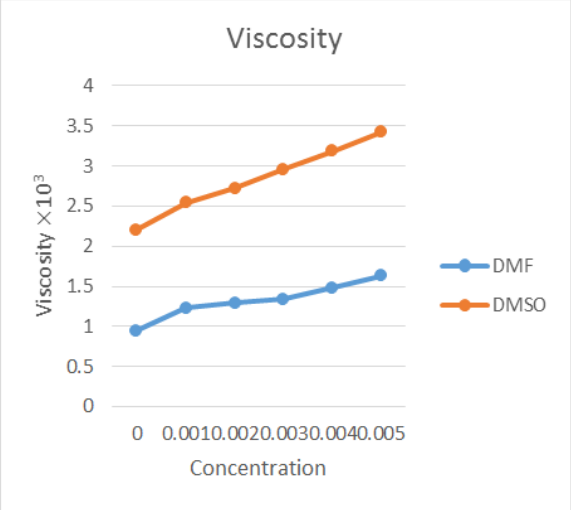
Conc. (M) Mol/dm^3	Density(ρ) Kg/m^{-3}	Viscosity(η) $\times 10^3$ NSm^{-2}	Ultasonic velocity(v) m/s	Refractive Index
0.000	1126.28	2.2026	1553.0	1.4740
0.001	1128.27	2.5426	1563.24	1.4742
0.002	1128.96	2.7287	1584.54	1.4745
0.003	1129.42	2.9642	1596.48	1.476
0.004	1129.86	3.1874	1608.74	1.4748
0.005	1130.32	3.4217	1618.56	1.4749

Ultrasonic parameters in DMSO

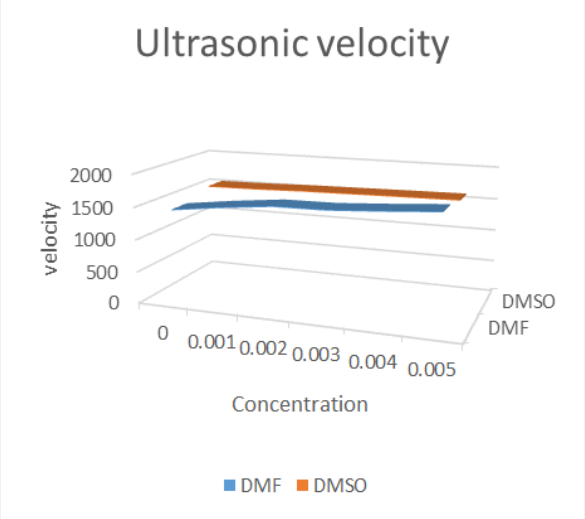
Conc. (M) Mol/dm^3	Adiabetic compressibility (β) $\times 10^{-10}$	Intermolecular Free path (L_f) $\times 10^{-11}$	Acoustic impedances (Z) $\times 10^{6}$	Relative Association (RA)	Ultrasonic Attenuation $(\frac{\propto}{f^2})$ $\times 10^{-14}$	Relaxation Time (τ) $\times 10^{-13}$
0.000	3.68138	3.910414	1.749110	1	4.11835	10.8115
0.001	3.62690	3.881372	1.763756	0.995204	4.653046	12.2956
0.002	3.52778	3.828032	1.788882	0.982427	4.792002	12.8354
0.003	3.47390	3.798622	1.803096	0.975477	5.087577	13.7297
0.004	3.41987	3.768928	1.817650	0.968420	5.344458	14.5337
0.005	3.37707	3.745324	1.829490	0.962936	5.631233	15.4071

GRAPHICAL REPRESENTATION

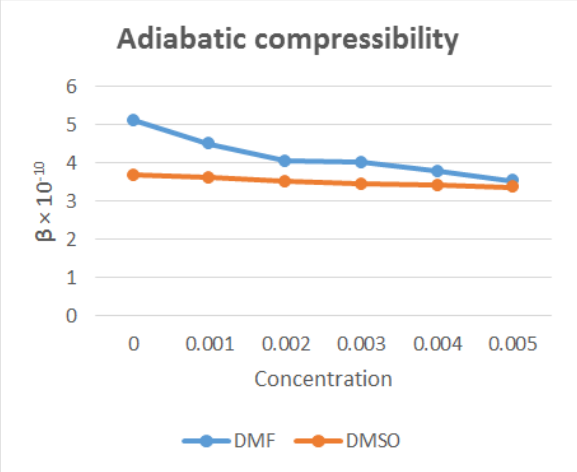
1. Viscosity



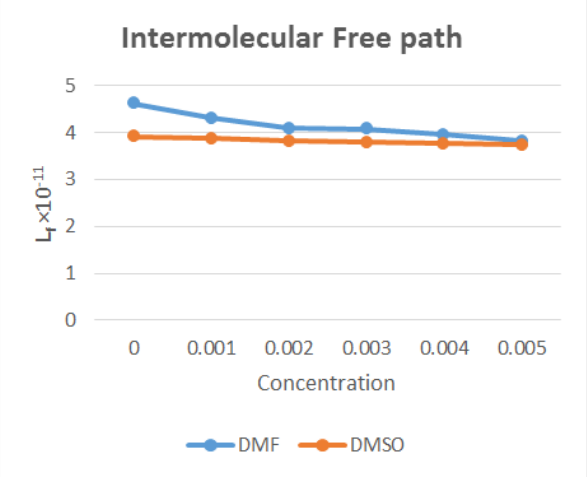
2. Ultrasonic velocity



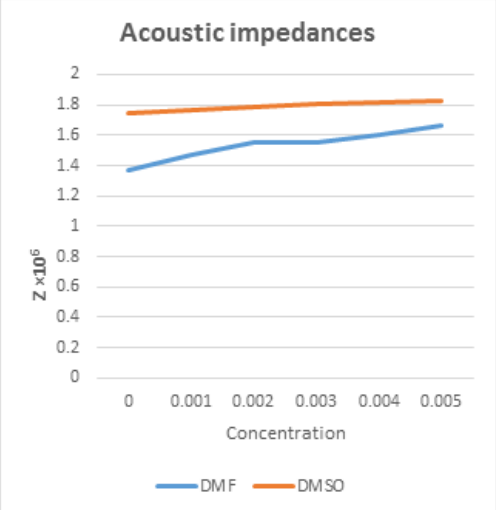
3. Adiabatic compressibility (β)



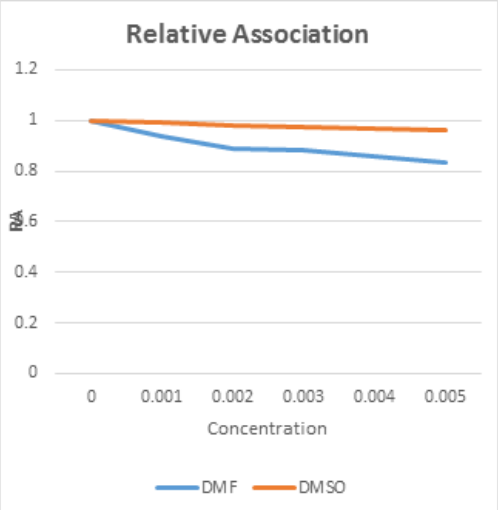
4. Intermolecular Free path (L_f)



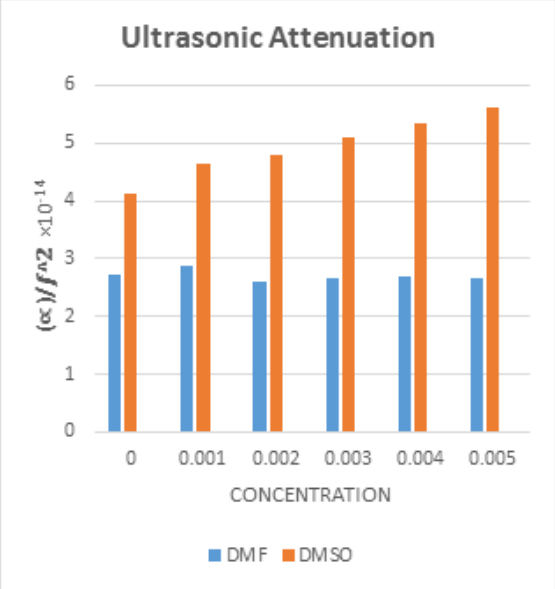
5. Acoustic impedances (Z)



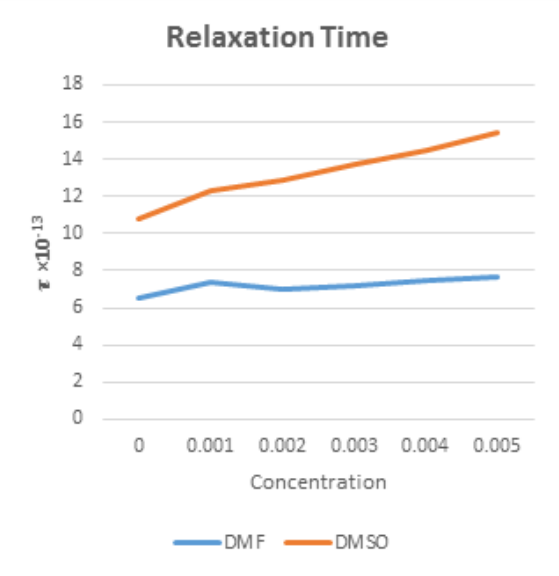
6. Relative Association (RA)



7. Ultrasonic Attenuation($\frac{\propto}{f^2}$)



8. Relaxation Time (τ)



3.2 Compound 1b

Solvent: DMF Temp. 20^0 C

Conc. (M) Mol/dm^3	Density(ρ) Kg/m^{-3}	Viscosity(η) ×10^3 NSm^{-2}	Ultasonic velocity(v) m/s	Refractive Index
0.000	970.76	0.94577	1415.0	1.4305
0.001	971.24	1.19423	1462.53	1.4306
0.002	971.86	1.27421	1513.20	1.4308
0.003	972.41	1.29946	1572.24	1.4309
0.004	972.91	1.32764	1618.51	1.4310
0.005	973.42	1.48742	1666.71	1.4312

Ultrasonic parameters in DMF

Conc. (M) Mol/dm^3	Adiabetic compressibility (β) × 10^{-10}	Intermolecular Free path (L_f) ×10^{-11}	Acoustic impedances (Z) ×10^6	Relative Association (RA)	Ultrasonic Attenuation ($\frac{\propto}{f^2}$) ×10^{-14}	Relaxation Time (τ) ×10^{-13}
0.000	5.14488	4.62265	1.37362	1.00000	2.71240	6.48783
0.001	4.81352	4.47145	1.42047	0.96797	3.10024	7.66460
0.002	4.49368	4.32034	1.47062	0.93615	2.98467	7.63453
0.003	4.16018	4.15692	1.52886	0.90151	2.71210	7.20799
0.004	3.92369	4.03705	1.57467	0.87619	2.53868	6.94566
0.005	3.69810	3.91928	1.6224	0.85129	2.60316	7.33418

Solvent: DMSO Temp. 20^0 C

Conc. (M) Mol/dm^3	Density(ρ) Kg/m^{-3}	Viscosity(η) ×10^3 NSm^{-2}	Ultasonic velocity(v) m/s	Refractive Index
0.000	1126.28	2.2026	1553.0	1.4740
0.001	1128.62	2.2733	1590.24	1.4744

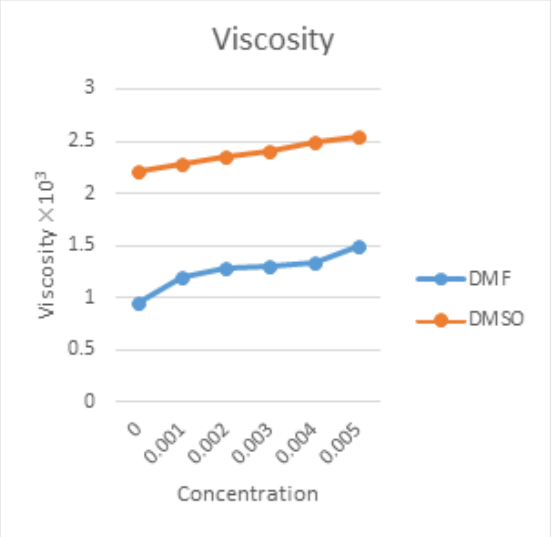
0.002	1129.04	2.3475	1598.72	1.4746
0.003	1129.92	2.4082	1604.57	1.4748
0.004	1130.42	2.4976	1615.54	1.4750
0.005	1131.28	2.5489	1624.82	1.4751

Ultrasonic parameters in DMSO

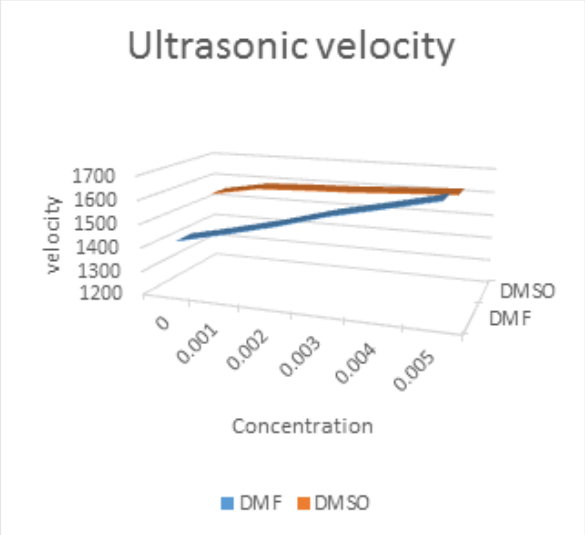
Conc. (M) Mol/dm^3	Adiabetic compressibility (β) $\times 10^{-10}$	Intermolecular Free path (L_f) $\times 10^{-11}$	Acoustic impedances (Z) $\times 10^{6}$	Relative Association (RA)	Ultrasonic Attenuation $(\frac{\propto}{f^2})$ $\times 10^{-14}$	Relaxation Time (τ) $\times 10^{-13}$
0.000	3.68138	3.910414	1.749110	1.00000	4.11835	10.8115
0.001	3.50370	3.81488	1.79477	0.97861	3.95066	10.61994
0.002	3.46534	3.79393	1.80501	0.97378	4.01354	10.84651
0.003	3.43744	3.77863	1.81303	0.97098	4.06928	11.03739
0.004	3.38941	3.75214	1.82623	0.96482	4.13313	11.28720
0.005	3.34826	3.72929	1.83812	0.96004	4.14301	11.37917

GRAPHICAL REPRESENTATION

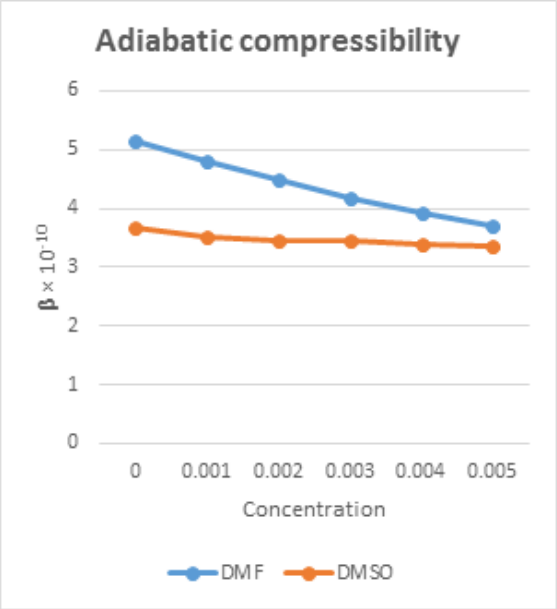
1. Viscosity



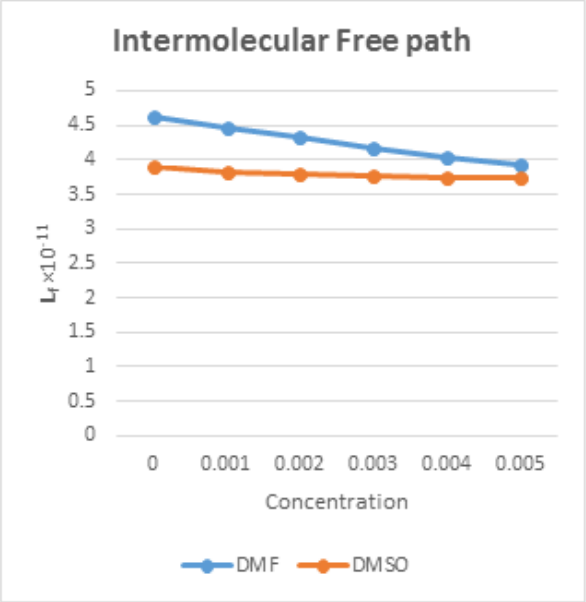
2. Ultrasonic velocity



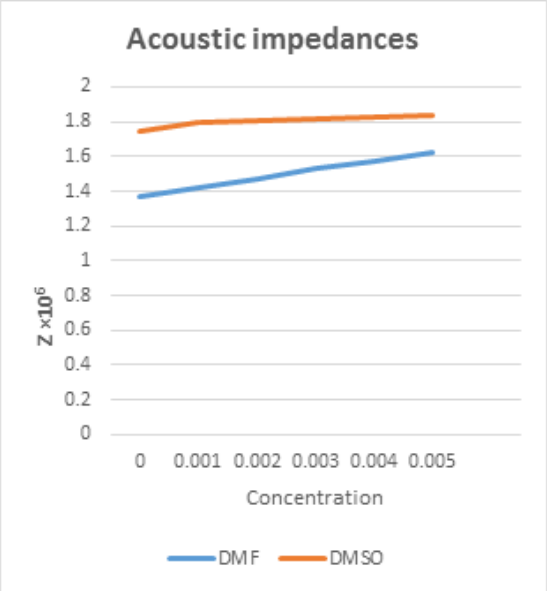
3. Adiabatic compressibility (β)



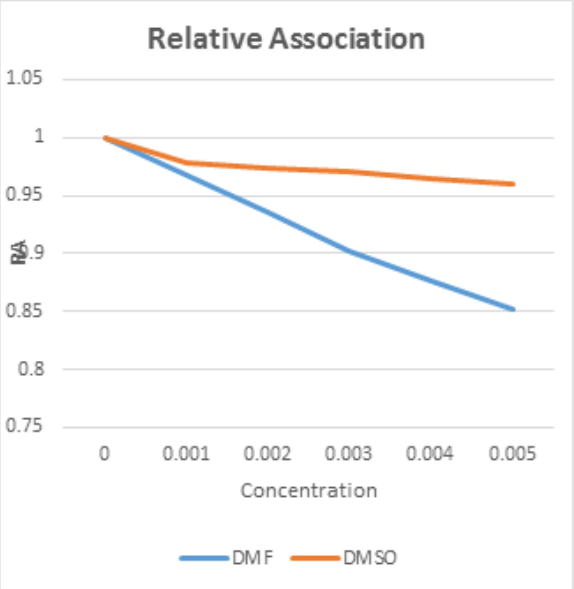
4. Intermolecular Free path (L_f)



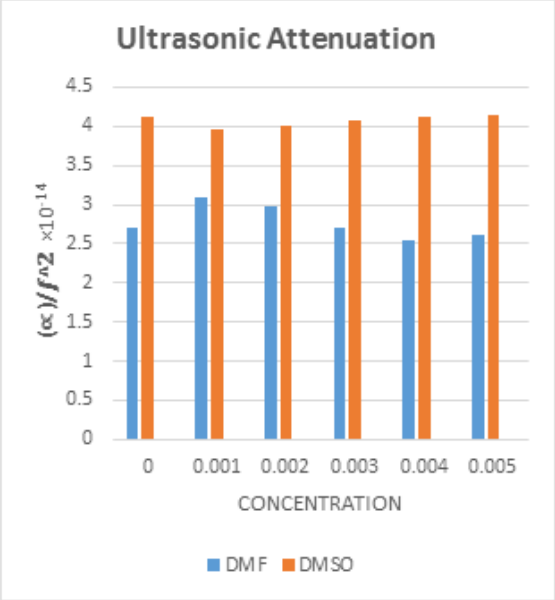
5. Acoustic impedances (Z)



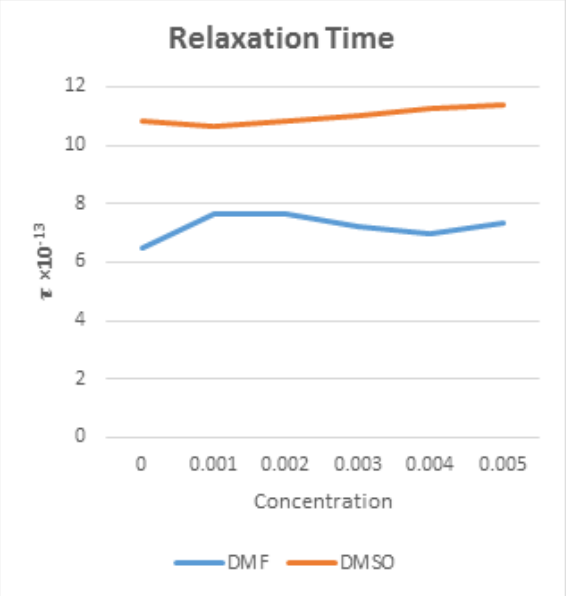
6. Relative Association (RA)



7. Ultrasonic Attenuation($\frac{\propto}{f^2}$)



8. Relaxation Time (τ)



Physico-chemical meaning that they are dependent on, or produced by, the combined actions of physical and chemical attributes. The physicochemical properties can be useful to manufacturing, food and beverages, and other chemical or biological product-based industries. The most important properties of an ideal drug are: effectiveness, safety, and selectivity. Here Thiohydantoin acts as good drugs for Cancer. It shows properties like antimicrobial, anticancer, antimalarial etc. The Thiohydantoin shows different physico-chemical properties in different solvent as well as different concentration which indicated that the different interaction of thiohydantoin molecules in different solvents.

In above experiment clear that the ρ, η and U values increased linearly with concentration (C), due to specific molecular interactions. The variation of adiabatic compressibility with concentration. Here the concentration increases and adiabatic compressibility decreases due to formation of large cluster molecules. The aggregation of solvent molecules around the solute, supporting solute-solvent interaction. The intermolecular free path is a clear evidence for strong interactions between solvent and compound molecules in DMSO and DMF. Such interactions may be due to Ionic-dipole, dipole-dipole, dipole-induced-dipole interactions.

Relative association decreases with increase in concentration for a thiohydantoin in DMSO and DMF. This may be due to the breaking up of the associated solvent molecules on addition of solute which indicates the structure-forming tendencies of solutes decreases at higher concentration in both the solvents. In DMF solvent the thiohydantoin molecules shows weak association than DMSO and less tendency to form structure. If relaxation time (τ) increasing with concentration which supports structure making capacity of the solute. Here the concentration of thiohydantoin increases which increase structure making capacity in DMSO than DMF.

IV. CONCLUSION

The synthesized Thiohydantoin might show different effect in DMSO and DMF. The good correlations are observed between density, viscosity and other physicochemical parameters and concentration in different solvents .The linear or nonlinear increases or decreases of acoustical parameters indicate the existence of strong molecular interactions in the solutions that depend on the interaction between solute and solvent molecules and structure formation tendency of solute. The polarity of DMSO is slightly higher than DMF due to which DMSO shows more structure making capacity than DMF.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Design of Novel Thiohydantoin Derivatives and Exploration Their Physico-Chemical Parameters

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ABSTRACT

Thiohydantoin analogues was heterocyclic non-aromatic five membered cyclic compounds obtained from aurones derivatives. In this article, we synthesized novel thiohydantoin derivatives and exploration of physicochemical parameters like density, viscosity, ultrasonic velocity, intermolecular free path, adiabatic compressibility etc. The structural elucidation of resultant compounds was done on the basis ^{1}HNMR, IR, Mass etc. The present study revealed that, thiohydantoin analogues shows more structure making capacity in DMSO than DMF.

Keyword: 2-Thiohydantoin, Physicochemical properties, Viscosity, Refractive index.

INTRODUCTION

2-Thiohydantoin is an important class of compounds within chemistry. It is a sulphur derivative of hydantoin which is obtained by replacing the oxygen atom of carbonyl group by sulphur. Thiohydantoin is a intermediate to synthesis of many drugs[1-12]. In solid state thiohydantoin shows π-π stacking, hydrogen bonding which is important in pharmaceutical industries.[13-16]

One of the most important things that drew the attention of researchers to synthesized thiohydantoin due to wide range of application like anti-inflammatory, anti-ulcer[17], antifungal, antibacterial[18], HIV[19], hypolipidemic[20], antimutagenic[21], against HSV[22], anticarcinogenic[23], on tuberculosis[24] and pesticide[25], derivatives of thiohydantoin are also used as a fungicide[26], N-phenyl derivative of 2-Thiohydantion shows antiparasitic activity against Trypanosoma brucei species[27].

K.H. Chikhalia *et al.,*[28] reported a series of thiohydantoin derivatives having ethyl linked 3,4-dimethoxyphenylethyl thiourea derivatives with styryl bridge possessing antibacterial properties as well as anti HIV activity. Abubshait S.A.[29] synthesized some 2-thiohydantoin drivatives and reported anticancer and antimicrobial properties against *Gram-positive* and *Gram-negative* bacteria. Kolhe S.V.[30] prepared 2-thiohydantoin derivatives by mixing aurones derivative with suitable thiourea by refluxing with KOH and ethaonol as a solvent and reported antimicrobial properties using microbes such as

Escherichia coli, *Staphylococcus aureus*, *Klebsilla, pseudomons*. Saied E.M. *et al.,*[31] synthesized 1, 3-disubstituted 2-thiohydantoin analogues and reported anti-inflammatory activity. Gotmare P.A. *et al.,*[32] synthesized 2-Thiohydantoin analogous and reported physicochemical properties.

Literature survey reveals that, substituted 2-thiohydantoin were found to be very instrumental in controlling the diseases in the field of medicine, agriculture. The present study has been undertaken to synthesis some new 2-thiohydantoin analogues and test them for their physico-chemical properties.

MATERIALS AND METHODS

All chemical s and reagents used in this research were commercially sourced and of analytical grade. The purity of resultant compound was check by using TLC. The IR spectra were recorded in KBr by using FT-(IR Perkin Elmer-Spectrum RX-FTIR). Mass spectra were recorded on mass spectrometer while ^{1}HNMR were recorded on FT NMR Spectrometer (Bruker Avance Neo 500 MHz).

General Procedure for synthesis of 2-Thiohydantoin:-Aurone (0.01 M) and N-substituted thiourea (0.01 M) were taking in round bottom flask along with 10% KOH and Ethanol as a solvent. A reaction mixture was reflux for 3 hours. After this period, the mixture was poured in to ice cold water and filter it by using suction pump. The final product recrystallized with Ethanol.

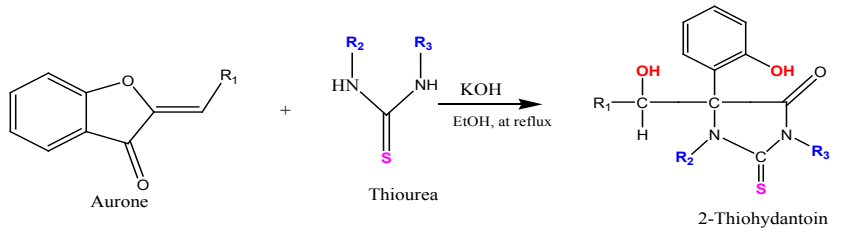


Table: 1

Sr. No	Compounds	R_1	R_2	R_3
1	1a	C_4H_3O	C_6H_5	C_6H_5
2	1b	C_6H_4Cl	C_6H_5	H

Preparation of 5-(hydroxyl(4-methoxyphenyl) methyl)-5-(2-hydroxyphenyl)-1,3-diphenyl-2-thioxoimidazolidin-4-one(1a)

2-(4-methoxybenzylidene)benzofuran-3(2H)-one (0.01M) reflux with N,N-diphenyl thiourea (0.01M) in presence of 10% KOH and appropriate ethanol solvent up to 3 hours. After completion of reaction, cooled the mixture and poured in to ice cold water. The solid product obtained which was filter and washed with dilute HCl and water. The product was crystallized by using ethanol.

Mol. Formula $C_{29}H_{24}O_4N_2S$: Yellowish Crystalline solid. m. p. 258°C yield 70%, Elemental analysis (%): C, 70.14; H, 4.87; N, 5.64; S, 6.46; O, 12.89; IR (KBr cm^{-1}) 3617.5 (O-H), 3016 (=CH), 1614 (C=N), 1438 (Ar C=C), ESI-MS[M+H]$^+$ Calculated for $C_{29}H_{24}O_4N_2S$: m/z 496.15, 497.15, 498.15; ^{1}H-NMR (500 MHz, DMSO) 3.76 (s, 3H), 5.68 (s, 1H), 6.86-7.38 (m, *J*=8.4,1.1 Hz, 11H), 7.43 7.70 (m, 6H).

Preparation of 5-((4-chlorophenyl)(hydroxy) methyl)-5-(2-hydroxyphenyl)-3-phenyl-2-thioxoimidazolidin-4-one (1b)

2-(4-chlorobenzylidene)benzofuran-3(2H)-one(0.01M) reflux with N-phenyl thiourea (0.01M) in presence of 10% KOH and appropriate ethanol solvent up to 3 hours. After completion of reaction, cooled the mixture and poured in to ice cold water. The solid product obtained which was filter and washed with dilute HCl and water. The product was crystallized by using ethanol.

Mol. Formula $C_{22}H_{17}O_3N_2SCl$: faint yellowish Crystalline solid, m.p. 228°C, yield 74%, Elemental analysis (%): C,62.19; H,4.03; N, 6.59; O, 11.30; S, 7.55;Cl,8.34. IR (KBr cm^{-1}) 3616.5 (O-H), 3268.1 (N-H), 1682(Amide C=O), 1436 (Ar C=C), 755.2 (C-Cl); ESI-MS[M+H]$^+$ Calculated for $C_{22}H_{17}O_3N_2SCl$: m/z 424.06, 426.06, 425.07, 427.07. ^{1}H-NMR (500 MHz, DMSO) 5.58 (s, 1H), 7.04 (m, *J*=8.0,7.8 Hz, 1H), 7.48 (m, *J*=8.3,1.6,0.5 Hz, 8H), 8.02(m, *J*=8.0,1.4 Hz, 1H).

Physicochemical Properties of Thiohydantoin Derivatives

Physico-chemical properties are essential

indicators used in hazard, exposure and risk assessments, hence in this experiments the physico-chemical parameters were studied in different solvents, and different concentrations, with temperature 20°C.

Density and Viscosity

Viscosity and density are affected by temperature. Which implies, for any given fluid, when the temperature is raised, the particle in it start to move apart, bringing down fluid density thereby the value of viscosity also falls down or fluid becomes less viscous. The density and viscosity were taken in different solvent like DMSO and DMF with different concentration and temperature at 20 degree. The density was measured by using pycnometer and viscosity by Ostwald viscometer using fallowing formula.

$$\eta_y = \eta_w \frac{d_y \times d_y}{d_w \times d_w}$$

Acoustic parameters

Ultrasonic velocity was useful to determine the strength of material as well as particle interaction in solution hence most of the scientist are attracted toward these parameters. Here ultrasonic parameters was measured using a single-crystal Interferometer (Mittal Enterprises) operating at 1MHz with an accuracy of ±1.0m/s.

The acoustic parameters were determine using fallowing formulae

Adiabatic compressibility (β)

$$\beta = \frac{1}{\rho v^2}$$

Intermolecular free path length (L_f)

$$L_f = K\beta^{1/2}$$

Where *K* is the temperature dependent Jacobson's constant

Acoustic impedance (*Z*) is given as follows:

$$Z = \rho V,$$

Relative association (RA)

$$RA = \left(\frac{\rho}{\rho_0}\right)\left(\frac{v_0}{v}\right),$$

Ultrasonic attenuation (α/f^2)

$$\alpha/f^2 = \frac{8\pi^2\eta}{\rho v^3}$$

Relaxation time (τ)

$$\tau = \frac{4\eta}{3\rho v^2}$$

RESULTS AND DISCUSSION:

The physico-chemical properties of thiohydantoin derivatives were given below

Compound 1a
Solvent: DMF Temperature 20°C

Conc. (M) Mol/dm^3	Density(ρ)Kg/m^{-3}	Viscosity(∝)×10^3 NSm^{-2}	Ultasonic velocity(v) m/s	Refractive Index
0.000	970.76	0.94577	1415	1.4305
0.001	972.46	1.19646	1434.4	1.422
0.002	972.94	1.2428	1558.8	1.424
0.003	973.88	1.30469	1603.2	1.425
0.004	974.68	1.40073	1632	1.426
0.005	976.2	1.5086	1694.8	1.426

Ultrasonic parameters in DMF

Conc. (M) Mol/dm^3	Adiabetic compressibility (β)×10^{-10}	Intermolecular Free path(L_f)×10^{-11}	Acoustic impedances(Z)×10^6	Relative Association(RA)	Ultrasonic Attenuation (α/f^2)×10^{-14}	Relaxation Time(τ)×10^{-13}
0.000	5.14488	4.622658	1.373625	1.000000	2.7124	6.4869
0.001	4.99790	4.556149	1.394896	0.988202	3.28825	7.9731
0.002	4.22993	4.191512	1.516618	0.909788	2.66007	7.0094
0.003	3.99502	4.073461	1.561324	0.885446	2.56637	6.9498
0.004	3.85210	3.999935	1.590677	0.870535	2.60784	7.1944
0.005	3.56635	3.848718	1.654463	0.839585	2.50397	7.1737

Solvent: DMSO Temperature 20 °C

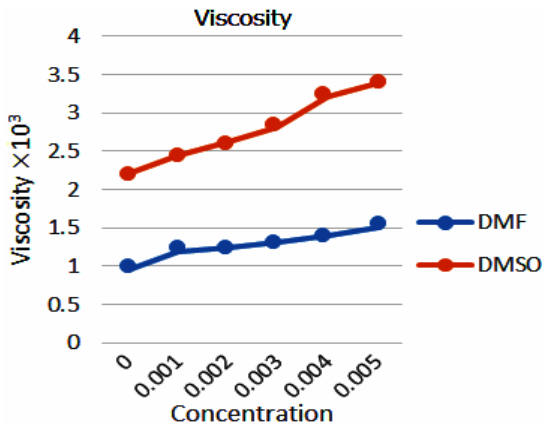
Conc. (M)Mol/dm^3	Density(ρ)Kg/m^{-3}	Viscosity($\propto$)×10^3 NSm^{-2}	Ultasonic velocity(v)m/s	Refractive Index
0.000	1126.28	2.2026	1553.0	1.4740
0.001	1129.04	2.4404	1566.2	1.4742
0.002	1129.86	2.6248	1594.6	1.4744
0.003	1130.12	2.8067	1604.0	1.4748
0.004	1130.98	3.2115	1734.2	1.4751
0.005	1131.06	3.3924	1788.2	1.4752

Ultrasonic parameters in DMSO

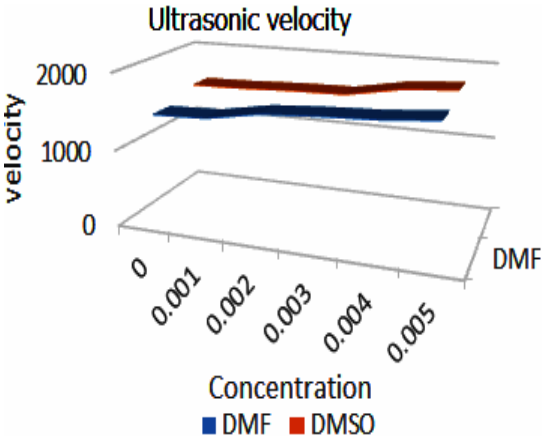
Conc. (M) Mol/dm^3	Adiabetic compressibility (β)×10^{-10}	Intermolecular Free path(L_f)×10^{-11}	Acoustic impedances(Z)×10^6	Relative Association(RA)	Ultrasonic Attenuation^{-14} ($\propto/f^2$)×10^{10}	Relaxation Time(τ)×10^{-13}
0.000	3.68138	3.910414	1.749110	1	4.11835	10.8115
0.001	3.61074	3.872715	1.768302	0.994001	4.43771	11.7489
0.002	3.48074	3.802360	1.801674	0.977024	4.51924	12.1817
0.003	3.43897	3.779470	1.812872	0.971591	4.74645	12.8695
0.004	2.94000	3.494549	1.961345	0.899266	4.29442	12.5891
0.005	2.76492	3.388900	2.022560	0.872172	4.13954	12.5063

Graphical representation

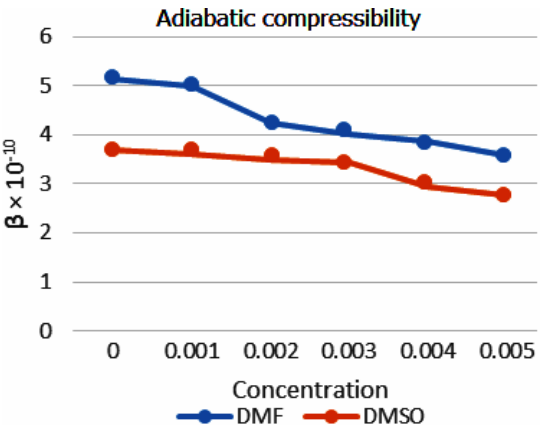
1. Viscosity



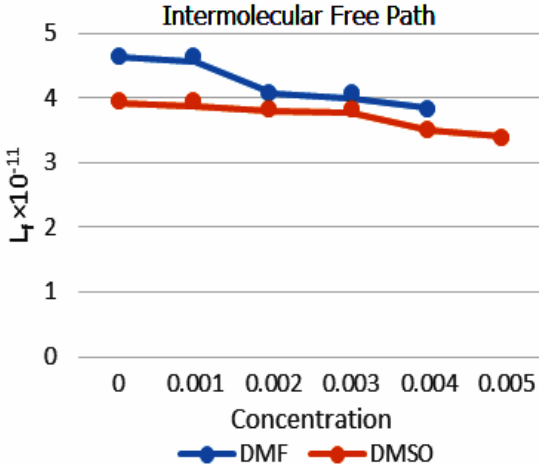
2. Ultrasonic velocity



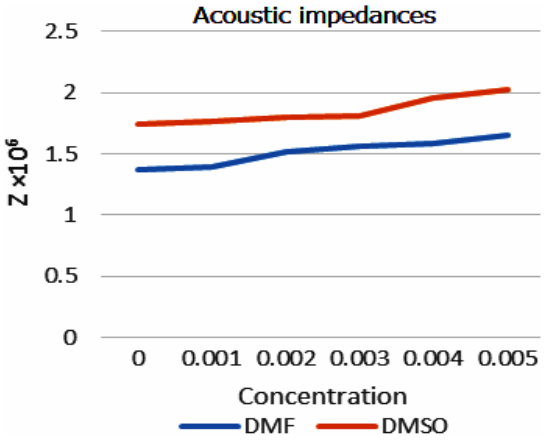
3. Adiabatic compressibility (β)



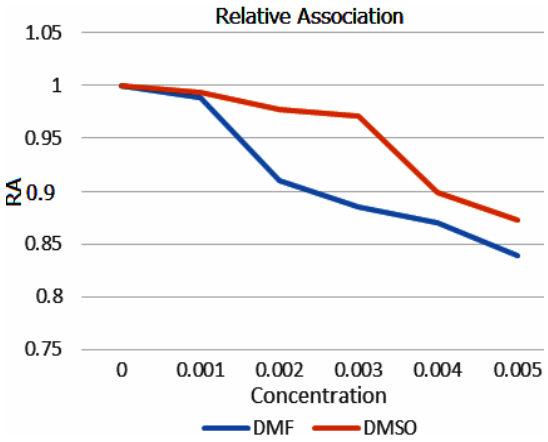
4. Intermolecular Free path (L_f)



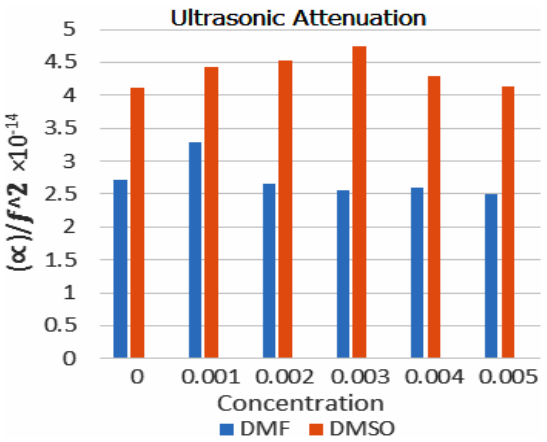
5. Acoustic impedances (Z)



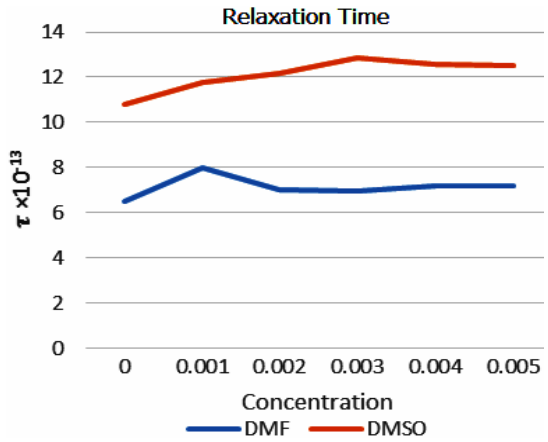
6. Relative Association (RA)



7. Ultrasonic Attenuation(α/f^2)



8. Relaxation Time (τ)



Compound 2a
Solvent: DMF Temperature 20°C

Conc. (M)Mol/dm³	Density(ρ)Kg/m⁻³	Viscosity(∝)×103 NSm-2	Ultasonic velocity(v) m/s	Refractive Index
0.000	970.76	0.94577	1415	1.4305
0.001	971.68	1.15997	1438.72	1.4306
0.002	971.91	1.22426	1452.81	1.4308
0.003	972.18	1.30241	1464.86	1.4309
0.004	972.82	1.42826	1506.91	1.4311
0.005	973.52	1.51763	1585.68	1.4312

Ultrasonic parameters in DMF

Conc. (M) Mol/dm³	Adiabetic compressibility⁻¹⁰ (β)×10	Intermolecular Free path(L_f)×10⁻¹¹	Acoustic impedances (Z)×10⁶	Relative Association(RA)	Ultrasonic Attenuation(∝/f²)×10¹⁴	Relaxation Time(τ)×10⁻¹³
0.000	5.14488	4.622658	1.373625	1.000000	2.71240	6.4878
0.001	4.97192	4.544431	1.397975	0.984445	3.16187	7.6897
0.002	4.87479	4.499826	1.412000	0.975128	3.24019	7.9574
0.003	4.79359	4.462190	1.424107	0.967375	3.16000	8.3243
0.004	4.52681	4.336246	1.465952	0.941000	3.38424	8.6206
0.005	4.08530	4.119357	1.543691	0.894898	3.08406	8.2666

Solvent: DMSO Temperature 20°C

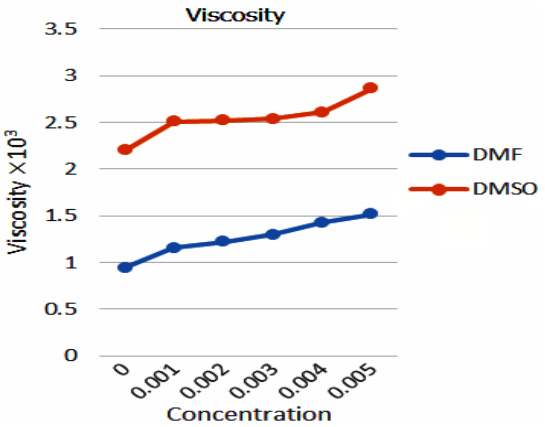
Conc. (M)Mol/dm^3	Density(ρ)Kg/m^{-3}	Viscosity(∝)×10^3 NSm^{-2}	Ultasonic velocity(v) m/s	Refractive Index
0.000	1126.28	2.2026	1553.0	1.4740
0.001	1127.26	2.5128	1609.0	1.4742
0.002	1127.98	2.5247	1612.22	1.4746
0.003	1128.48	2.5382	1614.20	1.4747
0.004	1128.82	2.6141	1618.70	1.4748
0.005	1129.72	2.8663	1622.0	1.4750

Ultrasonic parameters in DMSO

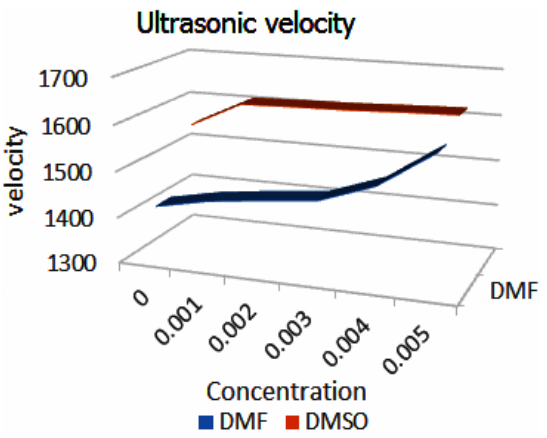
Conc. (M) Mol/dm^3	Adiabetic compressibility (β)×10^{-10}	Intermolecular Free path (L_f)×10^{-11}	Acoustic impedances (Z)×10^6	Relative Association (RA)	Ultrasonic Attenuation (∝/f^2)×10^{-14}	Relaxation Time (τ)×10^{-13}
0.000	3.68138	3.910414	1.749110	1	4.11835	10.8115
0.001	3.426603	3.772675	1.813761	0.966035	4.22099	11.4808
0.002	3.410751	3.763938	1.818551	0.964721	4.21303	11.4817
0.003	3.400881	3.758488	1.821592	0.963965	4.21802	11.5094
0.004	3.380980	3.747475	1.827220	0.961575	4.30687	11.7846
0.005	3.645538	3.738360	1.832405	0.960384	4.39528	12.0510

Graphical representation

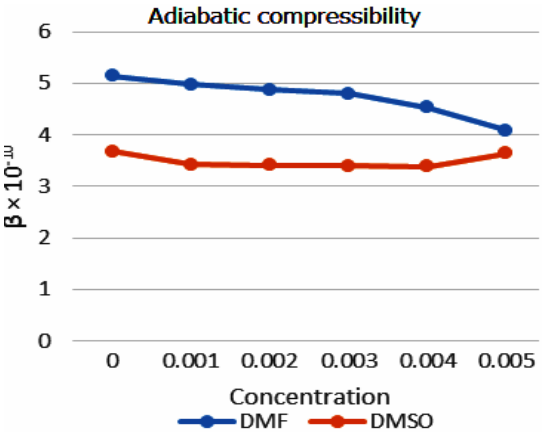
1. Viscosity



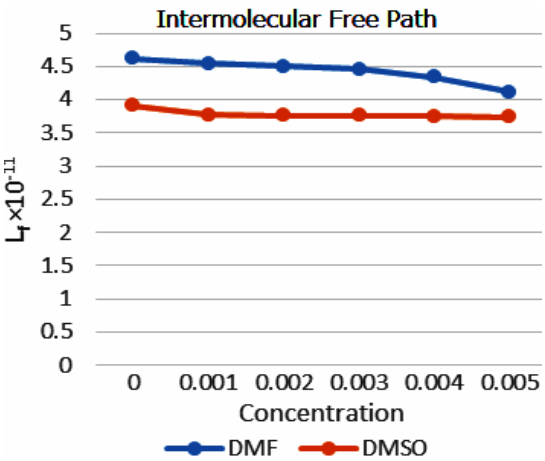
2. Ultrasonic velocity



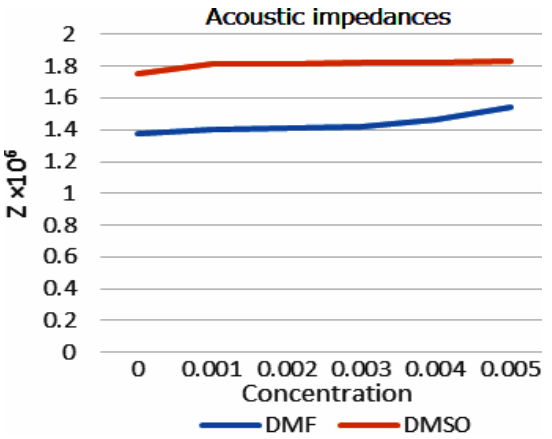
3. Adiabatic compressibility (β)



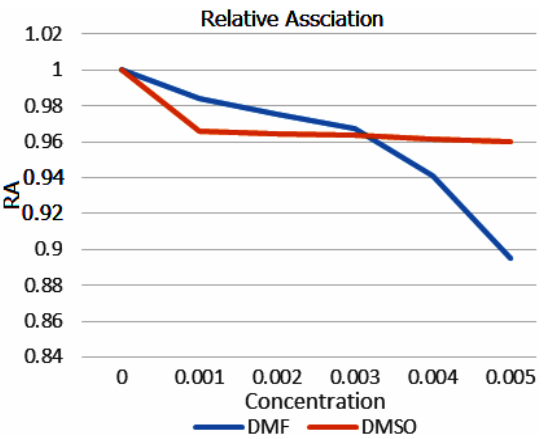
4. Intermolecular Free path (L_f)



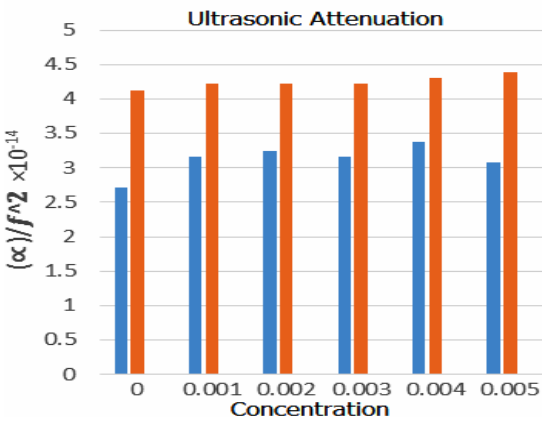
5. Acoustic impedances (Z)



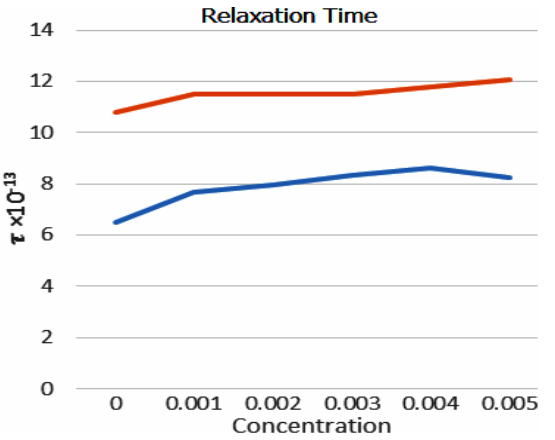
6. Relative Association (RA)



7. Ultrasonic Attenuation(α/f^2)



8. Relaxation Time (τ)



Physicochemical properties are a key to determinant of pharmacokinetic and pharmacodynamics profile, and essential to increasing the success rate of drug sample candidates within the preclinical development process. The importance of the physicochemical properties for active transport. The density and viscosity are depends on temperature and concentration, here the density and viscosity increases by increasing concentration but solvent changes change the density and viscosity that means density as well as viscosity affected by solvent.

Ultrasonic velocity in which sound waves travel through liquid sample. Here Ultrasonic velocity increases by increasing concentration due to an increase of cohesive forces which is created due to strong molecular interactions. The experimental Ultrasonic velocity values are different for the same compound in the two different solvents. This suggests that solvent plays an important role in solutions, molecular interactions exists which differs with different solvents. In this case thiohydantoins shows higher Ultrasonic velocity in DMSO solvent than DMF because in DMSO samples shows strong interaction with solvent DMSO.

If intermolecular free path decreases with increase of concentration, explain that the distance between solute and solvent molecules decrease due to increase in solute-solvent interactions, which causes velocity to increase. It is supported by compressibility and relaxation time. Here relaxation time increases by increasing concentration. Compressibility is a measure of the relative volume change of a sample as a response to a pressure change. Here compressibility decreases by increasing concentration that means concentration increases which increase strong interaction between solute and solvent.

CONCLUSION

It is concluded that physicochemical properties of a thiohydantoin derivatives depends on its structure, concentration and solvents in which it is dissolved. In this case DMSO and DMF shows different values for same compound due to interactions changes in different solvents thereby affecting properties. Further, position of substitution in a compound also affects physicochemical properties. In DMSO solvent, strong solute solvent interaction appear than DMF.

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Conflict of interest

The authors declare no conflict of interest.

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SYNTHESIS, CHARACTERISTICS AND ANTICANCER ACTIVITY OF NOVEL 2-THIOHYDANTOIN ANALOGUES

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Abstract
Breast cancer is the most commonly diagnosed cancer in female, hence there is an urgent demand for the discovery of novel anticancer drugs with potent activity but also safe for long-term application. Toward this aim, the current study described the synthesis and characterization of novel analogues of thiohydantoins. The results revealed that the synthesized compounds possess a cytotoxic activity against MCF-7 cell line in best to moderate level. Among synthesized compounds, compound 1d exhibited the most potent cytotoxic activity with IC50 of 0.74 µg/ml, compared to Doxorubicin drug (IC50 value 0.68 µg/ml). This review highlights that, synthesized compounds endowed with promising anti-breast cancer properties.

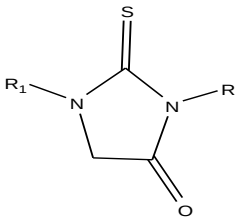
Key word: Cancer, Thiohydantoin, MCF-7 cell line etc

1. Introduction

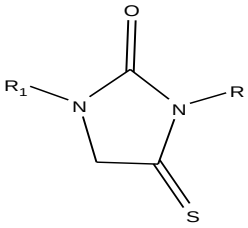
Cancer is a universal disease, which effect on the particular organs as well as disturb to whole body system[i]. The cancer occurs due to uncontrolled progression of normal cells. The numbers of factors influenced on the normal cell due to which the transformation of a normal cell to a cancerous cell[ii]. In universe a different types of cancer are present out of which, the breast cancer is very common to the entire world and normally diagnosed in female candidates. In worldwide an estimated value for the breast cancer grasp more than one million women's. The periodical statistical data will be observed for this disease varied widely such as in 2008, nearly about 421,000 cases were recovered for breast cancer, where as in 2009–2010, more than 49,500 women were diagnosed with breast cancer in Europe. From the breast cancer about 11,600 women's and 75 men were died in 2010. The estimated data caused from this cancer is more than 458,000 women in 2008 worldwide. In 2008, the new cases 184,450 were appeared in persistent stages and this number varies to 230,480 in 2011 in USA. This estimated value is increases day by day and new cases (~268,600) for breast cancer was identified in women, the breast cancer also detected in men in 2019[iii].Environmental factors and dietary habits are the primary source of breast cancer induction with some secondary factors like virus-mediated genetic disturbances [iv]. In an average about 42,170 women in the U.S. predictable to die in 2020[v]. Now a day number of therapies are present to cure this devastating disease such as

radiotherapy, hormone therapy, chemotherapy, proton beam therapy, targeted drug therapy, clinical trials, immunotherapy, cryoablation etc[vi-viii] .Including this, the another way also available to treat the cancer and remove carcinogenic organ from body by surgery, preventive diagnostic, staging, palliative, supportive, cryosurgery, laser, electro surgery and various others [ix-x].

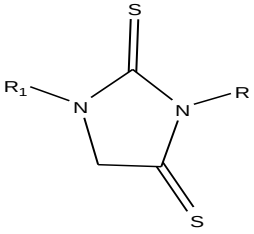
Thiohydantoin containing a nonaromatic ring along with sulfur anolog. In thiohydantoin one or more oxygen atoms were replaced by sulfur[xi-xv]. The number of thiohydantoins are present like 2-thiohydantoin[xvi] (Figer-1), 4-thiohydantoin[xvii] (Figer-2), and 2, 4-thiohydantoin[xviii] (Figer-3).



2-Thiohydantoin
Figer-1



4-Thiohydantoin
Figer-2



2,4-Thiohydantoin
Figer-3

The well-known analogue is 2-thiohydantoins because it shows wide range of applications as anticonvulsant[xix], antiepileptic[xx], antimicrobial[xxi], antiviral[xxii], antineoplastic[xxiii], hypolipidemic[xxiv], antithrombiotic[xxv] and potential antitumor activities[xxvi-xxvii].

Recently Abdellatif *et al*. reported the synthesis of hybrid (3,5-disubstituted)-2-thiohydantoin-pyrazole compounds with considerable anticancer activity toward MCF-7, A-549, and HCT-116 cell lines[xxviii]. Elhady *et al*. reported the synthesis of novel 2‐thioxoimidazolidin‐4‐one derivatives bearing pyrazole, triazole and benzoxazole moieties and explore its anticancer properties based on the group present in 2-thiohydantoin moiety [xxix]. The current study aims to design and develop novel 2-thiohydantoin derivatives and explore anticancer applications.

2. Experiment

The starting material were commercially available in analytical grade. The purity of resultant compound was check by using TLC. The IR spectra were recorded in KBr by using FT-(IR Perkin Elmer -Spectrum RX-IFTIR).Mass spectra were recorded on mass spectrometer while 1HNMR were recorded on FT NMR Spectrometer (Bruker Avance Neo 500 MHz).

2.1 General Procedure for synthesis of 2-Thiohydantoin:- A mixture of aurone (0.01 M) and N-substituted thiourea (0.01 M) were taking in round bottom flask along with 10% KOH and Ethanol as a solvent. A reaction mixture was reflux about 3 hr. The mixture had been cooled, poured into ice cold water and filtered using a suction pump. The final product recrystallized with Ethanol.

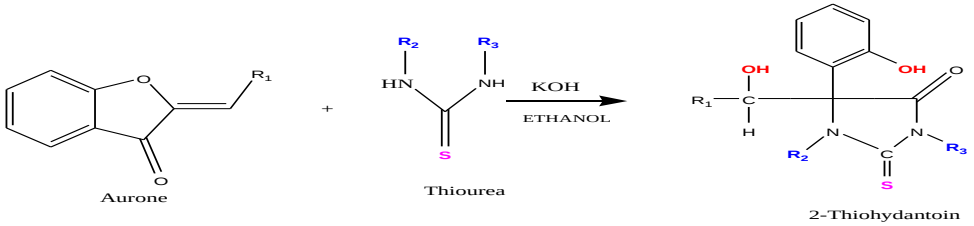


Table-01

Sr. no.	Compounds	R_1	R_2	R_3
1.	1a	C_4H_3O	C_6H_5	C_6H_5
2.	1b	C_6H_4Cl	C_6H_5	H
3.	1c	C_6H_5	CH_3	CH_3
4.	1d	C_7H_7	CH_3	CH_3

2.2 Preparation of 5-(hydroxyl(4-methoxyphenyl)methyl)-5-(2-hydroxyphenyl)-1,3-diphenyl-2-thioxoimidazolidin-4-one(1a)

2-(4-methoxybenzylidene) benzofuran-3(2H)-one (0.01M) was refluxed with N,N-diphenyl thiourea (0.01M) in presence of 10% KOH and appropriate ethanol solvent up to 3 hours. After completion of reaction, cooled the mixture and poured in to ice cold water. After filtering and washing with diluted HCl and water, a solid product was produced. The product was crystallized by using ethanol.

Mol. Formula $C_{29}H_{24}O_4N_2S$: yellowish Crystalline solid, m.p 258^oC , yield 70%, Elemental analysis (%):C,70.14; H,4.87; N,5.64; O,12.89; S,6.46; IR (KBr cm-1) 3617.5 (O-H), 3016 (=CH), 1614 (C=N), 1438 (Ar C=C),ESI-MS[M+H]+ Calculated for $C_{29}H_{24}O_4N_2S$: *m/z* 496.15, 497.15,498.15 ; ^{1}H-NMR (500 MHz, DMSO) δ3.76 (s, 3H), 5.68 (s,1H), 6.86-7.38 (m, *J* =8.4,1.1 Hz, 11H), 7.43 7.70 (m, 6H),

2.3 Preparation of 5-((4-chlorophenyl)(hydroxy)methyl)-5-(2-hydroxyphenyl)-3-phenyl-2-thioxoimidazolidin-4-one (1b)

2-(4-chlorobenzylidene)benzofuran-3(2H)-one(0.01M) was refluxed with N-phenyl thiourea (0.01M) in presence of 10% KOH and appropriate ethanol solvent up to 3 hours. After completion of reaction, cooled the mixture and poured in to ice cold water. After filtering and washing with diluted HCl and water, a solid product was produced. The product was crystallized by using ethanol.

Mol. Formula $C_{22}H_{17}O_3N_2SCl$: faint yellowish Crystalline solid, m.p 228^oC, yield 74%, Elemental analysis (%):C,62.19; H,4.03; N,6.59; O,11.30; S,7.55;Cl,8.34. IR (KBr cm-1) 3616.5 (O-H), 3268.1 (N-H), 1682(Amide C=O), 1436 (Ar C=C), 755.2 (C-Cl); ESI-MS[M+H]+ Calculated for $C_{22}H_{17}O_3N_2SCl$: *m/z* 424.06, 426.06, 425.07, 427.07. ^{1}H-NMR (500 MHz, DMSO) δ5.58 (s, 1H), 7.04 (m, *J* = 8.0,7.8 Hz, 1H), 7.48 (m, *J* = 8.3,1.6,0.5 Hz, 8H), 8.02(m, *J* = 8.0,1.4 Hz, 1H).

2.4 Preparation of 5-(hydroxyl (phenyl) methyl)-5-(2-hydroxyphenyl)-1,3-dimethyl-2-thioxoimidazolidin-4-one(1c)

2-benzylidenebenzofuran-3(2H)-one (0.01M) was refluxed with N,N-dimethyl thiourea (0.01M) in presence of 10% KOH and appropriate ethanol solvent up to 3 hours. After completion of reaction, cooled the mixture and poured in to ice cold water. After filtering and washing with diluted HCl and water, a solid product was produced. The product was crystallized by using ethanol.

Mol. Formula $C_{18}H_{18}O_3N_2S$: faint red crystalline solid, m.p 210^oC, yield 76%, Elemental analysis (%): C, 63.14; H, 5.30; N, 8.88; O, 14.02; S, 9.36.

IR (KBr cm-1) 3520.5 (O-H), 3268.1 , 1712(Amide C=O), 1436 (Ar C=C), 755.2 ; ESI-MS M+H]+ Calculated for $C_{18}H_{18}O_3N_2S$: *m/z* 342.10, 343.11, 344.10,. ^{1}H-NMR (500 MHz, DMSO) δ 3.08 (3H, s), 3.40 (3H, s), 5.64 (1H, s), 6.64 (1H, m, *J* = 8.3, 1.3, 0.5 Hz), 7.04 (1H, m, *J* = 8.0, 7.7, 1.3 Hz).

2.5 Preparation of 5-(hydroxy(p-tolyl)methyl)-5-(2-hydroxyphenyl)-1,3-dimethyl-2-thioxoimidazolidin-4-one(1d)

2-(4-methylbenzylidene)benzofuran-3(2H)-one (0.01M) was refluxed with N,N-dimethyl thiourea (0.01M) in presence of 10% KOH and appropriate ethanol solvent up to 3 hours. After completion of reaction, cooled the mixture and poured in to ice cold water. The solid product obtained which was filtered and washed with dilute HCl and water. The product was crystallized by using ethanol.

Mol. Formula $C_{19}H_{20}O_3N_2S$: faint orange crystalline solid, m.p 224^{o}C, yield 73%, Elemental analysis (%): C, 64.02; H, 5.66; N, 7.86; O, 13.47; S, 9.01. IR (KBr cm-1) 3416.5 (O-H), 1720(Amide C=O), 1436 (Ar C=C), 755.2; ESI-MS[M+H]+ Calculated for $C_{19}H_{20}O_3N_2S$: *m/z* 356.12,357.12,358.12. ^{1}H-NMR (500 MHz, DMSO) δ 2.27 (3H, s), 3.08 (3H, s), 3.40 (3H, s), 5.62 (1H, s), 6.64 (1H, m, *J* = 8.3, 1.3, 0.5 Hz), 7.04 (1H, m, *J* = 8.0, 7.7, 1.3 Hz), 7.15-7.35 (5H, 7.21 (m, *J* = 8.0, 1.2, 0.5 Hz).

3. Result and discussion

Biological assessment

The anti-cancer activity of all synthesized compounds has been evaluated against cell lines MCF-7 (breast carcinoma cell line). Cytotoxicity of the 2-thiohydantoin derivatives on MCF-7 cell line (Procured from NCCS Pune) was determined by NRU (Neutral Red Uptake) Assay. The cells (5000-8000 cells/well) were cultured in 96 well plates for 24 h in DMEM medium (Dulbecco's Modified Eagle Medium-AT149-1L) supplemented with 10% FBS (Fetal Bovine Serum - HIMEDIA-RM 10432) and 1% antibiotic solution at 37°C with 5% CO2. Next day, medium was removed and fresh culture medium was added to each well of the plate. 5 µl of Treatment dilutions (of different concentrations) were added to the defined wells and treated plates were incubated for 24 h. 100 µl of NRU (SRL Chem-36248) (40 µg/ml in PBS - phosphate buffered saline) was added to the defined wells and incubated (Heal Force-Smartcell CO2 Incubator-Hf-90) for 1 h. After that medium was removed, NRU was dissolved in 100 µl of NRU Destain solution. Finally plates were read at 550/660 nm using Elisa Plate Reader (iMark BioRad-USA). IC-50 Was calculated.

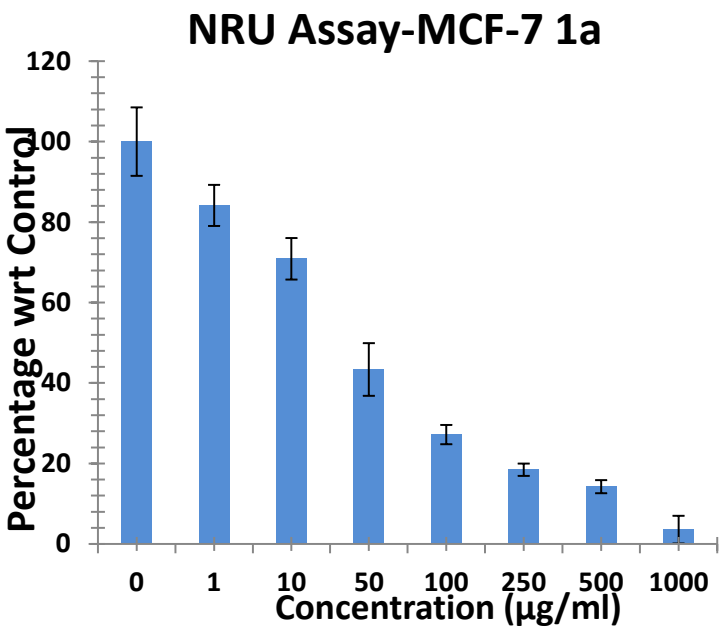
Table 2 show the IC 50 value of the synthesized compounds as well as reference compound Doxorubicin against breast carcinoma cell line MCF-7. Tables 3, 4, 5 and 6, show percentage viability in vitro cytotoxicity against breast carcinoma cell line MCF-7.

Table 2

Sample	IC50 value (µg/ml)
1a	**36.06**
1b	**27.31**
1c	**2.19**
1d	**0.74**
Doxorubicin (Reference)	**0.68**

Table 3. Cytotoxicity of compounds 1a against breast carcinoma cell line MCF-7

Concentration µg/mL	Viability (%)
0	100
1	84.14239
10	70.87379
50	43.3657
100	27.18447
250	18.4466
500	14.23948
1000	3.559871



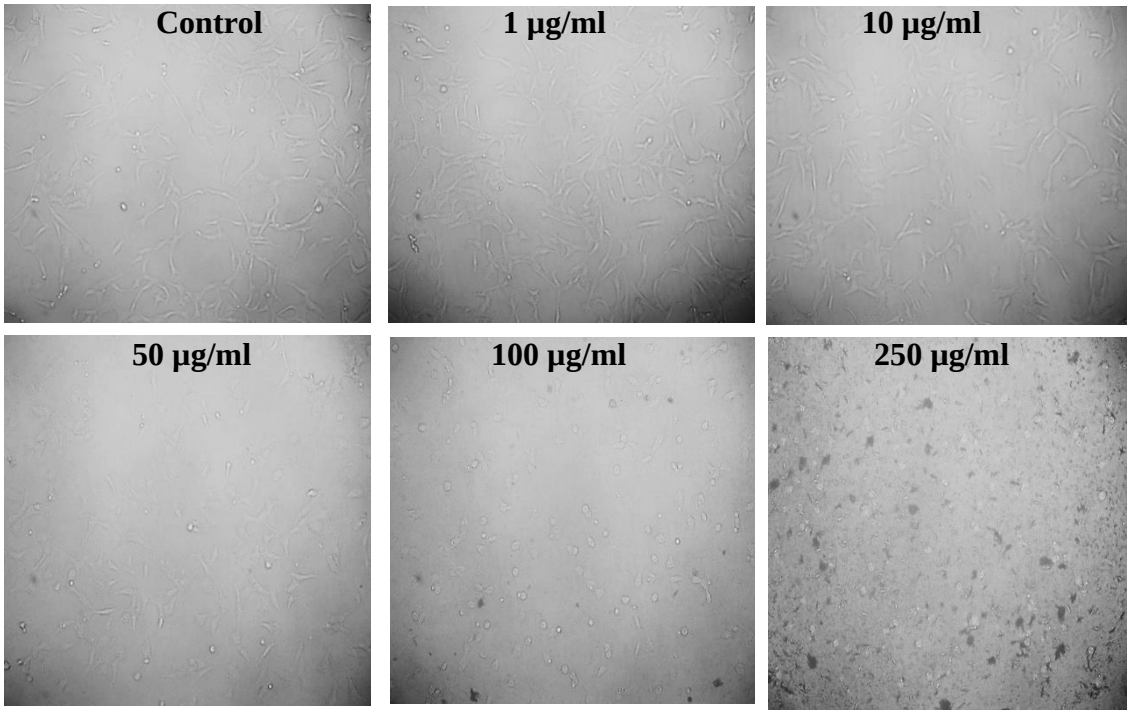
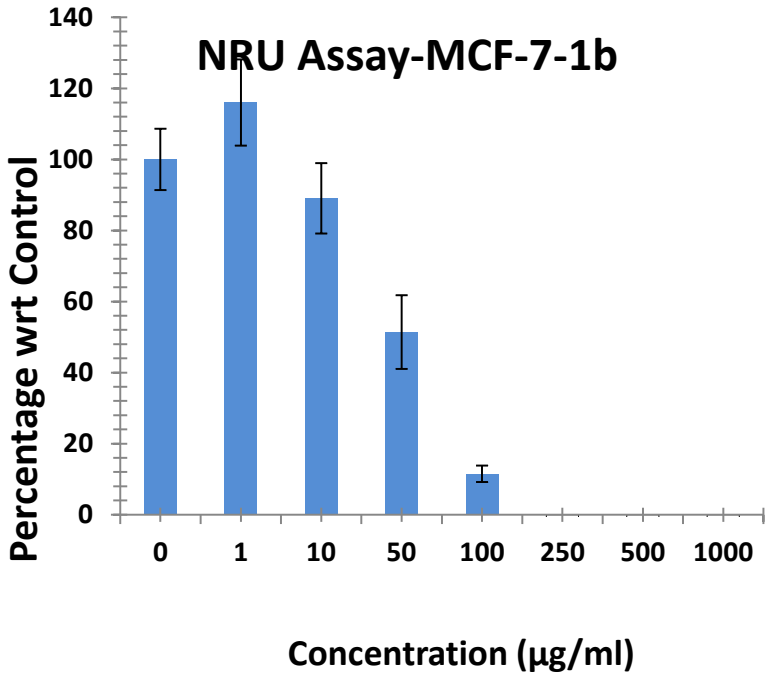


Table 4. Cytotoxicity of compounds 1b against breast carcinoma cell line MCF-7

Concentration µg/mL	Viability (%)
0	100
1	116.0112
10	89.04494
50	51.40449
100	11.51685
250	-9.55056
500	-51.1236
1000	-46.9109



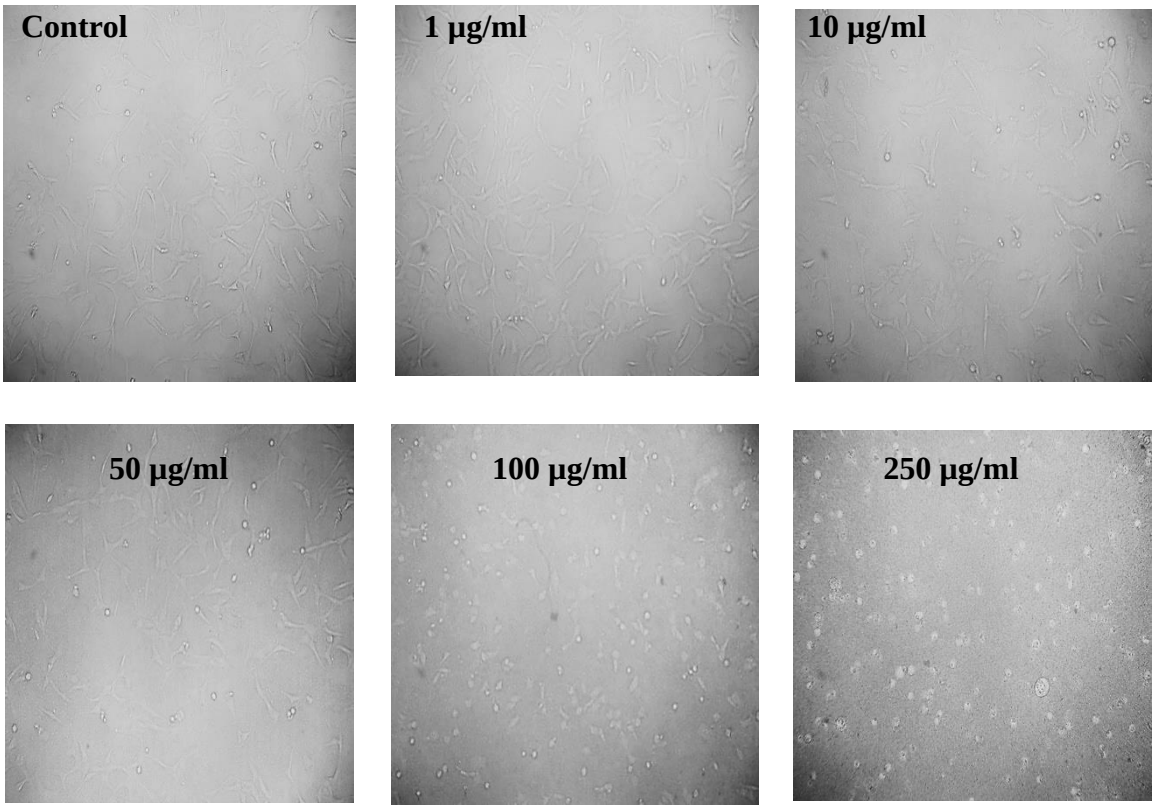
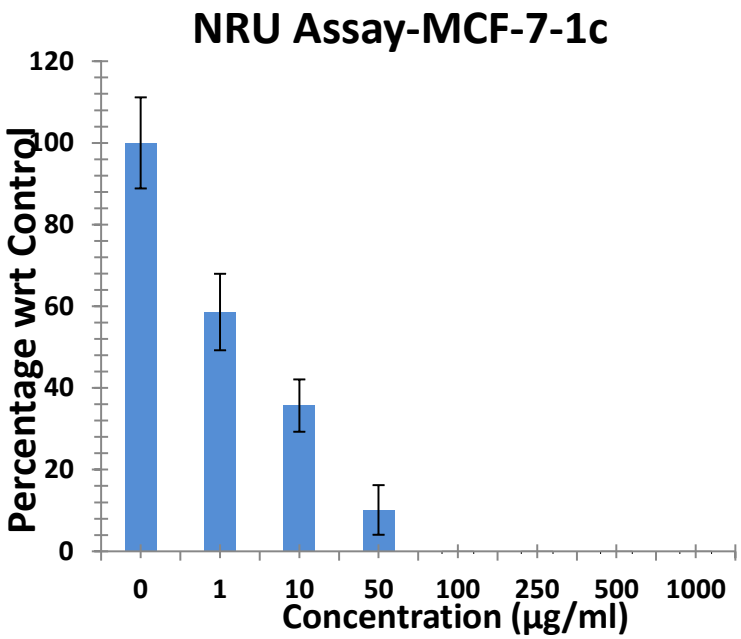


Table 5. Cytotoxicity of compounds 1c against breast carcinoma cell line MCF-7

Concentration µg/mL	Viability (%)
0	100
1	58.59031
10	35.68282
50	10.13216
100	-12.3348
250	-7.04846
500	-23.348
1000	-89.4273



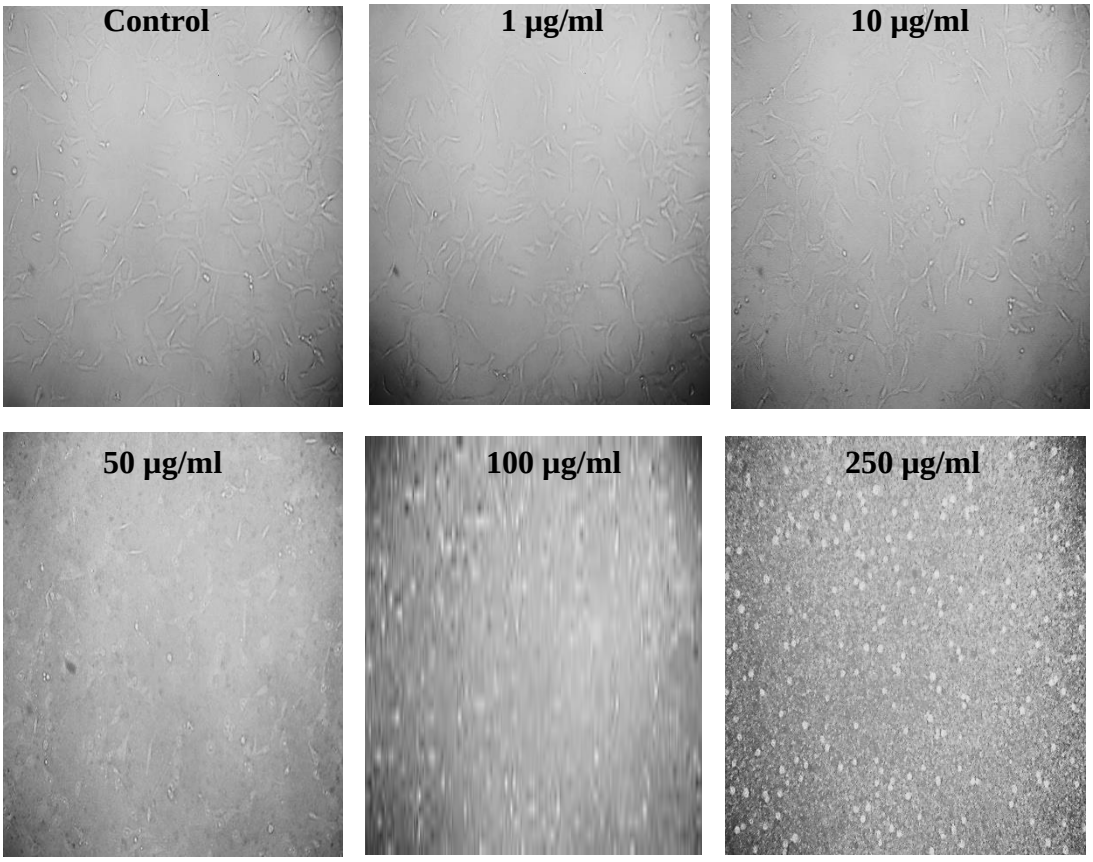
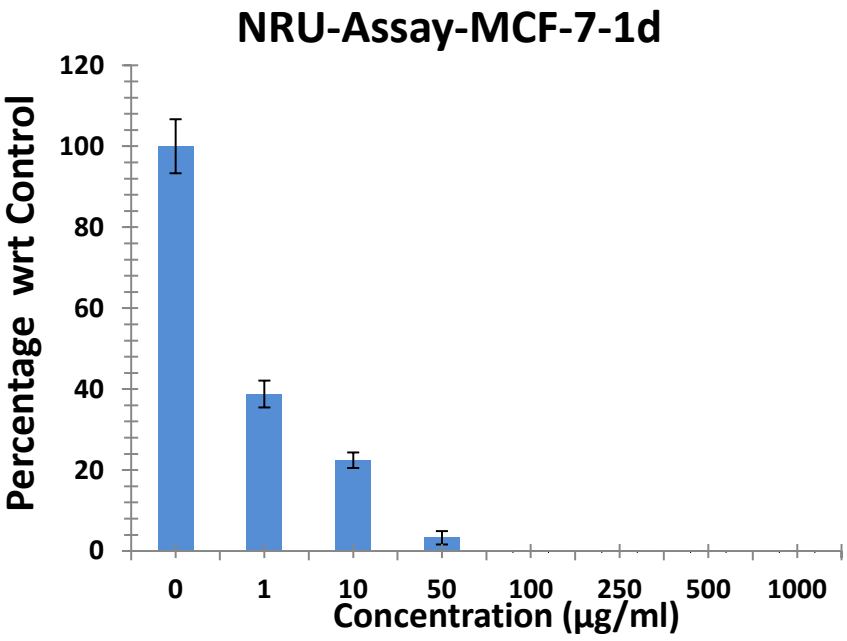
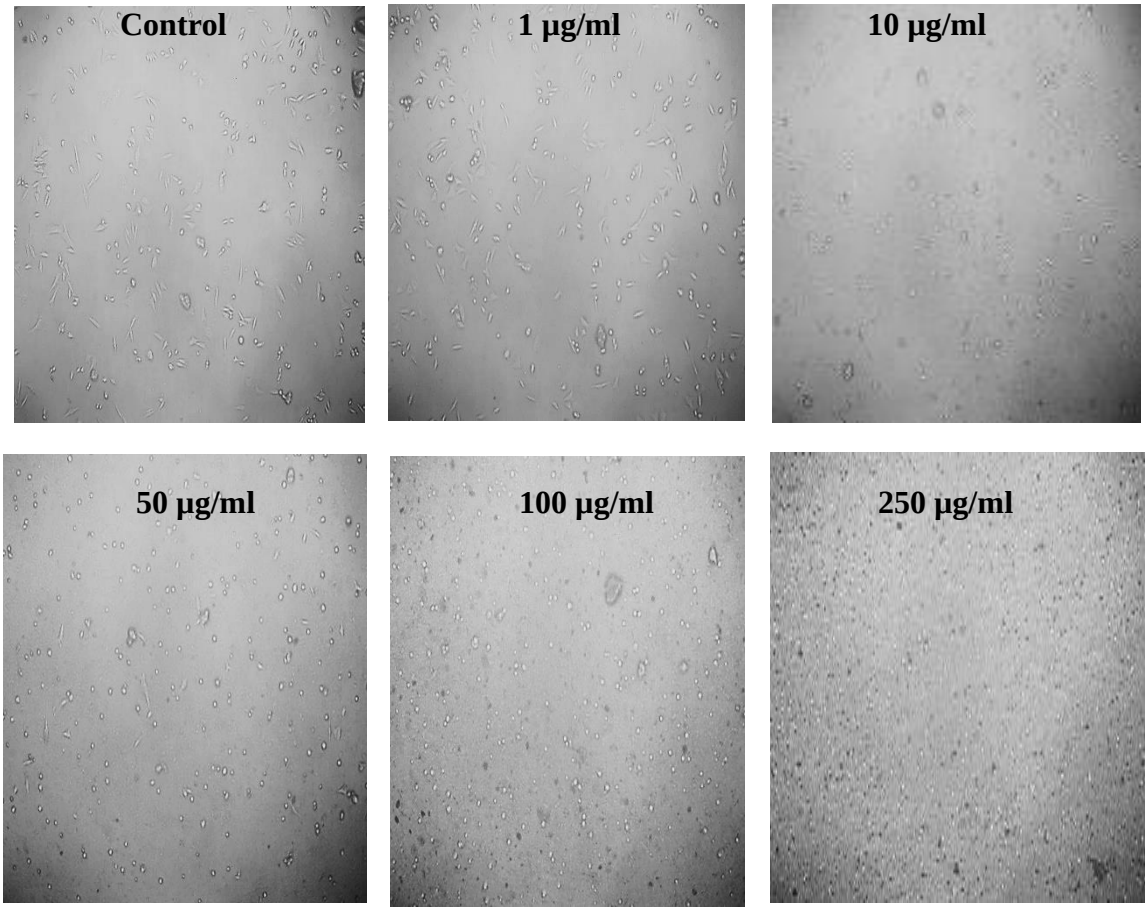


Table 6. Cytotoxicity of compounds 1d against breast carcinoma cell line MCF-7

Concentration µg/mL	Viability (%)
0	100
1	38.78505
10	22.42991
50	3.271028
100	-2.02492
250	-2.49221
500	-22.5857
1000	-11.0592





The resulting data of the 50% inhibition concentration (IC50) summarized in Table 2 showed that, the synthesized 2-Thiohydantoin compounds have different activity against breast cancer cell line MCF-7. Data examination revealed that, the tested compounds showed good to moderate activity. The compound 1c and 1d shows best activity against MCF-7 cell line. Doxorubicin is a anticancer drugs used since 1960. If synthesized compound compare to Doxorubicin then compound 1c and 1d shows best result while compound 1a and 1b shows moderate result again MCF-7 cell line

Generally the structure and biological activity of the compound is responsible for anticancer activity. In 2-Thiohydantoin number of groups like phenyl, benzyl, hydroxyl etc. present at N1 and N3 increases the reactivity against cancerous cell.

4. Conclusion

In this work, we report the effective synthesis of 2-thiohydantoin derivatives and evaluated anticancer property. In present study the compound 1d is very effective against MCF-7 cell line due to methyl group attached to N1 and N3 position. The other compounds like 1a, 1b and 1c shows moderate activity. If different groups are attached at different positions which are responsible to change the effectiveness against MCF-7 line. These results highlight the significance of these compounds as promising new prospects for the discovery and development of innovative chemotherapeutic drugs in the treatment of breast cancer.

Conflicts of interest

The authors declare there is no conflict of interest.

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NOVEL SYNTHESIS AND ANTICANCER SCREENING OF NEW THIOHYDANTOIN-CHALCONE CONJUGATES

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Abstract: Thiohydantoins and chalcones both are the privileged pharmacophores with significant importance in medicinal chemistry. A series of eight thiohydantoin- chalcones conjugates was synthesized and these hybrid compounds were also screened for in vitro anticancer activity. Few compounds were found active against the pathogenic bacterial strains.

Index Terms - Breast Cancer activity, chalcones, thiohydantoin, MCF-7 cell line, pharmacophores

I. INTRODUCTION

Thiohydantoins are sulfur analogs of hydantoins with one or both carbonyl groups replaced by thiocarbonyl groups[1]. Among the known thiohydantoins, 2-thiohydantoins are most notably known due of their wide applications as hypolipidemic[2] , anticarcinogenic[3] , antimutagenic[4] , antithyroidal[5], antiviral (e.g., against herpes simplex virus, HSV)[6] , human immunodeficiency virus (HIV)[7] and tuberculosis[8] , antimicrobial (antifungal and antibacterial)[9] , anti-ulcer and anti-inflammatory agents[10] , as well as pesticides[11]. Additionally, 2-thiohydantoins have been used as reference standards for the development of C-terminal protein sequencing[12,] as reagents for the development of dyes[13] and in textile printing, metal cation complexation and polymerization catalysis[14]. It is therefore not surprising that various different synthetic methods have been developed to prepare 2-thiohydantoin and its derivatives. Some of the most commonly used methods are the treatment of α-amino acids with acetic anhydride followed by ammonium thiocyanate[15] and the coupling reaction between α-amino acid derivatives and isothiocyanate [4a,12b,16] . Other preparative methods for 2-thiohydantoins include the reactions between thiourea and benzil[17] thiourea and α-halo acids[18,] oxazolinone and thiocyanate [19], amino amide and diimidazole thiocarbonate [20], and others[21]. In addition, some of the above reactions have been modified to take place under microwave irradiation[17c] and solid-phase[16a, 22] or fluorous-phase [23] supported reaction conditions. However, the above methods often suffer from one or more synthetic limitations for large-scale preparation of 2-thiohydantoin derivatives due to their use of expensive, moisture sensitive and/or highly toxic starting materials and reagents. Moreover, the methods developed for combinatorial synthesis and used to prepare 2-thiohydantoin derivatives in small quantities for purposes like biological testing may not be feasible when operated on a large scale [22d, 24]. A Thiohydantoin derivative has also been reported as herbicidal25. Bucherer reaction has also been reported for the synthesis of thiohydantoin26. Sulfenylated thiohydantoins has also been reported as fungicides. Ant diabetic hydantoins have been synthesized by Japanese scientists27. 1-3-diglycidyl-5, 5-dimethyl hydantoin has been used for primed steel plate to give a good coating for weathering, alkali, acid and water resistance28. Some thiohydantoin derivatives have been used in the treatment of blood circulation disorder29. Some thiohydantoins have been reported as inhibitors of pyrimidine biosynthesis30, 5, 5-disubstituted thiohydantoins have also been synthesized for their anti HIV activity31. Synthesis of benzylidene derivatives of 3(2, 3, 4-chlorophenyl) thiohydantoins are reported for their anticonvulsant

properties32, 1-bromo thiohydantoins is reported where transposition of halogen atom from nitrogen to 3-alkyl group is studied33. 1-N-phenyl substituted 2-thiohydantoins derivatives were synthesized by Z. Jinpei et al for their antinociceptive activity34. Acetylation of 3-substituted 1-amino-thiohydantoins has been reported35. Reaction of 5-arylidene-3-phenyl-2-thiohydantoin with 2,3,4,6-tetra-o-acetyl-a-D-gluco-pyranosyl bromide are reported. The product is arylidene-phenyl [(tetra acetyl glyco pyranosyl) thiohydantoin.36 Chalcones are one of the most important compounds. The framework 1,3-diphenylprop-2-en-1-one is well known by the generic term ‘‘chalcone,’’ a name coined by Kostanecki and Tambor37. It is also known as benzal acetophenone and benzylidene acetophenone. The chalcones has most important properties like anticancer 38, antimalarial39, antimicrobial40 and antiinflammatory41etc. 2-Hydroxy chalcones are a group of naturally occurring compounds and are used as the intermediates for the synthesis of various other flavanoids41, 42. The unsaturated carbonyl system in chalcones makes them biologically active43.Indeed,chalcones constitute an important group of natural compounds that are especially abundant in fruits (e.g., citruses, apples), vegetables (e.g., tomatoes, shallots, bean sprouts, potatoes) and various plants and spices (e.g., licorice),many of which have been used for centuries in traditional herbal medicine[44-45]

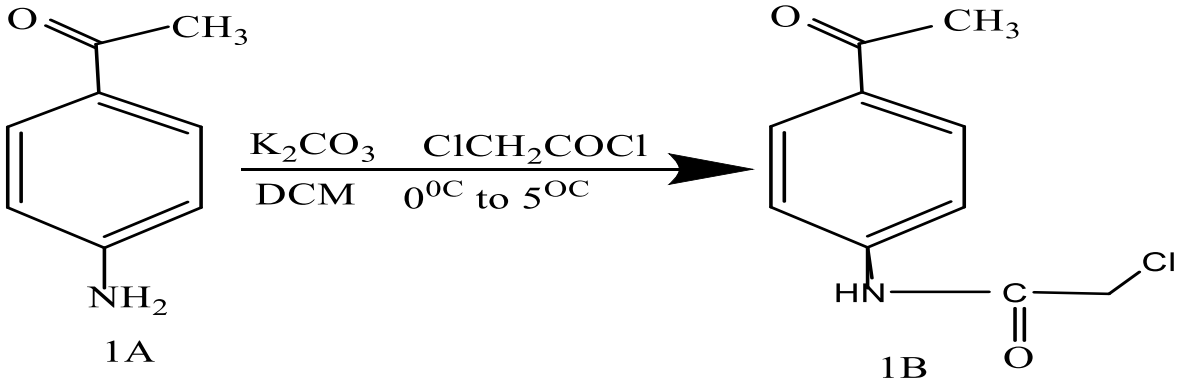
The cancer is occurs due to uncontrolled progression of normal cells. The numbers of factors influenced on the normal cell due to which the transformation of a normal cell to a cancerous cell[46]. In universe a different types of cancer are present out of which, the breast cancer is very common to the entire world and normally diagnosed in female candidates. In worldwide an estimated value for the breast cancer grasps more than one million women’s. The periodical statistical data will be observed for this disease varied widely such as in 2008, nearly about 421,000 cases were recovered for breast cancer, where as in 2009–2010, more than 49,500 women were diagnosed with breast cancer in Europe. From the breast cancer about 11,600 women’s and 75 men were died in 2010. The estimated data caused from this cancer is more than 458,000 women in 2008 worldwide. In 2008, the new cases 184,450 were appeared in persistent stages and this number varies to 230,480 in 2011 in USA. This estimated value is increases day by day and new cases (~268,600) for breast cancer was identified in women, the breast cancer also detected in men in 2019[47].

II .METHODOLOGY

The chemicals used in the synthesis were purchased from Sigma Aldrich and were used as such. Melting points of the compounds have been measured using automated melting point apparatus and are uncorrected. IR spectra were recorded in Nijol, 1H NMR spectra were recorded in $CDCl_3$ with TMS as an internal standard. The purity of synthesized compound was check by TLC. The structural elucidation of compound was done on the basis of chemical and spectral data.

2.1 Preparation of N-(3-(4-acetyl phenyl)-2- Chloro acetamide (1B) :-

0.01mol of Para-amino acetophenone (1A) was dissolved in dichloromethane (DCM) and cooled to 0-5 ºC in ice bath. Further, 0.01 mol of potassium carbonate (K_2CO_3) were added to this reaction mixture followed by drop wise addition of 0.01 mol of Chloro acetyl chloride ($ClCOCH_2Cl$) at 0 ºC temperature. This reaction mixture was stirred at room temperature for 3 hrs. After completion of reaction, solvent was evaporated. The residue was washed with distilled water to get N-(4-acetyl phenyl)-2- Chloro acetamide (1B).



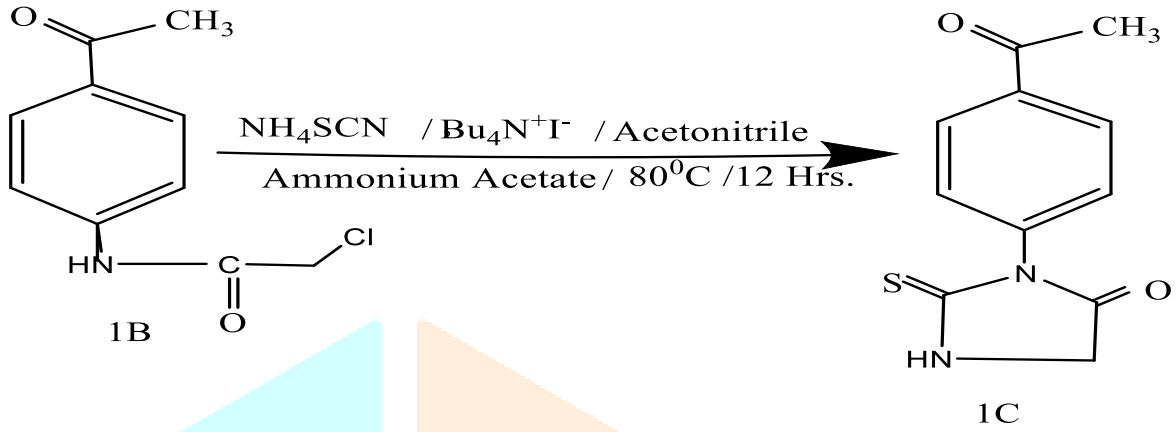
1A 1B

2.2 Preparation of N-(3-(4-acetyl phenyl) imidazolidine-2,4-dione) (1C) :-

0.01 mol of 1B was refluxed with 0.01 mol of NH_4CNS in presence of 0.01 mol of tetra butyl ammonium iodide and ammonium acetate using acetonitrile as solvent at 80 ºC for 12 hrs., after completion of reaction solvent was evaporated. The crude product N-(3-(4-acetyl phenyl) imidazolidine-2, 4-dione) 1C was extracted with ethyl acetate and was purified with column chromatography using ethyl acetate and hexane as eluent.

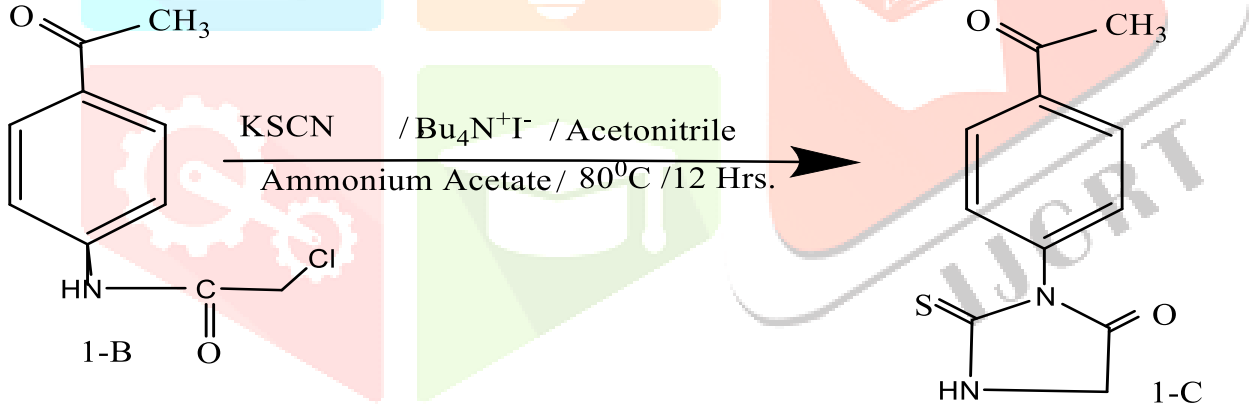
To compared the yield and texture of 1C the reaction was refluxed with two different thiocyanate with **Scheme - A and Scheme –B**

Scheme: - A Refluxed with NH_4CNS :-



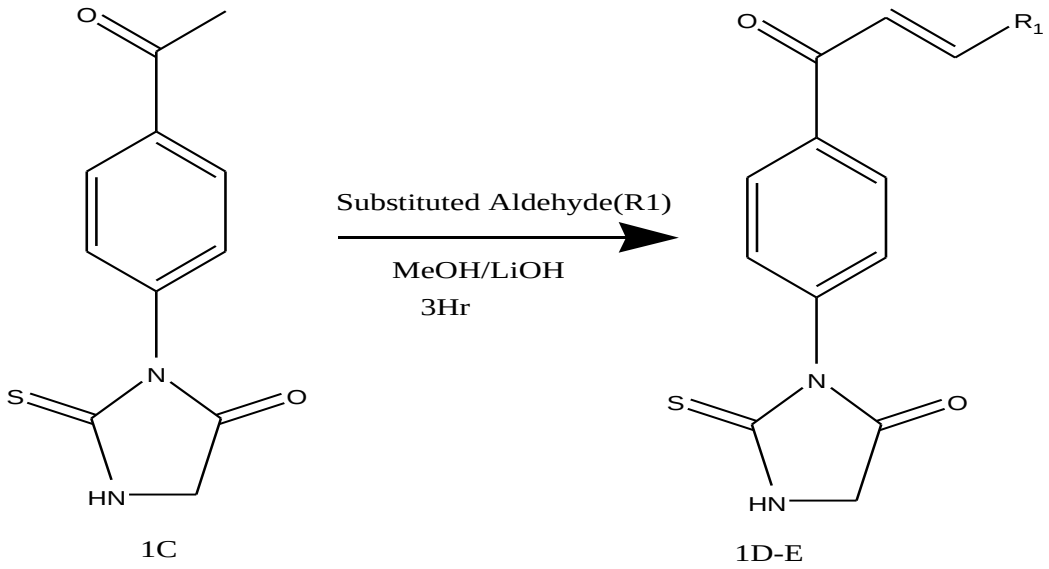
Scheme: - B Refluxed with KCNS :-

0.01 mol of 1B was refluxed with 0.01 mol KCNS in presence of 0.01 mol of tetra butyl ammonium iodide and ammonium acetate using acetonitrile as solvent at 80 ºC for 12 hrs., after completion of reaction solvent was evaporated. The crude product N-(3-(4-acetyl phenyl) imidazolidine-2, 4-dione) 1C was extracted with ethyl acetate and was purified with column chromatography using ethyl acetate and hexane as eluent.



2.3Preparation of N-(3-(4-Carboxy phenyl)-3" substituted Chalcone-Thiohydantoin Conjugates (1D-E) :-

To a well stirred solution of N-(3-(4-acetyl phenyl)- imidazolidine-2,4-dione) 1C (0.01 mol) in methanol, 0.01 mol of LiOH were added followed by the addition of 0.01 mol of corresponding substituted aromatic aldehyde. The reaction mixture was stirred at room temperature for 3 hrs. After formation of cake, keep the reaction overnight, completion of reaction, precipitate obtained was filtered washed with distilled water. The crude product obtained was purified by crystalized from methanol.



1C 1D-E

Table 1: Synthesized Chalcone-Thiohydantoin Conjugates Compounds, M.P. and yields

Sr. No.	Compounds	R_1	M. P. (^oC)	Yield (%)
1	1E	C5H3O2	276	74%
2	1D	C6H4NO2	225	71 %

III.SPECTRAL ANALYSIS

Compound 1E

Mol. Formula $C_{18}H_{14}O_4N_2S$: Brown red amorphous solid, m.p 276 ^oC , yield 74%, Elemental analysis (%):C,61.01; H,3.98; N,7.90; O,18.06; S,9.05; IR (KBr cm-1) 3426.58 (N-H), 17.34 (C=O), 1642.5 (Ar C-H),ESI-MS[M+H]+ Calculated for **$C_{18}H_{14}O_4N_2S$**: *m/z* 354.08, 355.06; 1H-NMR (500 MHz, DMSO): δ 3.81 (2H, d, *J* = 6.8 Hz), 3.96 (2H, d, *J* = 17.7 Hz), 4.32 (2H, d, *J* = 9.7 Hz), 5.70 (1H, dt, *J* = 10.7, 9.7 Hz), 5.89-6.03 (3H, 5.96 (d, *J* = 15.8 Hz), 5.96 (d, *J* = 5.9 Hz), 5.97 (d, *J* = 5.9 Hz)), 6.36 (1H, d, *J* = 3.5 Hz), 6.63 (1H, d, *J* = 10.7 Hz), 7.01 (1H, dt, *J* = 15.8, 6.8 Hz), 7.15 (1H, d, *J* = 3.5 Hz), 9.74 (1H, s).

Compound 1D

Mol. Formula $C_{19}H_{15}O_4N_3S$: Golden yellow amorphous solid, m.p 225^oC , yield 71%, Elemental analysis (%):C,59.83; H,3.96; N,11.02; O,16.78; S,8.41; IR (KBr cm-1) 3420.58 (N-H), 17.34 (C=O), 1632.5 (Ar C-H),ESI-MS[M+H]+ Calculated for **$C_{19}H_{15}O_4N_3S$** : *m/z* 381.08, 382.08; 1H-NMR (500 MHz, DMSO): δ 3.30 (2H, d, *J* = 6.8 Hz), 3.96 (2H, d, *J* = 17.7 Hz), 4.32 (2H, d, *J* = 9.7 Hz), 5.70 (1H, dt, *J* = 10.7, 9.7 Hz), 5.90-6.06 (3H, 5.96 (d, *J* = 5.9 Hz), 5.99 (d, *J* = 15.8 Hz), 5.97 (d, *J* = 5.9 Hz)), 6.56-6.75 (3H, 6.63 (d, *J* = 10.7 Hz).

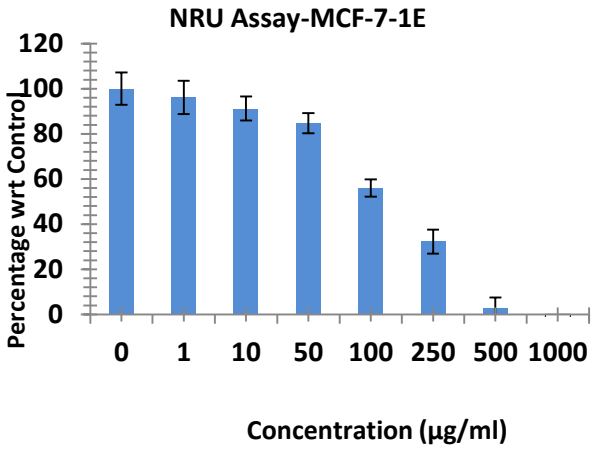
IV. BIOLOGICAL ASSESSMENT

The anti-cancer activity of synthesized compounds has been evaluated against cell lines MCF-7 (breast carcinoma cell line. Cytotoxicity of the Chalcone-thiohydantoin conjugates derivatives on MCF-7 cell line (Procured from NCCS Pune) was determined by NRU (Neutral Red Uptake) Assay. The cells (5000-8000 cells/well) were cultured in 96 well plates for 24 h in DMEM medium (Dulbecco's Modified Eagle Medium-AT149-1L) supplemented with 10% FBS (Fetal Bovine Serum - HIMEDIA-RM 10432) and 1% antibiotic solution at 37°C with 5% CO2. Next day, medium was removed and fresh culture medium was added to each well of the plate. 5 µl of Treatment dilutions (of different concentrations) were added to the defined wells and treated plates were incubated for 24 h. 100 µl of NRU (SRL Chem-36248) (40 µg/ml in PBS - phosphate buffered saline) was added to the defined wells and incubated (Heal Force-Smartcell CO2 Incubator-Hf-90) for 1 h. After that medium was removed, NRU was dissolved in 100 µl of NRU Destain solution. Finally plates were read at 550/660 nm using Elisa Plate Reader (iMark BioRad-USA). IC-50 Was calculated.

Tables 2 show the IC 50 value of the synthesized compounds as well as reference compound Doxorubicin against breast carcinoma cell line MCF-7. Tables 3, 4, 5 and 6, show percentage viability in vitro cytotoxicity against breast carcinoma cell line MCF-7.

Table: 2

Concentration ug/mL	Viability (%)
0	100
1	96.17486
10	91.25683
50	84.69945
100	56.01093
250	32.24044
500	3.005464
1000	-177.322



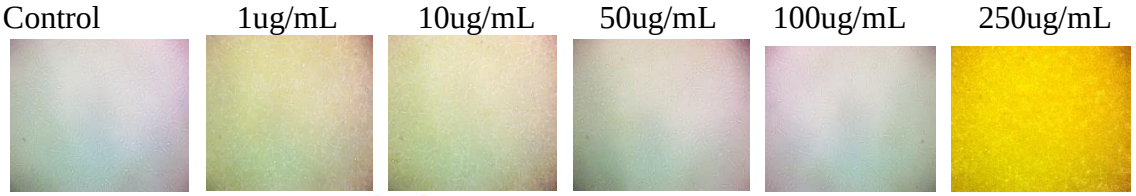
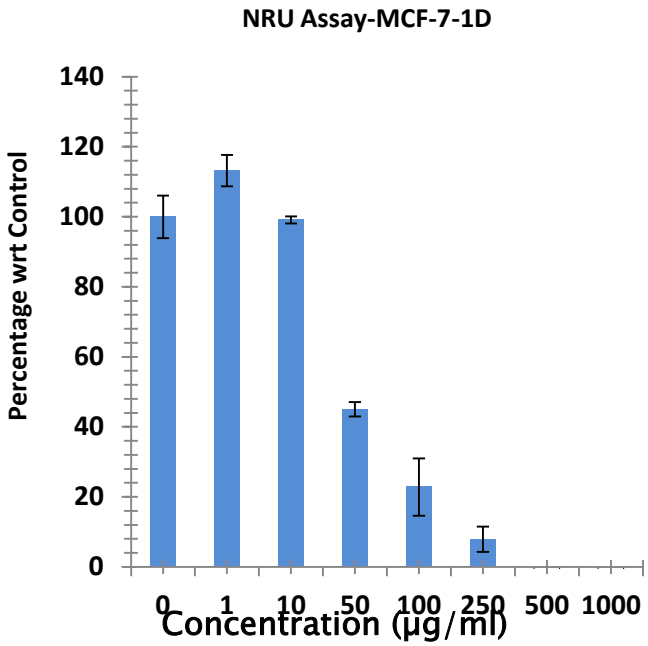
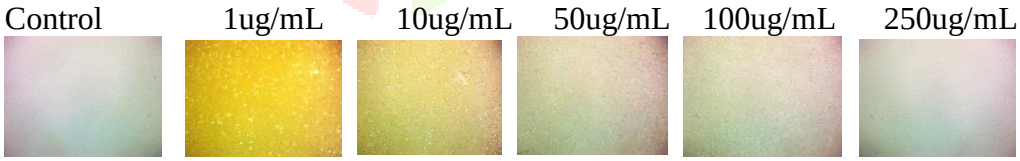


Table :3

Concentration ug/mL	Viability (%)
0	100
1	113.1579
10	99.12281
50	45.02924
100	22.80702
250	7.894737
500	15.2047
1000	47.6608





IV.RESULT AND CONCLUSION

The result evaluated that, thiohydantoin conjates shows moderate to good effect on breast cancer cell line.Therefore, much research efforts are still required to be focused on studying the substituents effects that highly enhance the drug-like properties of the thiohydantoin conjates scaffolds to reach the outmost challenges and prominent to improve human health and reduce suffering.

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Synthesis, characterisation and antimicrobial activity of n-substituted 2-thiohydantoin derivatives

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Abstract
Novel 2-thiohydantoin derivatives (1a and 1b) were synthesized from aurones with solvent ethanol. The structures of synthetic compounds were characterized using Fourier-transform infrared spectroscopy (FT-IR), 1H-nuclear magnetic resonance (NMR) spectroscopy, and mass spectrometry. Synthesized compounds shows good to moderate antibacterial and antifungal activities against Bacterial culture, *Escherichia coli* (MTCC-452), *Pseudomonas aeruginosa* (MTCC-3541), *Mycobacterium tuberculosis* (MTCC-300), *Enterococcus faecalis*, *Aspergillus niger*, (MTCC-281), *Candida*. *Albicans*, (MTCC-854) species.

Keywords: 2-thiohydantoin, antibacterial, antifungal

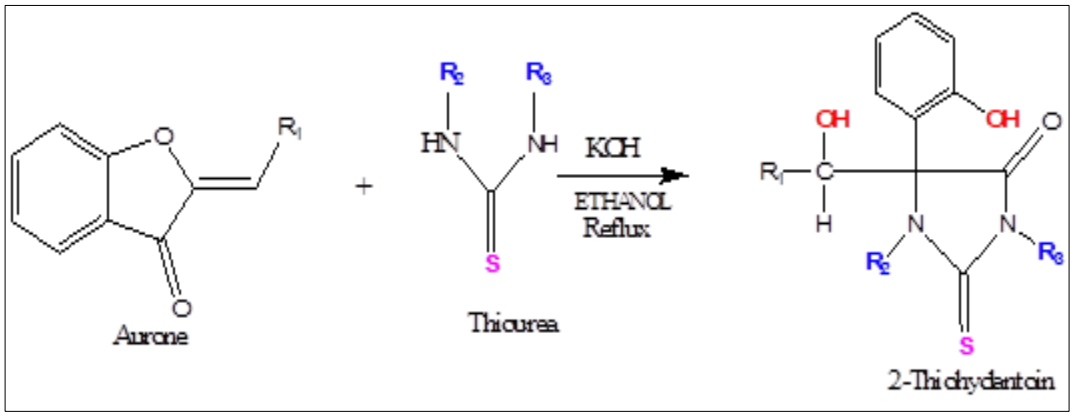
1. Introduction
The chemical substances that stop microorganisms from growing or that eradicate them, is known as an antimicrobial agent. This characteristic is displayed by a variety of substances when utilized at a sufficiently higher focus. Nonetheless, the term is typically limited to substances that exhibit efficacy at concentrations appropriate for real-world use. The substance ought to have a wide range of antibacterial activity at low concentrations.
Hippocrates, a Greek physician who lived in 450 B.C., is credited with introducing the idea of disease as a pathogenic process and organizing the field of medicine through the use of deduction, analysis, and abbreviation. James Gregory (1753-1821) is credited with popularizing heroic symptomatic treatment, which included bloodletting, high dosages of ematic, and drastic purgatives - many of which had disastrous outcomes. This treatment, which lacked any scientific foundation, was dubbed ("allopathy").
The oldest and most revered scripture, the Rigveda, which was composed between 4500 and 1600 B.C., contains the first record of the use of plants for medicinal purposes. Certain drug properties and their applications have been detailed in detail in the Ayurveda, which is regarded as an "Upa-Veda." Actually, the basis of India's traditional medical knowledge is Aryurveda [1].
Several Western scholars have determined that Ayurveda dates back to between 2500 and 600 B.C. Ayurveda is divided into eight branches, which are separated by two later works called Sushruta [2].
Literature survey reveals that chalcones, aurones and 2-thiohydantoin derivatives has antimicrobial, anti-inflammatory, anti-diabetic. Anticancer, analgesic, insecticidal etc. properties.
Kolli *et al*. revealed that, 2-thioxo imidazolidinones derivatives shows moderate to higher antimicrobial activity against *Escherichia coli*, *Enterococcus faecalis*, *Pseudomonas aeruginosa* and Staphylococcus aureus [3].
Joshi *et al*., synthesized thiohydantoin derivative and explored regioselectivity as well as antimicrobial activity [4].
Badiger *et al*., synthesized 5-[6-aryl-2-(4-methoxybenzyl)imidazo[2,l-b][l,3,4] thiadiazol-5-yl]methylene-2-thioxoimidazolidin-4-one derivatives & screened for their antibacterial and antifungal activities [5].
Bhambi *et al*., synthesized 3-Thiazolidin-4-one-2-yl-methylene hydrazido-1H-indole 2 and 3-[2-thioxo-imidazolin-4-one-3-yl-imino methylene]-1H-indole 3, which were characterized for their antibacterial and antifungal activities, with some showing significant inhibition [6].

2-Thiohydantoins are important class of compounds within pharmaceutical industries and exist in various pharmacologically active molecules that possess important bioactivities like antimicrobial [7], antiviral [8], fungicides [9], anti-parasite, [10] and anticancer [11].
These molecules contribute to drug discovery and the importance of these compounds in bioactive, we have decided to synthesize the thiohydantoin derivatives and investigated its antimicrobial properties because these properties explain the nature and reactivity towards drugs.

2. Methods and Materials

2.1 General

Using TLC, the final compound's purity was assessed. The FT-(IR Perkin Elmer - Spectrum RX-IFTIR) was used to record the IR spectra in KBr. While 1HNMR data was recorded on an FT NMR Spectrometer (Bruker Avance Neo 500 MHz), mass spectra were recorded on a mass spectrometer. The data are presented as chemical shifts in parts per million downfield from TMS, assignment, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, and m = multiplet), and coupling constant, in that order.
A round bottom flask containing 10% KOH and ethanol as a solvent was filled with aurone (0.01 M) and N-substituted thiourea (0.01 M). For three hours, reflux was a reaction mixture. The mixture was then added to ice-cold water and filtered using a suction pump after this time. Ethanol was used to help the finished product recrystallize.



Compounds	R1	R2	R3
1a	C7H7O	C6H5	C6H5
1b	C6H4Cl	H	C6H5

2.2 Preparation of 5-(hydroxyl (4-methoxyphenyl) methyl)-5-(2-hydroxyphenyl)-1,3-diphenyl-2-thioxoimidazolidin-4-one (Thiohydantoin-1a)

2-(4-methoxybenzylidene) benzofuran-3(2H)-one (0.01 M) and 1,3-diphenylthiourea (0.01 M) were taking in round bottom flask along with 10% KOH and Ethanol as a solvent. A reaction mixture was reflux for 3 hours. After complete the reaction, the mixture was poured in to ice cold water and filter it by using suction pump. The final product recrystallized with Ethanol.

Mol. Formula $C_{29}H_{24}O_4N_2S$

Light yellow amorphous solid, M.P 226 °C, yield 71%, Elemental analysis (%):C,70.14; H,4.87; N,5.64; O,12.89; S,6.46; IR (KBr cm-1) 3548.78 (O-H), 3418.58 (N-H), 1690.05 (C=O), 1632.5 (Ar C-H),ESI-MS[M+H]+ Calculated for $C_{29}H_{24}O_4N_2S$ *m/z* 496.12, 497.15; 1H-NMR (500 MHz, DMSO): δ 3.76 (3H, s), 5.66 (1H, s), 6.85-7.37 (11H, 6.91 (ddd, *J* = 8.4, 1.1, 0.5 Hz), 8.03 (1H, ddd, *J* = 8.0, 1.3, 0.5 Hz).

2.3 Preparation of 5-((4-chlorophenyl)(hydroxy)methyl)-5-(2-hydroxyphenyl)-3-phenyl-2-thioxoimidazolidin-4-one (Thiohydantoin-1b)

2-(4-chlorobenzylidene) benzofuran-3(2H)-one (0.01 M) and 1-phenylthiourea (0.01 M) were taking in round bottom flask along with 10% KOH and Ethanol as a solvent. A reaction mixture was reflux for 3 hours. After complete the reaction, the mixture was poured in to ice cold water and filter it by using suction pump. The final product recrystallized with Ethanol.

Mol. Formula $C_{22}H_{17}O_3N_2SCl$

Faint yellowish crystalline solid, M.P. 228 °C, yield 74%, Elemental analysis (%): C, 62.19; H, 4.03; N, 6.59; O, 11.30; S, 7.55; Cl, 8.34. IR (KBr cm-1) 3616.5 (O-H), 3268.1 (N-H), 1682(Amide C=O), 1436 (Ar C=C), 755.2 (C-Cl); ESI-MS [M+H]+ Calculated for $C_{22}H_{17}O_3N_2SCl$: m/z 424.06, 426.06, 425.07, 427.07. 1H-NMR (500 MHz, DMSO) 5.58 (s, 1H), 7.04 (m, *J*=8.0, 7. 8 Hz, 1H), 7.48 (m, *J*=8.3, 1. 6, 0. 5 Hz, 8H), 8.02(m, *J*=8.0, 1.4 Hz, 1H).

3. Antimicrobial Screening

The Antibacterial activity was checked by following Zone Inhibition Method (Kirby-Bauer method). The MHA plates were inoculated by spreading with 100 µl of Bacterial culture, *Escherichia coli* (MTCC-452), *Pseudomonas aeruginosa* (MTCC-3541), *Mycobacterium tuberculosis* (MTCC-300), *Enterococcus faecalis*, *Aspergillus niger*, (MTCC-281), *Candida*. *Albicans*, (MTCC- 854). (Adjusted to 0.5 McFarland Unit - Approx cell density (1.5 X 108 CFU/mL) and followed by placing the discs containing 10 µl of different concentration (0 to 1000 mg/ml). One disc in each plate was loaded with solvent alone which served as vehicle control and Ciprofloxacin disc (10µg) were taken as positive control. The plates were incubated at 37 °C for 24 hrs. A clear zones created around the disc were measured and recorded.

3.1 Result and Discussion

The antimicrobial activities of synthesized compounds 1a and 1b, have been assayed at the concentration of 1000 µg/disc against some pathogens *viz*. bacteria *Escherichia*

coli (MTCC-452), *Pseudomonas aeruginosa* (MTCC-3541),*Mycobacterium tuberculosis* (MTCC-300), *Enterococcus faecalis*, and some fungi *viz*. *Aspergillus niger*, (MTCC-281), *Candida*. *Albicans*, (MTCC- 854). The efficacy of titled compounds is given in following table.

Table 1: Zone of inhibition (mm)

Compounds	Zone of inhibition (mm)					
	Bacterial pathogens				Fungal pathogens	
	E. coli	***P. aeruginosa***	***M. tuberculosis***	***E. faecalis***	***A. niger***	***C. Albicans***
1a	15.33	20.67	18	16.24	15	21
1b	12.14	12	9.50	11.46	10	13

The results of antimicrobial screening indicate that the titled compound shows good to moderate antimicrobial activity against tested bacteria. Here compound 1a shows highest antimicrobial activity than compound 1b due to electron donating group present at para position as well as phenyl group attached to nitrogen in thiohydantoins. These changes in functional groups cause changes in the biological activities of the compounds. The newly synthesized titled compounds are capable to cramp the growth of fungal and bacterial pathogens.

Conclusion

The presented data showed that the diversity of chemical synthesis of thiohydantoins has benefited many drug discovery projects. The chemical structure of these molecules possesses two main variable positions 3-N and 5-C where most of their derivatives could be synthesized. In present study compound 1a shows higher antimicrobial activity than 1b due to presence of electron donating group directly attached to benzene ring as well as nitrogen atom contains phenyl group.

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Conflicts of Interest

The authors declare no conflicts of interest.

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AN EFFICIENT PROCEDURE FOR THE SYNTHESIS OF NOVEL HETEROCYCLIC COUMARAN-3-ONE DERIVATIVE AND ITS PHYSICO-CHEMICAL PARAMETERS

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ABSTRACT:

The heterocyclic coumaran-3-one derivative *was synthesized from chalcone and purity check by TLC. The characterization of* coumaran-3-one derivative *was done by IR, H-NMR and mass Spectrometer. The physico-chemical parameters of heterocyclic* coumaran-3-one derivative *such as density, viscosity, refractive index and acoustic parameter etc. has been studied at different temperature, concentrations and solvents etc.*

KEY WORDS: *Heterocyclic , density, refractive index, ultrasonic velocity, solvents etc.*

INTRODUCTIONS:

A coumaran-3-one derivative (aurone) is a heterocyclic chemical compound which is a type of flavonoid. Coumaran-3-one derivative is a constitute of a subclass of naturally occurring compounds which are structurally isomeric to flavones, biogenetically related to chalcones, and are responsible for imparting beautiful yellow colors to some of the flower petals[1-4]. It is a subtype of flavonoids these are isosteres of flavones[5-6]. The aurone shows great antimicrobial properties although the studies and biological activities of aurones are still limited, it is a promising material to prepared bioactive compounds with a broad spectrum of activity including such as anti-microbial[7], anti-cancer[8], anti-leishmanial[9-11], anti-histaminic[12], antiinflammatory[13], antioxidant[14], insect anti-feedant[15], herbicidal[16],anti-HIV[17-18], anti-HCV (hepatis C virus)[19-20], anti-malarial[21-22], ChE inhibitory[23-24], MAO inhibitory[25] activities. The antileishmanial activity of a series of aurones was first reported by Kayser and Kiderlen in 1999[26]. Aurones having great tendency to shows coupling reactions with ligands [27].

Lawrence et al. studied the aurone, isolated from Uvaria hamiltonii, which were subsequently evaluated for anticancer activity [28]. Chen et al. prepared new aurones which acts as a chemosensors for cyanide anions [29].

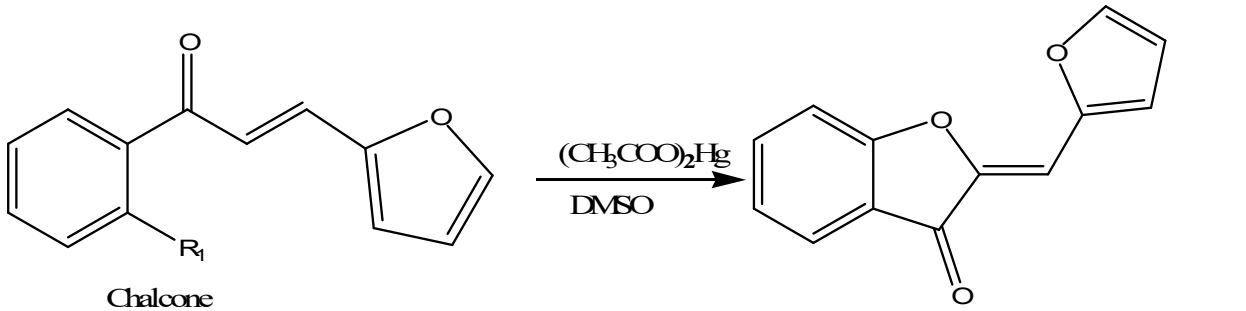
The properties like density, viscosity, refractive index , ultrasonic velocity play a very important role to find out thermochemistry parameters. Physico-chemical

properties are useful to design of new pesticides and drugs.Thus, the present work was undertaken to synthesized new heterocyclic coumaran-3-one derivative and study of its physicochemical properties such as density, viscosity, refractive index, acoustic parameter etc. in different solvents, different concentrations and different temperatures.

EXPERIMENTAL:

1. Synthesis of heterocyclic coumaran-3-one derivative:

The coumaran-3-one derivative was prepared by simple cyclization process. In this synthesis, the starting materials is 2-hydroxy chalcone which is prepared from equimolar mixture 2-hydroxy acetophenone and furfuraldehyde. The chalcone undergoes cyclization in presence of mercuric acetate with suitable solvent to gives coumaran-3-one derivative. The solvent like DMSO and pyridine showed good yield of aurones [30- 32]. Agrawal et al. described the method of preparation of aurone by cyclisation of Hydroxy chalcones using pyridine-Hg $(OAc)_2$.[33] The characterization of novel synthesized coumaran-3-one derivative was done by using spectroscopic technique like H-NMR (Bruker Avance Neo 500 MHz), IR (Perkin Elmer - Spectrum RX-IFTIR), mass spectrometry etc.



Chalcone

(*Z*)-2-(furan-2-ylmethylene)benzofuran-3(2*H*)-one

R_1=OH

Table:-1

Compound	Molecular formula	Molecular weight	Yield	colour	m.p.
(*Z*)-2-(furan-2-ylmethylene) benzofuran-3(2*H*)-one	$C_{13}H_8O_3$	212	74%	yellowish brown	102^0 C

SPECTRAL DATA :IR (KBr cm^{-1}) 1688 (C=O cyclic), 1642(C=C aliphatic), 1480 (C=C aromatic), 1210(C-O furane), **^{1}H-NMR (500 MHz, DMSO)** δ 6.34 (dd, *J* = 3.4,1.8 Hz, 1H), δ

6.80 (s, 1H), δ 7.08 (dd, J=3.4, 0.6 Hz, 1H), δ 7.64 (dd, *J* = 1.6, 0.8 Hz, 1H), **ES-MS[M+H]**$^+$ Calculated for $C_{13}H_8O_3$: *m/z* was found 212.04, 213.06.

2. Physicochemical parameters of coumaran-3-one derivative:

Physico-chemical properties are essential indicators used in hazard, exposure and risk assessments, hence in this experiments the physico-chemical parameters were studied in different solvents, different temperature and different concentrations.

Density and Viscosity:

Viscosity and density are affected by temperature. Which implies, for any given fluid, when the temperature is raised, the particle in it start to move apart, bringing down fluid density thereby the value of viscosity also falls down or fluid becomes less viscous. The density and viscosity were taken in different solvent like DMSO and DMF with different concentration and temperature. The density was measured by using pycnometer and viscosity by Ostwald viscometer using fallowing formula.

$$\eta_y = \eta_w \frac{d_y \times d_y}{d_w \times d_w}$$

Refractive index:

The refractive index is generally used to measure the concentration of a solute in an aqueous solution. In current experiment the Abbe's refractometer is used to determine refractive index of synthesized coumaran-3-one derivative in different solvents that is DMSO and DMF at various concentrations.

Acoustic parameters:

Ultrasonic velocity was useful to determine the strength of material as well as particle interaction in solution hence most of the scientist are attracted toward these parameters. Here ultrasonic parameters was measured using a single-crystal Interferometer (Mittal Enterprises) operating at 1MHz with an accuracy of ±1.0m/s.

The acoustic parameters were determine using fallowing formulae

a) Adiabatic compressibility (β)

$$\beta = \frac{1}{\rho v^2}$$

b) Intermolecular free path length (L_f)

$$L_f = K\beta^{1/2},$$

Where K is the temperature dependent Jacobson's constant

c) Acoustic impedance (Z) is given as follows:

$$Z = \rho V,$$

d) Relative association (RA)

$$RA=\left(\frac{\rho}{\rho_0}\right)\left(\frac{v_0}{v}\right),$$

e) Ultrasonic attenuation (α/f^2)

$$\alpha/f^2 = \frac{8\pi^2\eta}{\rho v^3}$$

f) Relaxation time (τ)

$$\tau = \frac{4\eta}{3\rho v^2}$$

RESULTS AND DISCUSSION:

Density and Viscosity of heterocyclic coumaran-3-one derivative: The tables given below, gives the values of density and Viscosity at different temperatures.

Table:-2 **Temperature: 303.15K**

Conc. (M).	DMSO Solvent		DMF Solvent	
	Density (ρ)(kg/m^3)	Viscosity (η.10^{-3}) NSM^{-2}	Density (ρ)(kg/m^3)	Viscosity (η)×10^{-3} NSM^{-2}
0.00	1112.888	1.38726	961.447	0.77064
0.01	1114.824	1.65091	966.942	0.79783
0.02	1115.624	1.69827	967.492	0.80924
0.03	1116.625	1.72817	968.874	0.82057
0.04	1117.184	1.89264	969.142	0.85762
0.05	111.782	2.10763	969.846	0.89081

Table:-3 **Temperature: 308.15K**

Conc. (M).	DMSO Solvent		DMF Solvent	
	Density (ρ)(kg/m^3)	Viscosity (η.10^{-3}) NSM^{-2}	Density (ρ)(kg/m^3)	Viscosity (η)×10^{-3} NSM^{-2}
0.00	1112.483	1.45428	957.628	0.70773
0.01	1114.276	1.50130	960.842	0.72865

0.02	1115.428	1.53762	963.827	0.74876
0.03	1116.142	1.57211	964.074	0.77142
0.04	1116.892	1.59762	966.242	0.78874
0.05	1117.124	1.62874	967.841	0.79823

Table:-4 **Temperature: 313.15K**

Conc. (M).	DMSO Solvent		DMF Solvent	
	Density (ρ)(kg/m^3)	Viscosity (η.10^{-3}) NSM^{-2}	Density (ρ)(kg/m^3)	Viscosity (η)×10^{-3} NSM^{-2}
0.00	1108.728	1.49087	940.286	0.65872
0.01	1109.287	1.51724	951.287	0.67428
0.02	1109.872	1.52422	952.874	0.68976
0.03	1114.426	1.54762	954.764	0.69982
0.04	1116.287	1.57428	957.876	0.71264
0.05	1116.827	1.59778	959.743	0.73878

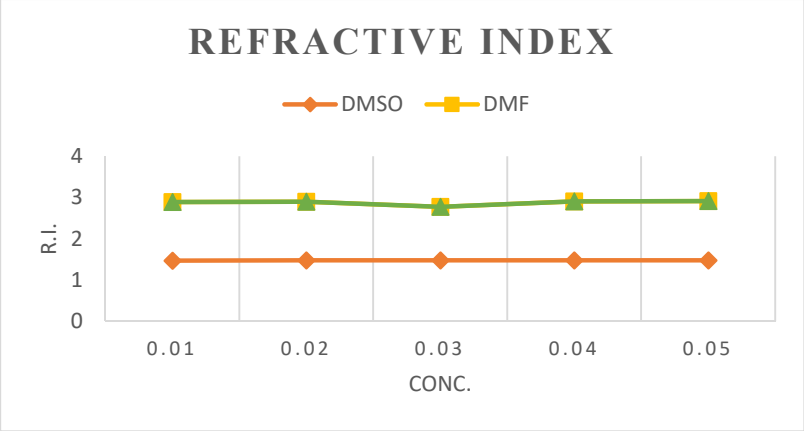
In viscosity measurements of different concentration of solutions depend on the size of the molecules and molecular weight. The larger the molecules, the more drag and also the more intermolecular attraction, and so the higher the viscosity.

If the concentration of solution increases then interaction between solute and solvent increases that leads to enhanced intermolecular attractions that contribute to a resistance to flow and viscosity increases. The density is slightly varies by changing the concentrations. In general, liquids tend to get "thinner" when their temperature increases and viscosity decreases. In different solvents the viscosity is depends on solvent density and interaction between solute solvent molecules, here the solvent dimethyl sulfoxide (DMSO) having higher density as well as higher viscosity than dimethyl formamide (DMF).

Refractive index of heterocyclic coumaran-3-one derivative: The tables given below gives the values of refractive index of synthesized heterocyclic coumaran-3-one derivative in different solvents

(M)	DMSO	DMF
	R.I.	R.I.
0.01	1.469	1.425
0.02	1.472	1.428

0.03	1.473	1.430
0.04	1.474	1.432
0.05	1.476	1.435

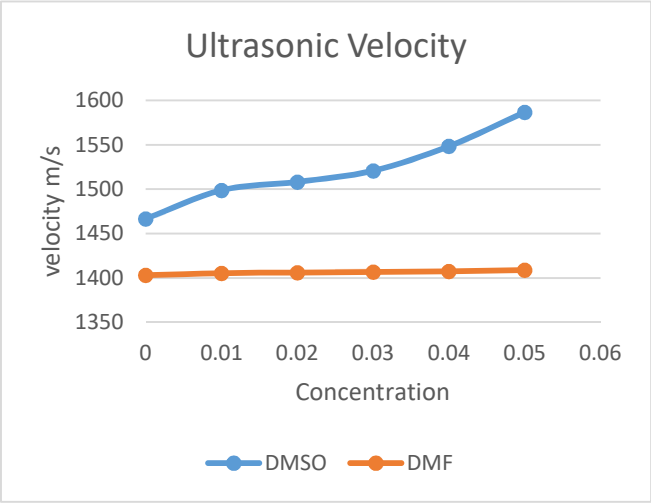


In this study, the refractive index heterocyclic coumaran-3-one derivative was studied in DMSO and DMF at wavelength 589 nm. The higher the refractive index the slower the light travel,which causes a correspondingly increased change in the direction of the light within the material. The refractive index is higher in DMSO than DMF at same wavelength which explain that, DMSO is thicker solvent than DMF. The Concentration is also responsible to change refractive index due to solute solvent interaction and change in thickness of solution.

Acoustic parameters of heterocyclic coumaran-3-one derivative:

The experimental values of acoustic parameters in different solvents and different concentration are given bellow

Conc. (M).	**DMSO Solvent Velocity (m/s)**	**DMF Solvent Velocity (m/s)**
0.00	1466.74	1402.91
0.01	1498.78	1405.24
0.02	1508.24	1406.12
0.03	1520.72	1406.63
0.04	1548.46	1407.48
0.05	1586.76	1408.94

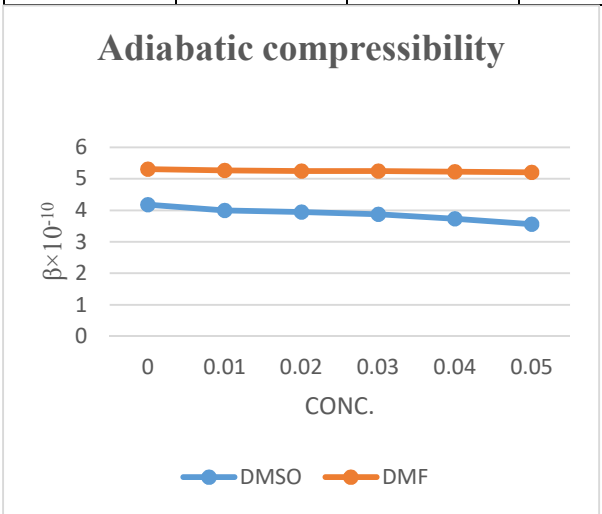


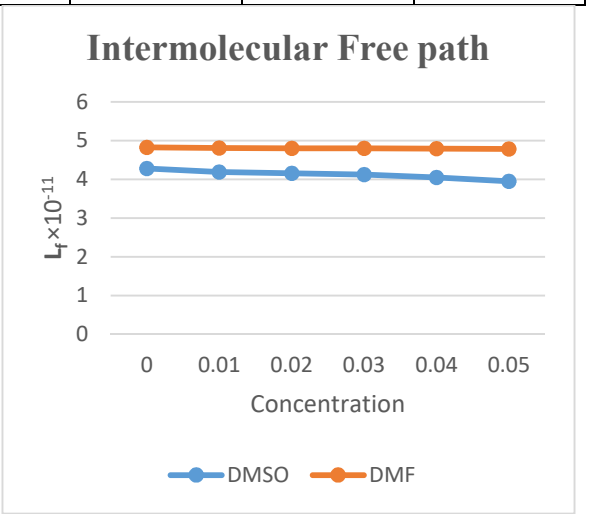
ACOUSTIC PARAMETERS AT 308.15K

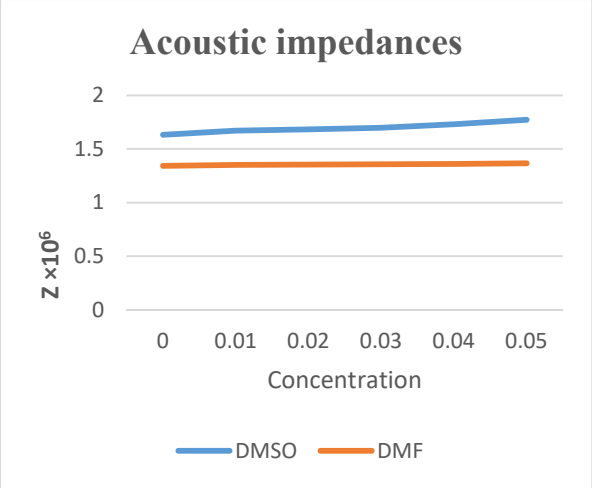
CONC.	DMSO SOLVENT					
	$\beta\times10^{-10}$	$L_f\times10^{-11}$	$Z\times10^{6}$	RA	$\alpha/f^2\times10^{-14}$	$\tau10^{-13}$
0.00	4.17831	4.28096	1.63172	1	3.26772	8.10191
0.01	3.99513	4.18607	1.67005	0.98020	3.15653	7.99729
0.02	3.94112	4.15767	1.68233	0.97505	3.16916	8.07991
0.03	3.87426	4.12223	1.69733	0.96767	3.15910	8.12092
0.04	3.73412	4.04702	1.72946	0.95097	3.03886	7.95428
0.05	3.55532	3.94893	1.77260	0.92821	2.87849	7.72089

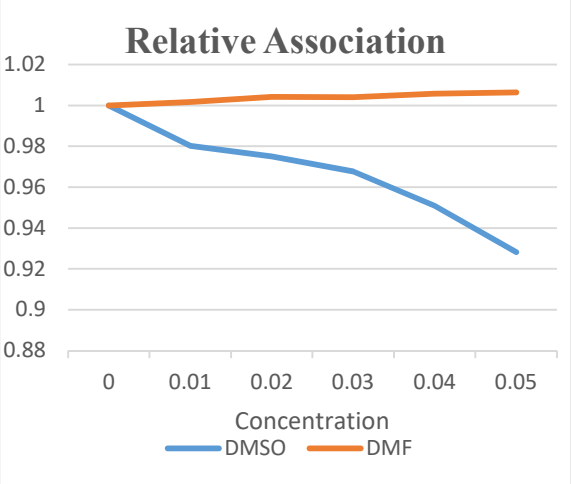
ACOUSTIC PARAMETERS AT 308.15K

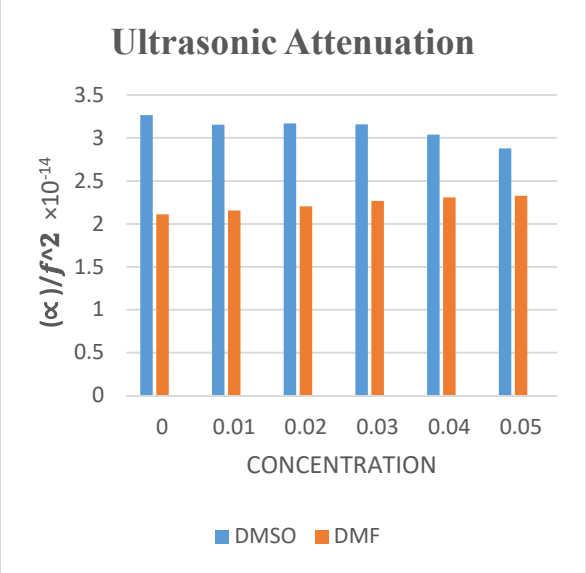
CONC.	DMF SOLVENT					
	$\beta\times10^{-10}$	$L_f\times10^{-11}$	$Z\times10^{6}$	RA	$\alpha/f^2\times10^{-14}$	$\tau10^{-13}$
0.00	5.30578	4.82403	1.34344	1	2.11126	4.97372
0.01	5.27074	4.80809	1.35017	1.00171	2.15577	5.12070
0.02	5.24769	4.79754	1.35523	1.00418	2.20417	5.23901
0.03	5.24262	4.79526	1.35606	1.00408	2.26788	5.39239
0.04	5.22491	4.78715	1.35988	1.00576	2.30964	5.49481
0.05	5.20517	4.77808	1.36359	1.00636	2.32612	5.53992

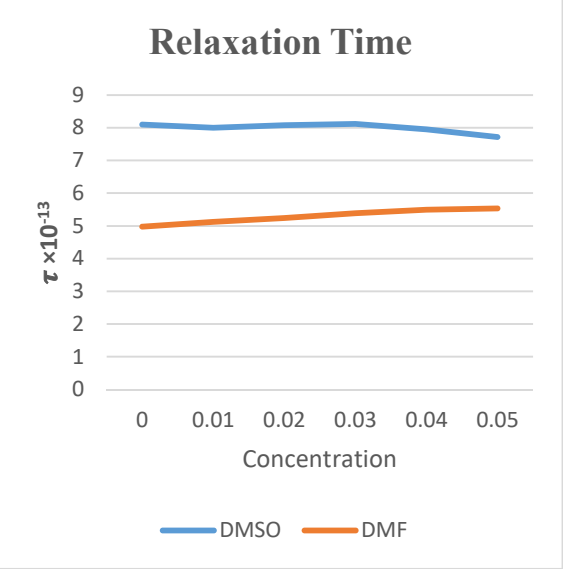












The ultrasonic velocity is continuously increases in both the solvent as concentration increases which indicate that solute and solvent shows strong intermolecular attraction, the ultrasonic velocity is higher in DMSO than DMF due to strong Molecular association in DMSO.

The compressibility factor is decreases if concentration increases because the solute intrinsic effect is more dominant and shows more attachment with solute. In DMSO Compressibility is higher than DMF due to strong interaction of solute and solvent. The intermolecular free path is useful to find out the distance between collision particles. In solution concentration increases the distance between particle decreases and average free path also decrease. In DMSO intermolecular free path is lower than DMF. In case of DMSO some parameter shows variation by increasing concentration which is due to weak and strong interaction of solute and solvent molecules.

However, acoustic impedance, relative association, ultrasonic

attenuation, and relaxation time increase with increasing concentration which indicate that strong intermolecular interaction between solute and solvent molecules.

CONCLUSION:

In this work, the synthesis of (Z)-2-(furane-2-ylmethylene) benzofurane-3(2H)-one and check the physico-chemical properties. It is concluded that, physicochemical properties of a compound depends on nature of solvent and concentration. The temperature also effect on density, viscosity and refractive index. Acoustic parameter was determine interaction between solute and solvent molecules in various concentrations.

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Study on the Synthesis, Characterization and Antimicrobial Activities of 5-Substituted Hydantoins.

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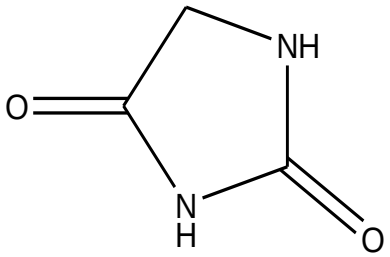
Abstract
Hydantoin, imidazolidine-2,4-dione, demonstrated by its use in a number of clinically authorized medications, including phenytoin, nitrofurantoin, and nilutamide etc. is a highly valued and preferred heterocyclic scaffold in the field of medicinal chemistry. Numerous pharmacological and biological characteristics, such as antibacterial, anticonvulsant, antidiabetic, anticancer, and anti-inflammatory effects, are displayed by the hydantoin scaffold. The main objective of this thorough review is to investigate the potential of hydantoin derivatives as antimicrobial agents and clarify their various mechanisms of action.
Keywords: *Hydantoin, Drugs, Antimicrobial properties, Pharmacophores, Heterocycles, Bioactive molecules, etc.*

Date of Submission: 07-01-2024 Date of acceptance: 20-01-2024

I. Introduction

Hydantoin is a heterocyclic compound with five members, also referred to as imidazolidine-2,4-dione. The class of chemicals that use the hydantoin substructure as a scaffold is generally referred to as "hydantoins" [1]. Heterocyclic-based scaffolds are well known to be extremely useful for finding bioactive molecules.



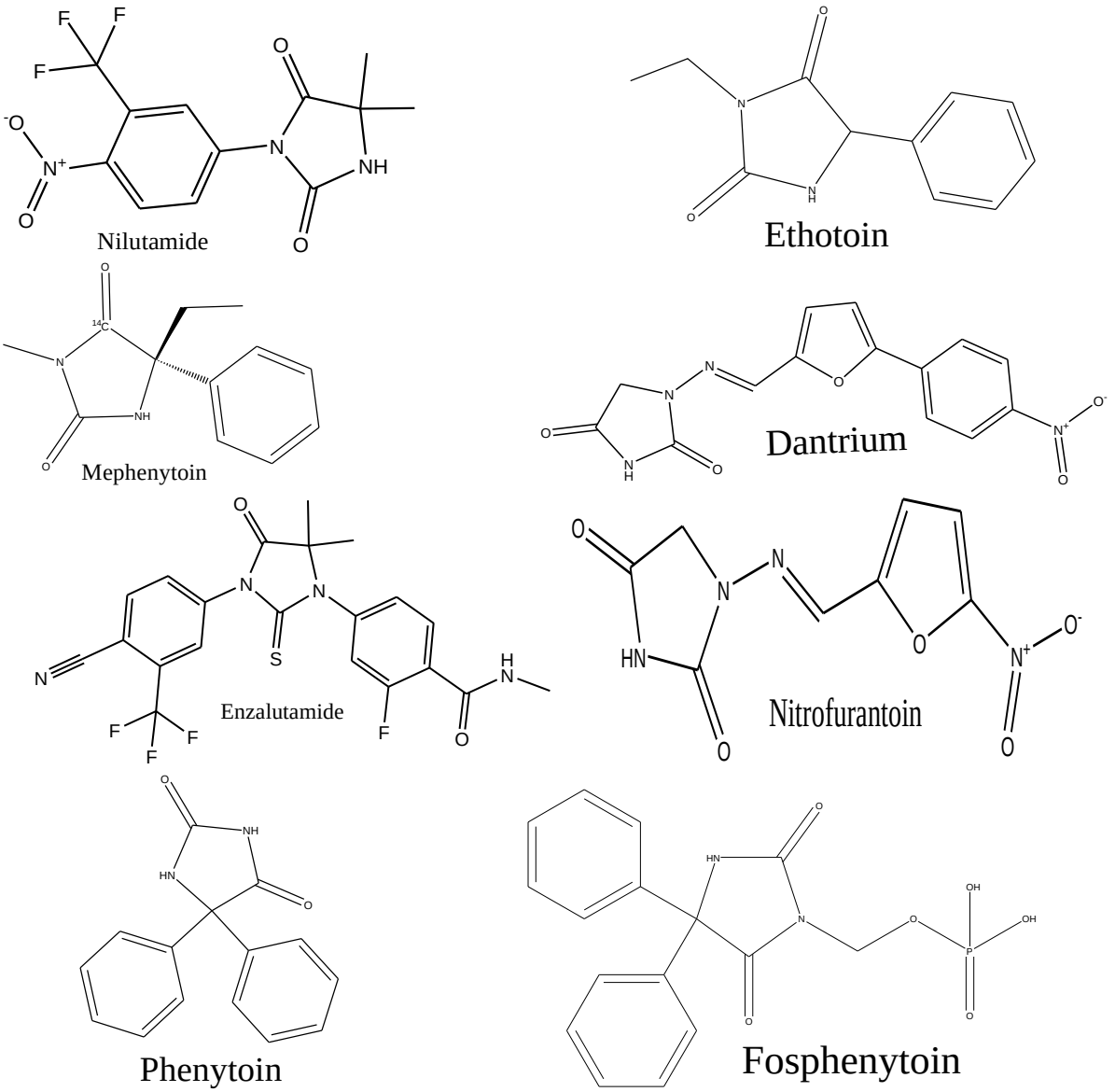
Hydantoin

imidazolidine-2,4-dione

These scaffolds have one carbon atom in the ring structure plus at least one heteroatom, such as nitrogen, sulfur, or oxygen. They may successfully generate intermolecular hydrogen bonds with biological targets thanks to their structural arrangement, which allows them to behave as hydrogen bond donors or acceptors [2]. Consequently, because these compounds have important pharmacophoric moieties or structural features and may find use in business and medicine, they have been thoroughly studied [2].

Hydantoin has four hydrogen donors and acceptors despite its small size [3]. The androgen receptor antagonists nilutamide, andenzalutamide, the muscle relaxants nitrofurantoin and dantrium, and the anticonvulsants phenytoin, mephenytoin,ethotoin, and fosphenytoin are a few examples of clinically approved medications containing the hydantoin moiety [1]. Many pharmacological and biological properties, such as anticancer [4-6], anti-inflammatory [7,8], antidiabetic [9], antibacterial [10,11], adrenoceptor modifying [12–14], anticonvulsant [15,16], antiplatelet [17], and anti-HIV activity [18,19], are exhibited by compounds based on hydantoin. Additionally, there are two widely used synthetic techniques for the manufacture of hydantoin. The first technique uses the Bucherer Bergs reaction, a single-step reaction involving potassium cyanide and ammonium carbonate that makes use of the matching cyclic ketones.

In summary, we described the importance and recent applications of hydantoin, 2-thiohydantoin, and selenohydantoin scaffolds in medicinal chemistry owing to their wide range of pharmacological properties. The data presented herein showed that many drug discovery projects took advantage of the chemical diversifiability and readiness for the synthesis of hydantoin. The hydantoin moiety functioned in two ways, specifically to frame structural components as medicinal scaffolds and pharmacophores as…



Figures: Some Clinically approved drugs containing the hydantoin moiety

Infectious diseases are stay chief deaths cause especially in rising countries, for instance new infectiousdiseases ascend and a developing number of multi-drug resistant strains of microbial pathogens occur [1]

Multidrug resistance indicates acritical function in the letdown of remedy of cancer and infectious illnesses [2]. Microorganisms have developedvarious approaches to face up to the antibiotics poisonous effects and different capsules [3],[4]. Discovery ofchemotherapeutic marketers played a very necessary position in controlling and preventing such diseases. Chemotherapeutic dealers are remoted both from dwelling organisms recognized as antibiotics, or they arechemical compounds organized throughchemist [5],[6]. Hydantoin derivatives have a diversity of biochemical andpharmacological traits and are used to deal with quite a few human ailments and extensive vary of otherpharmacological characteristics.

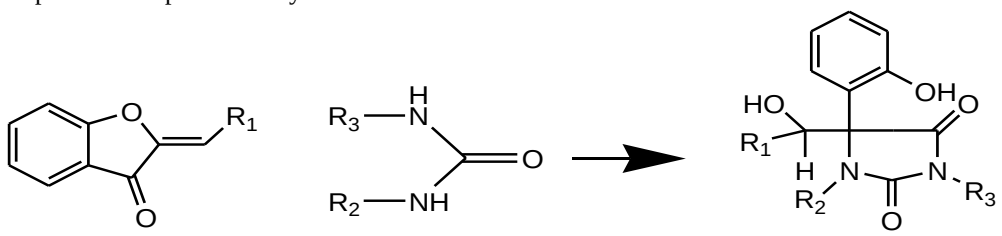
Fujisaki et al. 2013, reportedthe study investigates molecular modifications of new oxazolidinones against Gram-positive and Gram-negative strains. It investigates 4-aminomethyloxazolidin-2-ones, 4-

acylaminomethyloxazolidin-2-one derivatives, twin-drug type molecules, and synthesizes of additional 4-dialkylaminomethyloxazolidin-2-ones.

II. Material and method

All chemicals and reagents used in this research were commercially sourced and of analytical grade. The purity of resultant compoundwas check by using TLC. The IR spectra were recorded in KBr by using FT-(IR Perkin Elmer-Spectrum RX-FTIR). Mass spectra were recordedon mass spectrometer while 1 HNMR wererecorded on FT NMR Spectrometer (BrukerAvance Neo 500 MHz).

General Procedure for synthesis ofhydantoinderivatives: - Equimolar Aurone and N-substituted urea were taking in round bottom flaskalong with KOH and Ethanol as a solvent. Areaction mixture was reflux for few hours. After thisperiod, the mixture was poured in to ice cold waterand filter it by using Buchner funnel and suction pump. The final productrecrystallized with Ethanol.



Synthesis of5-(2-hydroxy-2-(4-methoxyphenyl)ethyl)-5-(2-hydroxyphenyl)-3-methylimidazolidine-2,4-dione (3a):2-(4-methoxybenzylidene)benzofuran- 3(2H)-one reflux withN-methyl ureain presence of KOH and appropriateethanol solvent up to few hours. After completion ofreaction, cooled the mixture and poured in to ice coldwater. The solid product obtained which was filterand washed with dilute HCl and water. The productwas crystallized by using ethanol.

Mol. Formula: $C_{19}H_{20}O_5N_2$: YellowishCrystalline solid. **m. p.** 248°C **yield** 75%, **Elemental analysis** (%): C, 64.04; H, 5.66; N, 7.86; O,22.45; **IR** (KBr cm-1) 3627.5 (OH), 3020 (=CH), 1625(C=N), 1442 (Ar C=C), **ESI-MS[M+H]** + Calculated for$C_{19}H_{20}O_5N_2$: m/z 356.14, 357.14, 358.14; **1 H-NMR**(500 MHz, DMSO) 2.29-2.41 (s, 3H), 2.35 (s, 1H), 3.33 (m, J=8.4,1.1 Hz, 11H), 3.74-4.58(m, 6H).

Synthesisof5-(2-hydroxy-2-(4-methoxyphenyl) ethyl)-5-(2-hydroxyphenyl)-3-phenylimidazolidine-2,4-dione(3b):2-(4-methoxybenzylidene) benzofuran- 3(2H)-one reflux with N-phenyl ureain presence of KOH and appropriate ethanolsolvent up to few hours. After completion of reaction,cooled the mixture and poured in to ice cold water.The solid product obtained which was filter andwashed with dilute HCl and water. The product wascrystallized by using ethanol.

Mol. Formula $C_{24}H_{22}N_2O_5$: faintyellowish Crystalline solid, **m.p.** 258°C, **yield**78%,**Elemental analysis** (%): C,68.89; H,5.30; N, 6.69;O, 19.12; **IR** (KBr cm -1) 3645.5 (OH), 3032 (=CH), 1631 (C=N), 1455 (Ar C=C),**ESI-MS[M+H]**+ Calculated for$C_{24}H_{22}O_5N_2$: m/z 418.15, 419.16, 420.16,**1 H-NMR** (500 MHz, DMSO) 6.0 (s, 1H), 7.08(m, J=8.0,7.0 Hz, 1H), 7.64(m, J=8.3,1.6,0.5 Hz,8H), 7.68 (m, J=8.0,1.4 Hz, 1H).

Antibacterial Assay: The Antibacterial activity was checked by following Zone Inhibition Method (Kirby-Bauer method). The MHA plates were inoculated by spreading with 100 µl of Bacterial culture, *E. coli* (adjusted to 0.5 McFarland Unit - Approx cell density (1.5 X 10^8 CFU/mL) and followed by placing the discs containing 10 µl of different concentration (0 to 100 mg/ml). 10 % of the sample was taken and serially diluted to achieve the required amount to be loaded on the disc. One disc in each plate was loaded with solvent alone which served as vehicle control and Ciprofloxacin disc (10µg) were taken as positive control. The plates of *E. coli* were incubated at 37 °C for 24 hrs. A clear zones created around the disc were measured and recorded.

Antifungal Assay: The Antifungal activity was checked by following Zone Inhibition Method (Kirby-Bauer method). The PDA plates were inoculated by spreading with 100 µl of fungal culture, A. niger (adjusted to 0.5 McFarland Unit - Approx cell density (1.5 X 108 CFU/mL) and followed by placing the discs containing 10 µl of different concentration (0 to 100 mg/ml). One disc in each plate was loaded with solvent alone which served as vehicle control and Amphotericin B (50µg) were taken as positive control. The plates of A. niger were incubated (Basil Scientific Corp. India- Incubator) at 37 °C for 48 hrs. The clear zones created around the disc were measured and recorded.

III. Results and Discussion

Based on the study, in the experimental work when test organism E. coli,A.niger,M. tuberculosis ,S. aureus was exposed with different amounts of disks on agar plate, sample 3a , 3b were found active against E. coli A.niger,M.tuberculosis,S.aureus and shown antibacterial activity against the organisms. Sample **3a** shown zone of inhibition (17mm) around the disk at highest dose of 1000 µg with respect to positive control 23.67 mm diameter zone at 10 µg dose while Sample **3b** shown highest zone of inhibition (6 mm) around the disk at highest dose of 1000 µg with respect to positive control 22.33 mm diameter zone at 10 µg dose.

IV. Conclusion

A novel set of imidazolidine-2, 4-dione compounds **3a** and **3b** have synthesized and characterized successfully. The screening of antimicrobial activity shows that both compounds possess antimicrobial activities. In addition, the objective of the study was succeeded with the promising molecules, which are proving to be a potential treatment of bacterial infection candidates.

Aim of the Study

Synthesis and analyzing for new hydantoin derivative (compound) as a precise antimicrobial action which maybe suitable to be used as chemotherapeutic means.

Acknowledgement

We are thankful to Principal Dr. S.H. Pande and Department of chemistry Shri Shivaji Art's, Commerce and Science College Akot for providing lab equipment's. Also thankful to Shri D. M. Jakate for his cooperation. We are also thankful to CIL and SAIF, Panjab University, Chandigarh for providing spectral data, Aakaar Biotech, Lucknow for providing antimicrobial screening data.

Declaration of Competing Interest

The authors declare no conflict of interest.

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Synthesis and Characterization of 5-Substituted Hydantoins as Potential Antimicrobial Inhibitor: A Review Article

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Abstract: ***This work presents the synthesis, characterization and evaluation of a series of new multifunctional N-substituted hydantoin derivative for their antibacterial and antifungal activity. Elemental analysis, ^{1}H NMR, IR and mass spectroscopy were used to confirm the newly synthesized compound structure. The antibacterial and antifungal properties of each synthesized molecule were examined. The examined compound showed significant to moderate antimicrobial activity against the tested Gram-positive, Gram-negative, and fungal strains. The antimicrobial activities were influenced by the structure and concentration of the tested compounds as well as the type of test microorganisms. The examined hydantoin derivatives seem as drug-like candidate for further evaluation of biological activities examined.***

Keywords: Hydantoin, Drugs, Antimicrobial properties, Pharmacophores, Heterocycles

1. Introduction

The important heterocyclic moiety hydantoin has two nitrogen atoms organized in a five-membered ring and contains nitrogen. Researchers have examined the properties and chemistry of hydantoins and their derivatives for more than 140 years. Many physiologically active compounds contain the hydantoin moiety, which has important medical applications [1]. The synthesis and characterization of hydantoin derivatives, a noteworthy family of heterocyclic compounds, have garnered a great deal of interest [2]. Hydantoin derivatives have been found to have fascinating effects on a range of biological targets [3,4]. Hydantoins have been extensively researched because of their many applications in both medicine and commerce as necessary pharmacophoric moieties or skeletal components. Despite its small size, hydantoin offers four derivatizable areas and four hydrogen donors and acceptors. The activity of hydantoin derivatives is dependent on the location and kind of substitution of hydantoin rings. By altering the hydantoin core at N-1 or N-3, the molecule's properties are changed [5].

Edward and Nielsen looked into the effects of various alkyl and aryl groups on these locations on the hydantoin ring under different circumstances [6]. Furthermore, hydantoins are essential components in the chemical production of artificial and natural amino acids. Derivatives of hydantoin are considered preferred structures in medicinal chemistry and have been used widely. Hydantoins, for instance, are helpful as nonsteroidal antiandrogens (enzalutamide and nilutamide), antibiotics (nitrofurantoin), and anticonvulsants (phenytoin and mephenytoin). the chemical structure of the above-mentioned drugs having hydantoin ring that have received clinical approval.

One of the main components in lowering the burden of infectious diseases worldwide is the use of antimicrobial medications. The consistent rise in antimicrobial resistance is a major global public health concern [7]. The development of novel molecules to combat bacteria and fungi has become one of the most important areas of antibacterial and antifungal research today, as the resistance of dangerous bacteria and fungi to currently available antimicrobial drugs is rapidly becoming a major concern worldwide. For this reason, chemists nowadays face more challenges and demands in their quest to discover novel, potent antibacterial and antifungal drugs. By lowering excessive sPLA2 release, hydantoin derivatives may be able to alleviate symptoms. They have shown strong antibacterial and anti-inflammatory properties [8], [9], and [10].In light of this, and as part of our ongoing research into potential therapeutic compounds [11,12,13,14,15,16].At the same time, some hydantoin derivatives also have applications in the agrochemical area as bactericides, fungicides, and herbicides [17,18,19,20,21].

2. Need of the Study

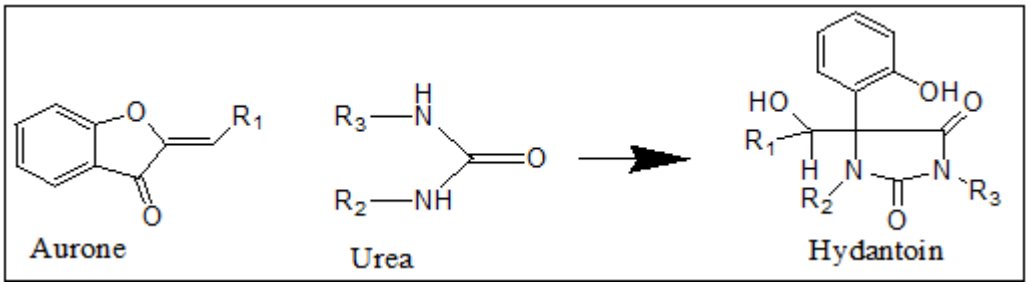
Even with the emergence of new infectious diseases and the growth of multi-drug resistant strains of microbial pathogens, infectious diseases continue to be a leading cause of death, particularly in underdeveloped nations. Antibiotic resistance is now a significant public health issue. The demand to create novel antibacterial and antifungal medicines with improved activity profiles and reduced toxicity is growing due to the quick emergence of resistance to the current antimicrobial medication portfolio [22].
Bacterial antibiotic resistance has emerged, making many antimicrobial drugs used to treat or prevent illnesses less effective [22]. New antimicrobial agents with broad-spectrum activity and a lower risk for the emergence of antibiotic resistance are desperately needed as a result. The major medical problem of bacterial and fungal resistance and the rapid rate at which it develops has therefore made the discovery and development of effective antibacterial and antifungal medications with novel mechanisms of action critical goals for infectious disease research programmers [23, 24]. The current generation of antimicrobial drugs has a number of disadvantages, including toxicity, drug resistance in microorganisms, and limited spectrum of action. The

emergence of novel bacterial pathogens and the development of increasingly effective antimicrobial medications have been the two main areas of research for the creation of new antimicrobial agents. The primary factors in the synthesis of efficacious medications are their rate of activity and structural characteristics. To create the potent antibacterial medication, a heterocyclic molecule has first been considered as a parent compound. Analyzing the extensive body of research on antibacterial literature reveals that heterocyclic compounds have been essential to the area of medicine. The fascinating biological significance of antibacterial pathogens has led to the urgency of drug discovery and the synthesis of new antimicrobial compounds; consequently, the design of new compounds to deal with these problems has become one of the most challenging targets in antibacterial and antifungal research today [25]. As a result, heterocycles are very popular in the field of pharmacology for their unique controlling properties within a drug, such as a solubility, lipophilicity, and polarity, and are also being investigated twice for the discovery of desired active drugs.

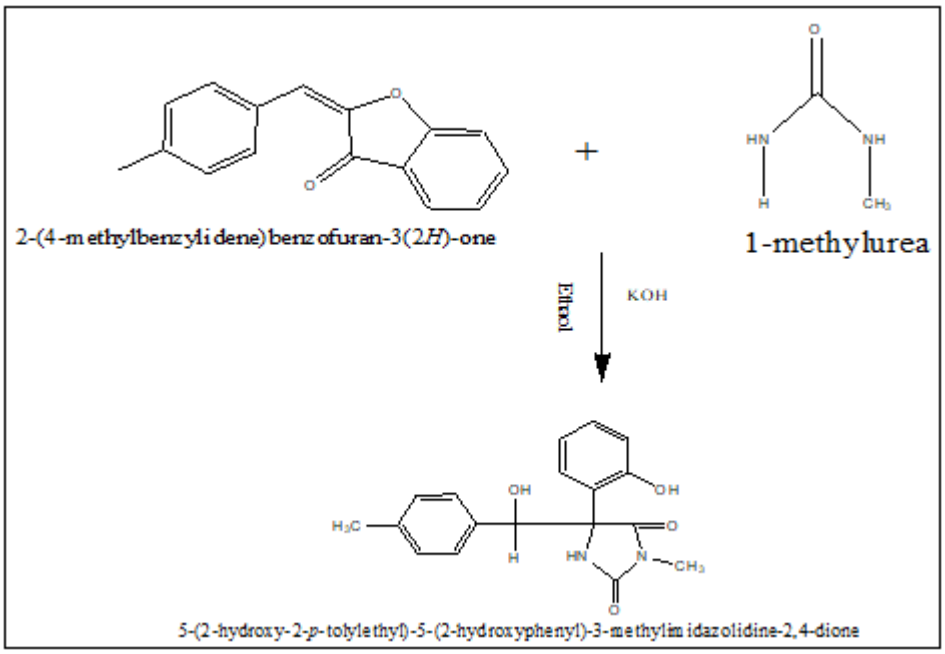
3. Material and methods

All chemicals and reagents used in this research were commercially sourced and of analytical grade. The purity of resultant compound was check by using TLC. The IR spectra were recorded in KBr by using FT-(IR Perkin Elmer-Spectrum RX-FTIR). Mass spectra were recorded on mass spectrometer while 1 HNMR were recorded on FT NMR Spectrometer (BrukerAvance Neo 500 MHz).

General Procedure for synthesis of hydantoin derivatives: - Equimolar Aurone and N-substituted urea were taking in round bottom flask along with KOH and Ethanol as a solvent. Areaction mixture was reflux for few hours. After this period, the mixture was poured in to ice cold water and filters it by using Buchner funnel and suction pump. The final product recrystallized with Ethanol



Synthesis of 5-(2-hydroxy-2-p-tolylethyl)-5-(2-hydroxyphenyl)-3-methylimidazolidine-2,4-dione (3a) :2-(4-methylbenzylidene) benzofuran- 3(2H)-one reflux withN-methyl urea in presence of KOH and appropriate ethanol solvent up to few hours. After completion ofreaction, cooled the mixture and poured in to ice coldwater. The solid product obtained which was filterand washed with dilute HCl and water. The productwas crystallized by using ethanol.



Mol. Formula: $C_{19}H_{20}N_2O_4$: Yellowish Crystalline solid. **m. p.** 244^{o}C **yield** 72%, **Elemental analysis** (%): C, 67.05; H, 5.92; N, 8.23; O,18.80; **IR** (KBr cm-1) 3635.5 (OH), 3018 (=CH), 1629(C=N), 1436 (Ar C=C), **ESI-MS[M+H]** + Calculated for$C_{19}H_{20}O_5N_2$: m/z 340.14, 341.15, 342.15; **1 H-NMR**(500 MHz, DMSO) 2.20-2.30 (s, 3H), 2.25 (s, 1H), 3.03 (m, J=8.4,1.1 Hz, 11H), 3.62-4.65(m, 6H).

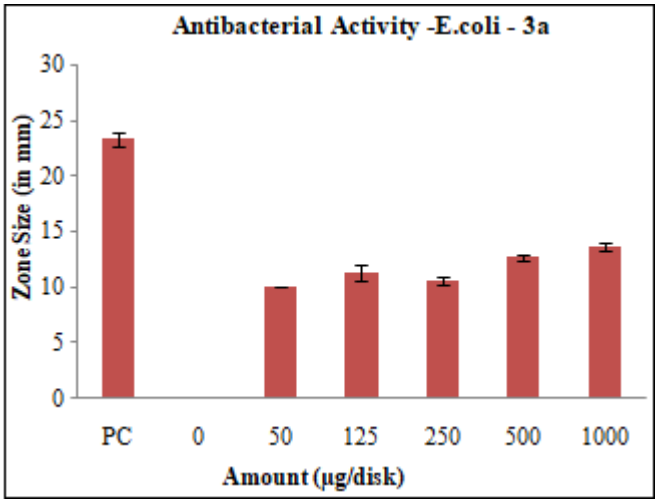
Antimicrobial activity

The disc diffusion technique was used to test for antimicrobial activity against various Gram-positive and Gram-negative bacterial and fungus strains in the newly synthesized compounds. The broth dilution method was used to determine the MIC of these molecules. A careful review revealed that two compounds had antimicrobial activity that was equivalent to that of the reference medications which are broad-spectrum antifungal and antibiotic agents, respectively. Additionally, these two compounds demonstrate lower MIC values against bacterial and fungal strains than reference drugs. Nearly both the drugs showed greater MIC values against Gram-negative bacterial strains than they did against Gram-positive bacterial strains when comparing the two groups of bacteria.

4. Result and Discussion

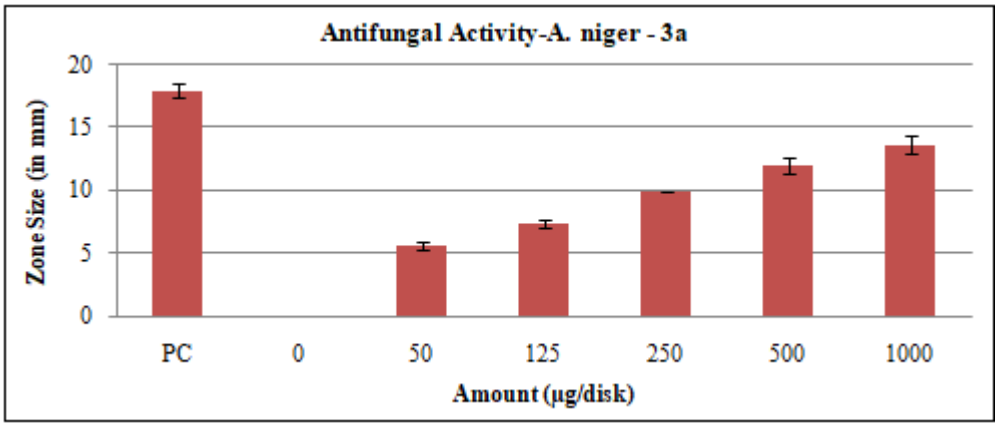
Bioassay	Antibacterial Activity
Test Organism	***E. Coli***
X Axis	Amount (µg/disk)
Y Axis	*Zone Size (in mm)*
Sample code	3a
Title	Antibacterial Activity-E.Coli–3a

Amount (µg/disk)	Plate A	Plate B	Plate C	Average	SD	SEM
PC	24	24	22	23.3333	1.1547	0.6666
0	0	0	0	0	0	0
50	10	10	10	10	0	0
125	10	12	12	11.3333	1.1547	0.6666667
250	11	10	11	10.6667	0.57735	0.3333333
500	13	12	13	12.6667	0.57735	0.3333333
1000	14	13	14	13.6667	0.57735	0.3333333



Bioassay	Antifungal Activity
Test Organism	***A. niger***
X Axis	Amount (µg/disk)
Y Axis	*Zone Size (in mm)*
Sample code	3a
Title	Antifungal Activity-A. niger –3a

Amount (µg/disk)	Plate A	Plate B	Plate C	Average	SD	SEM
PC	18	19	17	18	1	0.57735
0	0	0	0	0	0	0
50	5	6	6	5.66667	0.57735	0.33333
125	7	8	7	7.33333	0.57735	0.33333
250	10	10	10	10	0	0
500	11	13	12	12	1	0.57735
1000	13	15	13	13.6667	1.1547	0.66667



5. Conclusions

To sum up, we created and synthesized hydantoin derivatives in order to find novel substances that inhibit microbes. When these compounds were tested against strains of bacteria and fungi, both of them shown excellent efficacy. Broad-spectrum antibacterial action was demonstrated by the MIC ranges of the compounds against the gram-positive, gram-negative, and fungal pathogens under study.

Aim of the Study

To studies the antimicrobial activities of new hydantoin derivatives which may influenced to be used as chemotherapeutic means.

Acknowledgement

We are thankful to Principal Dr. S.H. Pande and Department of chemistry Shri Shivaji Art's, Commerce and Science College Akot for providing lab equipment's. Also thankful to Shri D. M. Jakate for his cooperation. We are also thankful to CIL and SAIF, Panjab University, Chandigarh for providing spectral data, Aakaar Biotech, Lucknow for providing antimicrobial screening data.

Declaration of Competing Interest

The authors declare no conflict of interest.

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Synthesis, Characterization and Antioxidant Activity of 7, 8-Benzoflavone Derivatives

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ABSTRACT: Heterocyclic compounds are widely known for their medicinal properties. Flavonoids have gained significant attention due to their potent pharmacological behaviour. Flavones among them have been reported to be an important class of heterocyclic compounds possessing a wide range of biological activities. The synthesis of 7,8-benzoflavone derivatives can be challenging due to the complexity of the molecular structure. The precise manipulation of chemical reactions to achieve the desired substitutions at specific positions requires careful planning and optimization. In present work series of ten novel 7,8-benzoflavone have been synthesized by reported literature and tested for antioxidant potential. Structural analysis carried by FTIR, 1HNMR and GCMS. It was found that structural modification and substitution effects on the pharmacological potency. The primary objective of this study is to assess the impact of functional groups on the chemical behavior of benzoflavone derivatives. The present study shows that electron-donating groups exhibit better antioxidant potential and increase radical scavenging. This work introduces new 7,8-benzoflavone derivatives, expanding the chemical diversity of this class of compounds. This contributes to the pool of potential bioactive molecules for further exploration. Depending on the antioxidant activity observed, these novel derivatives might have potential applications in pharmaceuticals, nutraceuticals, or functional foods.

Keywords: Acylation, Esterification, 7,8-Benzoflavone, Antioxidant, Baker-Venkataraman rearrangement, Flavones.

INTRODUCTION

Benzoflavone derivatives are a class of compounds that have gained significant attention in the field of medicinal chemistry due to their diverse pharmacological activities and potential therapeutic applications (Singh *et al.,* 2017; Yahiaoui *et al.,* 2008; Dhawan, 2003; Juvale *et al.,* 2013). The benzoflavone scaffold consists of fused benzene and flavone ring system, which imparts unique structural and chemical properties to these derivatives (Singh *et al.,* 2019; Dong *et al*., 2020; Wang *et al.,* 2008; Rishita *et al*., 2021). This structural design, combined with the flexibility for functional group modifications, offers numerous opportunities for designing and developing novel compounds with enhanced biological activity.

The flavone backbone, commonly found in natural products and plant extracts, possesses a wide range of biological effects, including antioxidant (Stermitz *et al.,* 2001), anti-inflammatory (Boek *et al.,* 2001), anticancer (Ji-Tai *et al.,* 2007; Eisinger *et al.,* 1981; Gupta *et al.,* 2010; Zampieri *et al.,* 2008; Jayashankara *et al*., 2008), antimicrobial (Sharma *et al.,* 2014; Desai *et al*., 2014), and neuroprotective activities (Abid *et al.,* 2009). The incorporation of a benzene ring into the flavone structure further extends the potential pharmacological properties of benzoflavone derivatives. The presence of the benzene ring confers lipophilicity, enabling these compounds to interact with specific cellular targets and exhibit improved drug-like properties.

The biological activities of benzoflavone derivatives have been extensively studied in various disease models and cell-based assays. For instance, these derivatives have shown promising antioxidant potential by scavenging free radicals and inhibiting oxidative stress-induced damage. Moreover, their anti-inflammatory properties have been attributed to the modulation of key inflammatory mediators, such as cytokines, enzymes, and transcription factors.

In addition to their antioxidant and anti-inflammatory effects, benzoflavone derivatives have exhibited significant anticancer activity. They have been reported to inhibit the proliferation of cancer cells, induce apoptosis, and interfere with various signaling pathways involved in tumor growth and metastasis. Furthermore, benzoflavone derivatives have demonstrated antimicrobial activity against both Gram-positive and Gram-negative bacteria, as well as antifungal properties.

The neuroprotective potential of benzoflavone derivatives has also been investigated extensively. These compounds have shown the ability to protect neuronal cells against oxidative stress, neuroinflammation, and neurodegenerative processes.

Furthermore, benzoflavone derivatives have been explored as potential candidates for the treatment of neurodegenerative disorders such as Alzheimer's disease and Parkinson's disease.

Given the broad spectrum of pharmacological activities exhibited by benzoflavone derivatives, they represent an attractive class of compounds for the development of novel therapeutics. However, despite the considerable research efforts in this field, there is still a need for a deeper understanding of the structure-activity relationships and the underlying mechanisms of action of benzoflavone derivatives.

Overall, the study of benzoflavone derivatives offers an exciting opportunity to contribute to the field of medicinal chemistry and drug discovery. By harnessing the unique structural features and biological activities of these compounds, we can pave the way for the development of novel therapeutic agents with enhanced efficacy and reduced side effects, ultimately benefiting patients and improving their quality of life.

MATERIAL AND METHODS

Benzaldehyde (99.5 %), Ethanol, Methanol, acetonitrile was acquired from Avra. 4-nitrobenzaldehyde (98%), Zinc chloride, acetic acid, Benzoic acid (99.9%), 4-chloro benzoic acid (98%), 4-nitro benzoic acid (98%) , 4-methoxy benzoic acid (97%) and 4-bromo benzoic acid were purchased from S D Fine-Chem Ltd. Acetonitrile and Ethyl Acetate (99%) were obtained from Sisco Research Laboratories Pvt. Ltd. All of these reagents were used as received without any further purification.

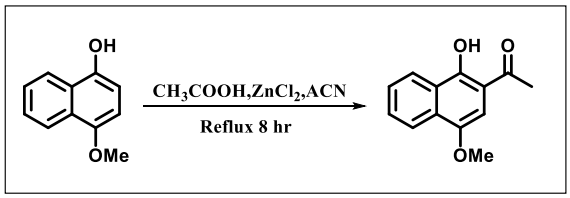
Characterization Techniques. The structure of synthesized compounds was determined by chemical properties elemental analysis and spectral data. The IR spectra were recorded on KBr pellet on SHIMADZU-400 FTIR spectrometer at Shri Shivaji Science College, Amravati, Maharashtra (India). 1H-NMR spectra were recorded on BRUKER AVANCE NEO 500 MHz spectrometer using CDCl3 solvent and TMS as internal standards at SAIF, Punjab University, Chandigarh (India). Chemical shifts are expressed in ppm. Mass spectrums were recorded on Thermo Scientific TSQ 8000 Gas Chromatogram.

Experimental

Stepwise synthesis of benzoflavone

a) Preparation of 1-(1-hydroxy-4-methoxynaphthalen-2-yl)ethan-1-one (1a)

There are different methods for the acetylation of α-naphthol. Here modified Nenchi's method is used for the acetylation reaction (Stoughton, 1935; Blicke et al., 1932; Wadodkar, 1977; Jamode, 1977).Fused zinc chloride (5g) was added in hot glacial acetic acid (34 mmol) and reflux, till dissolved then finely powdered 4-methoxynaphthalen-1-ol (2 mmol) was added with constant stirring and the mixture, was refluxed further for 8 hrs. Then the reaction mixture was cooled and poured in ice cold acidulated water. The solid obtained was filtered, washed with brine solution, and sodium sulphate and recrystallized from rectified spirit **(Scheme 1).**



Scheme 1: Preparation of (1a).

FT-IR: (KBr, ν/cm): 420.43, 485.03, 570.93, 678.94, 790.81, 856.39, 983.70, 1020.34, 1083.99, 1147.65, 1207.44, 1263.37, 1334.74, 1384.89, 1460.11, 1624.06 (C=O, acyl), 1745.58, 1836.23, 1880.60, 1963.53, 2048.40, 2100.48, 2231.64, 2297.22, 2657.91, 2694.56, 2735.06, 2827.64, 2922.16, 3059.10, 3228.84, 3745.76, 3909.71 ,4087.16, 4145.03 ,4281.97, 4415.06, 4642.66. HRMS (m/z): Cal. Mol. Wt.:216.12, Mol. Wt. (Found): 216.08. 1H NMR (ppm): (500 MHz, CDCl3): δ 13.98 (s,1H), 8.411-8.413 (t,1H), 8.394-8.396 (t,1H), 7.66-7.68 (d,1H), 7.54-7.57 (m,1H), 7.44-7.48 (s,1H), 3.45 (s,3H), 2.59 (s,3H)

Plausible mechanism of Acylation. Stepwise mechanism of acylation as shown in Fig. 1. According to literature reports phenols interacts with Lewis's acid $ZnCl_2$ and simultaneously, the acetic acid comes in vicinity via chelation. Due to chelation the electrophilic nature of carbonyl carbon of acetic acid increases.

Then the nucleophilic attack of the pi-bond on the carbonyl carbon generates the unstable tetrahedral intermediate.

Lastly, the unstable tetrahedral intermediate undergoes rearrangement to forms desired product by removal of water molecule and deprotonation (Fig. 1).

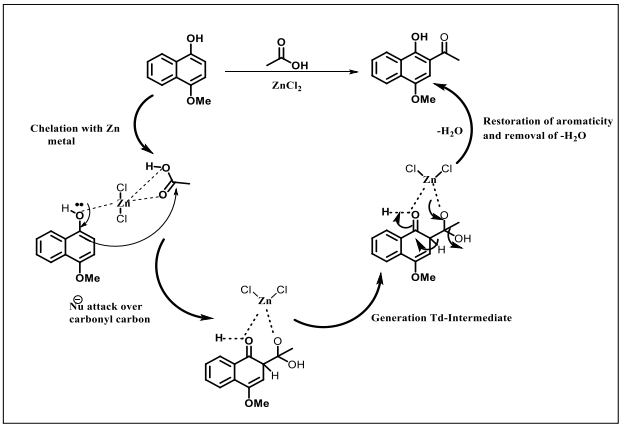
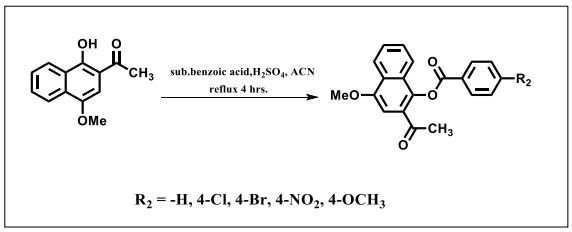


Fig. 1. Plausible mechanism of Acylation.

b) Esterification of 1-(1-hydroxy-4-methoxynaphthalen-2-yl)ethan-1-one with substituted aromatic acids to obtain esters (2a-e)

Esterification is a chemical reaction that involves the formation of an ester from a carboxylic acid and an alcohol, typically in the presence of an acid catalyst. Numbers of methods are available for esterification of phenols and alcohols with organic acids (Wadodkar *et al*., 1972; Doyle *et al*., 1948; Doifode, 1965). Esterification reactions are often conducted under reflux conditions, where the reactants are heated in the presence of an acid catalyst, such as sulfuric acid or hydrochloric acid. The acid catalyst protonates the carboxylic acid, making it more reactive towards the

alcohol. Products are confirmed by FTIR, NMR and GCMS characterization. General scheme for the synthesis of esters is given as below **(Scheme 2).** Structures of synthesized esters are shown in Table 1.



Scheme 2: Preparation of (2a-e)

a) 2-acetyl-4-methoxynaphthalen-1-yl benzoate (2a). FT-IR: (KBr, ν/cm): 420.48, 495.71, 559.36, 684.73, 794.67, 858.32, 931.62, 979.84, 1018.41, 1082.07, 1139.93, 1199.72, 1276.88, 1321.24, 1406.11, 1618.28 (C=O, Acyl), 1683.86 (C=O, benzoyl) , 1926.89, 2094.69, 2304.94, 2566.33, 2669.48, 2748.56, 2835.36, 2914.44, 3061.03, 3736.12, 3880.78, 4067.87, 4143.10, 4193.25, 4264.61, 4405.42, 4494.14, 4573.22. GCMS (m/z):Cal. Mol. Wt.: 321.03 Mol. Wt. (Found): 320.06. ^{1}H NMR (ppm): (500 MHz, $CDCl_3$): δ 14.05 (s,1H), 12.25 (s,1H), 8.47-8.48 (s,1H), 8.16-8.17 (d,2H), 7.74-7.76 (d,1H), 7.60-7.64 (t,2H), 7.51-7.58 (m,1H), 7.48-7.49 (d,1H), 7.23 7.25 (d,1H), 3.45 (s,3H), 2.67(s,3H)

b) 2-acetyl-4-methoxynaphthalen-1-yl 4-chlorobenzoate (2b). FT-IR: (KBr, ν/cm): 384.55, 418.55, 476.42, 563.21, 677.01, 798.53, 852.54, 929.69, 979.84, 1022.27, 1089.78, 1134.14, 1203.58, 1284.59, 1323.17, 1409.96, 1620.21 (C=O, Acyl) , 1681.93 (C=O, benzoyl), 1878.67, 1932.67, 2102.41, 2154.49, 2297.22, 2571.11, 2669.48, 2835.36, 2999.48, 2835.36, 2929.87, 3014.74, 3061.03, 3734.19, 3880.78, 4079.45, 4164.31, 4270.40, 4335.98, 4378.41, 4407.34, 4478.71, 4570.10**.** GCMS (m/z): Cal. Mol. Wt.: 353.12
Mol. Wt. (Found): 354.44. ^{1}H NMR (ppm): (500 MHz, $CDCl_3$): δ 13.99 (s,1H), 8.41-8.43 (s,1H), 7.70-7.71 (d,1H), 7.55-7.60 (m,2H), 7.47-7.50 (m,1H), 7.19-7.23 (t,1H), 3.45 (s,3H), 2.63(s,3H)

c) 2-acetyl-4-methoxynaphthalen-1-yl 4-bromobenzoate (2c). FT-IR: (KBr, ν/cm): 353.95, 420.50, 474.51, 564.20, 678.97, 800.49, 856.43, 927.80, 985.67, 1015.57, 1081.15, 1134.19, 1278.86, 1234.19, 1411.95, 1617.38, 1684.80, 1830.52, 1880.68, 1938.54, 2100.57, 2244.27, 2299.25, 2574.12, 2675.38, 2841.27, 2920.35, 3021.02, 3062.13, 3721.81, 3767.14, 3914.70, 3970.64, 4075.76, 4150.99, 4269.62, 4330.38, 4416.21, 4573.42
GCMS (m/z):Cal. Mol. Wt.: 400.01, Mol. Wt. (Found): 399.71.^{1}H NMR (ppm): (500 MHz, $CDCl_3$): δ 14 (s,1H), 8.43-8.45 (m,1H), 7.73-7.74 (d,1H), 7.59-7.62 (q,2H), 7.50-7.53 (m,1H), 7.24-7.25 (d,1H), 3.45 (s,3H), 2.67 (s,3H).

d) 2-acetyl-4-methoxynaphthalen-1-yl 4-nitrobenzoate (2d). FT-IR: (KBr, ν/cm): 422.21, 511.14, 567.07, 678.94, 719.45, 798.53, 860.25, 931.62, 981.77, 1020.43, 1126.43, 1207.44, 1286.52, 1328.95, 1415.75, 1614.42 (C=O, acyl), 1691.57 (C=O, benzoyl), 1824.66, 1876.74, 1957.75, 2090.84, 2144.84, 299.15,2 553.75,2 667.55,2 841.15,2 924.09,3 010.88,3 064.89, 3111.18, 3741.90, 3886.56, 4046.66, 4094.88, 4299.88, 4287.76, 4335.98, 4413.13, 4494.14, 4582.87.GCMS (m/z):Cal. Mol. Wt.: 364.15, Mol. Wt. (Found): 365.30.^{1}H NMR (ppm):(500 MHz, $CDCl_3$): δ14.03 (s,1H), 8.47-8.49 (d,1H), 7.76-7.78 (d,1H), 7.63-7.65 (t,2H), 7.53-7.56 (t,1H), 7.27-7.28 (d,1H), 3.45 (s,3H), 2.71(s,3H)

e) 2-acetyl-4-methoxynaphthalen-1-yl 4-methoxybenzoate (2e). FT-IR: (KBr, ν/cm): 419.54, 479.33, 563.24, 682.83, 745.52, 796.64, 862.22, 896.94, 980.84, 1024.25, 1086.93, 1149.62, 1271.14, 1308.76, 1408.10, 1461.14, 1621.24 (C=O, acyl), 1682.96 (C=O, benzoyl), 1832.45, 1963.62, 2094.78, 2301.18 2667.06, 2922.28, 3063.09, 3732.42, 3880.94, 3960.03, 4103.73, 4193.43, 4281.19, 4340.99, 4414.26, 4499.16.GCMS (m/z): Cal. Mol. Wt.: 349.29. Mol. Wt. (Found): 350.02

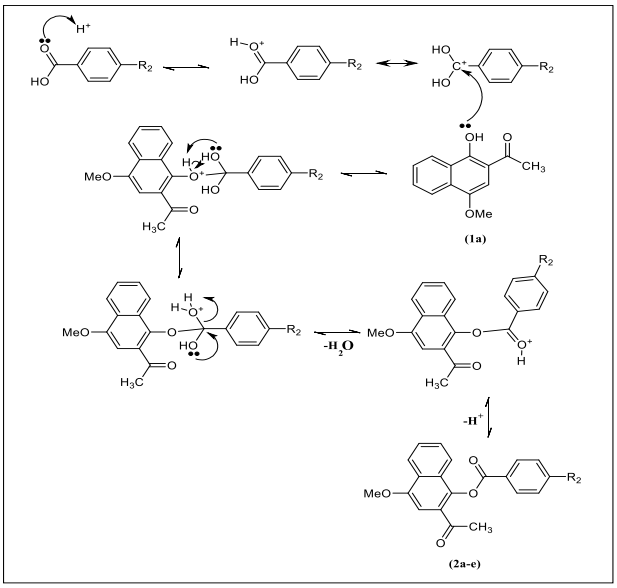


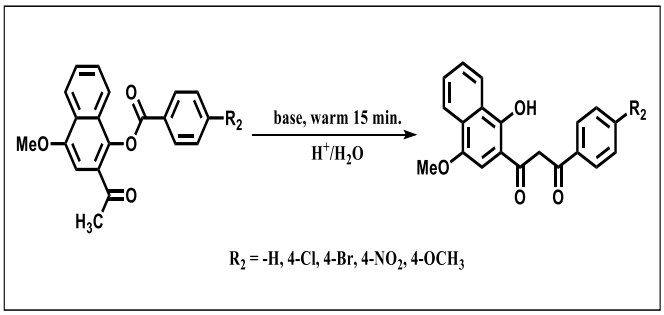
Fig. 2. Plausible mechanism of aromatic acids.

Plausible mechanism of esterification of aromatic acids. Esterification, in general is an acid catalysed process which involves an addition elimination mechanism. Carboxyl oxygen gets protonated by

H_2SO_4 to give delocalized carbocation making the carbocation a better electrophile. A proton is transferred to one of the hydroxyl groups to form a good leaving group. The hydroxy group's alcohol oxygen atom donates a pair of electrons to a carbon atom which makes a π bond by eliminating water. This reaction is possible only at reflux temperature (Fig. 2).

c) The Baker-Venkatraman transformation of esters to obtain (3a-e). Baker-Venkataraman is a base catalysed intramolecular Claisen condensation between ester and methyl ketone. Many bases have been reported but pyridine is found most suitable (Bourne *et al.,* 1949; Kumar *et al.,* 1999; Maiti *et al.,* 2011; Sarda *et al.,* 2006; Pandya *et al.,* 2012). This step involves the conversion of ester into diketones in presence of basic medium. This step follows Baker-Venkataraman rearrangement mechanism **(Scheme 3).**

Structures and spectral data of compounds (3a-e) is shown in Table 2.



Scheme 3: Preparation of (3a-e)

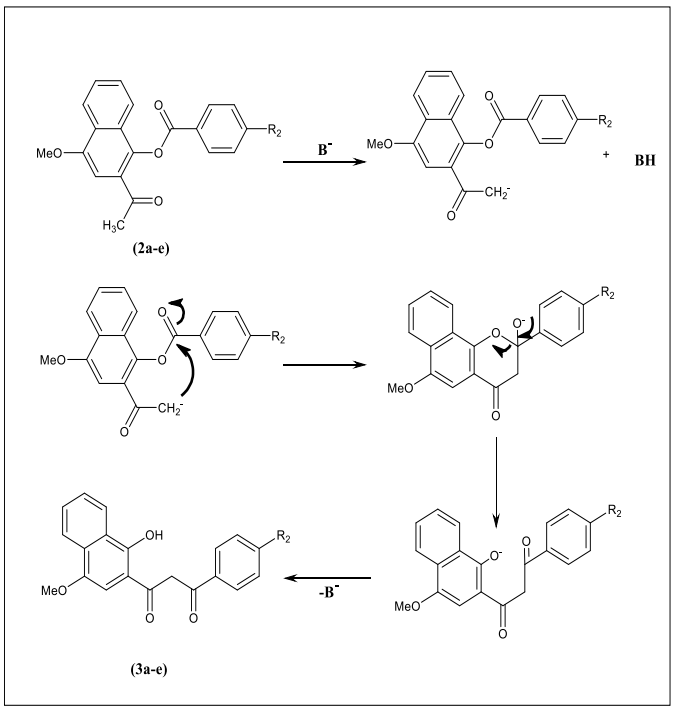
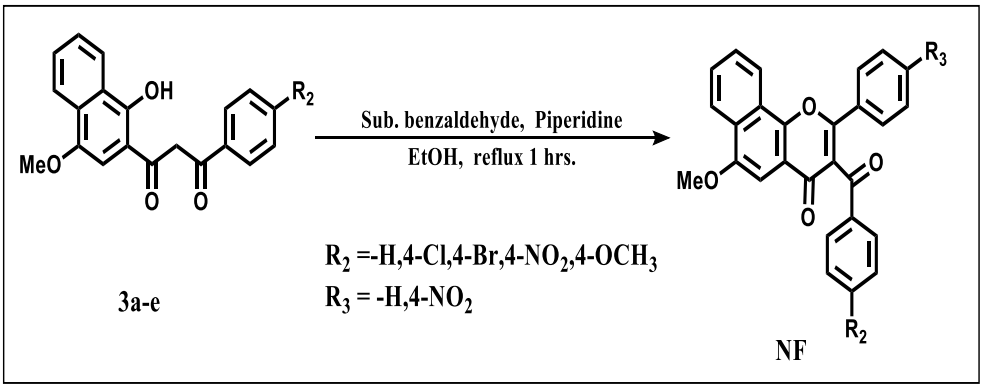


Fig. 3. Plausible mechanism of Baker-Venkataraman rearrangement.

Plausible mechanism of Baker-Venkatraman rearrangement. This mechanism involves an intramolecular Claisen Condensation between an ester and methyl ketone (Khanapur *et al*., 2015). Base abstracts α-proton to form enolate which subsequently attack on carbonyl of ester to form tetrahedral intermediate. Upon workup it forms β-diketones (Fig. 3).

d) Synthesis of benzoflavone derivatives (NF1-NF10). Literature survey already showed that there are various synthetic routs for 7,8-benzoflavone synthesis. Structure modification plays significant role in enhancing the biological potential (Yahiaoui *et al.,* 2008; Rokade *et al.,* 2009; Cushnie *et al.,* 2011; Yoon *et al*., 2012; Juvale *et al.,* 2013; Singh *et al.,* 2017; Vhanale *et al.,* 2019). To a mixture of glacial acetic acid and fused zinc chloride 4-methoxynaphthalen-1-ol was added under reflux condition to form 1-(1-hydroxy-4-methoxynaphthalen-2-yl)ethan-1-one **(1a)**, which further on acid catalyzed esterification with variously substituted benzoic acids gives benzoylated products **(2a-e)**. Under Baker-Venkataraman reaction condition esters are rearranged to 1, 3-diketones **(3a-e)**. Diketones on reaction with substituted aromatic aldehydes under aldol conditions followed by cyclization using suitable cyclizing agent converted to 7,8-benzoflavones **(Scheme 4).**



Scheme 4. Synthesis of Benzoflavones.

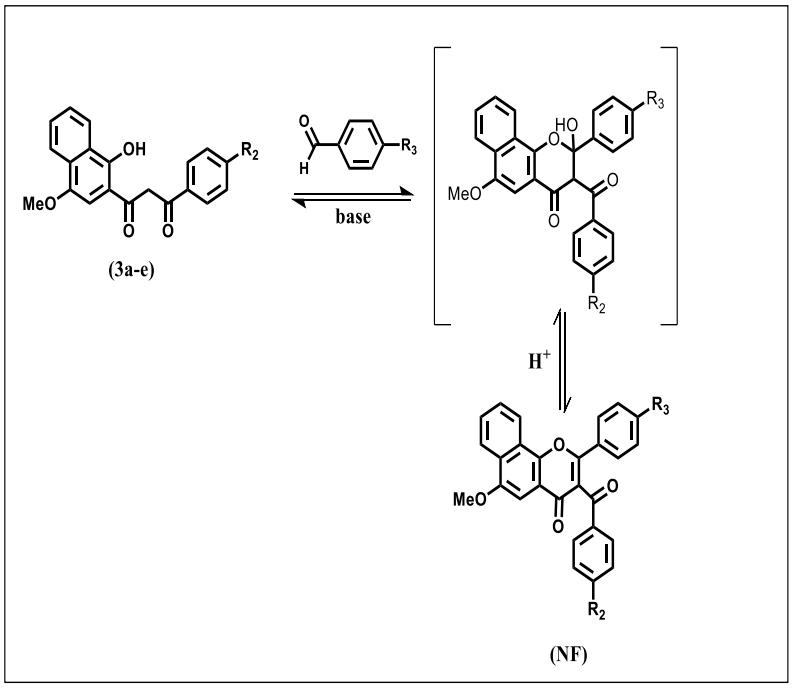


Fig. 4. Plausible mechanism of benzoflavone synthesis.

Structures and spectral data of compounds (NF1-NF10) are shown in Table 3.

Plausible Mechanism of benzoflavone synthesis. It was reported the possibility of the formation of an α-aroylchalcone as an intermediate which under the experimental conditions cyclizes to give the flavone (Chicholkar, 1981). Flavones are usually synthesized from β-diketones by refluxing them with acetic acid and H_2SO_4. This method involves base catalyzed piperidine cyclization. Structures are confirmed by spectral data. The reaction probably proceeds via intermediate flavanone which decomposes to flavone (Fig. 4).

Biological Investigation of benzoflavone derivatives.

Antioxidant activity. An antioxidant may be defined as "any substance that when present at low concentration, compared with those of the oxidizable substrate significantly delays or inhibits oxidation of that substrate."

Method: DPPH Free Radical Scavenging Assay.

Preparation of Sample: The free-radical scavenging activity was estimated by DPPH assay. The reaction mixture contained 10 µl of test sample and positive control ascorbic acid with 10 mg concentration and 190 µl of methanolic solution of 0.1 mM DPPH radical. The mixture was then shaken vigorously and incubated at 37 °C for 5 min. The absorbance was measured at 517 nm on ELISA plate reader indicated higher free radical scavenging activity, which was calculated using the following equation:

Antioxidant Potential of synthetic compounds. The antioxidant activities of benzoflavone derivatives were successfully assessed using the free radical scavenging assay. The results are shown in the Table 4 and Fig. 5.

$$\frac{\text{(\%) Free radical scavenging effect [Control Absorbance(Ac) - Sample Absorbance(As)]}}{\text{Control Absorbance(Ac)}} \times 100$$

Table 1: Structure of compounds (2a-2e).

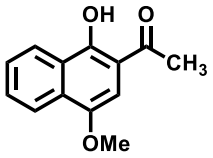
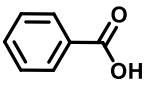
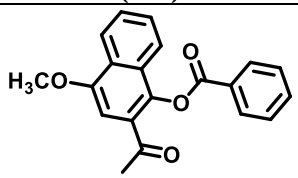
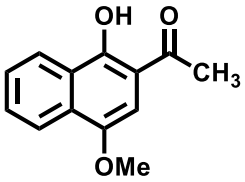
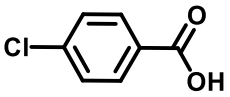
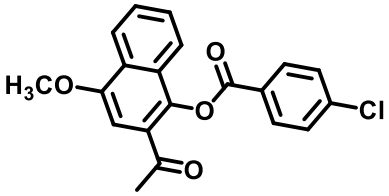
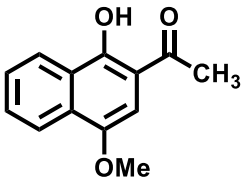
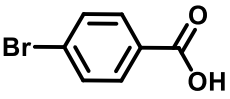
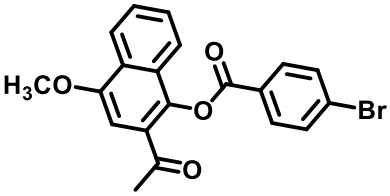
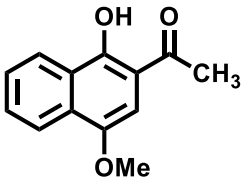
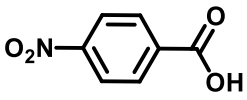
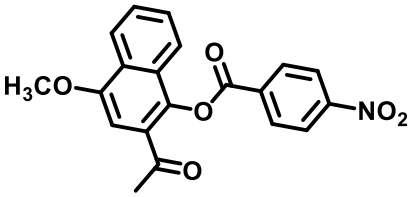
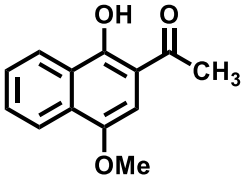
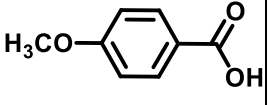
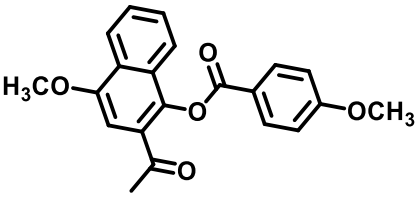
(1a)	(R_2)	(2a-e)
		 (2a)
		 (2b)
		 (2c)
		 (2d)
		 (2e)

Table 2: Confirmation of compounds by ^{1}HNMR and GCMS.

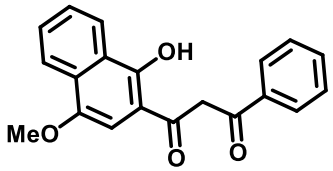
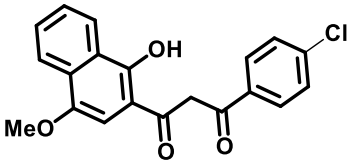
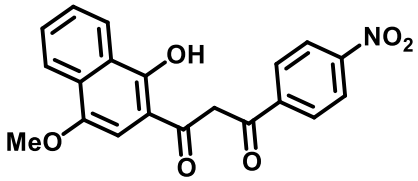
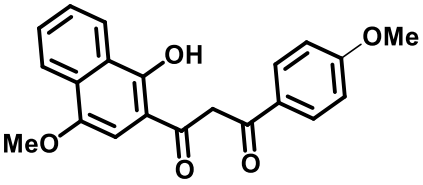
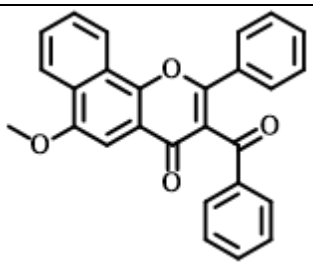
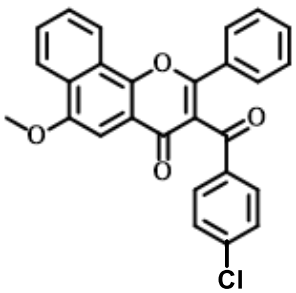
Structure and code of product	Confirmation by ^{1}HNMR and GCMS
 **(3a)**	^{1}H NMR (ppm): (500 MHz, $CDCl_3$): δ 11.04 (s, 1H), 8.59 (s,1H), 8.38 (s,2H), 7.96 (s,1H), 7.82-7.39 (m, 3H), 6.02 (s,1H), 3.81 (s,2H), 3.79 (s,3H).GCMS(m/z): Cal.Mol.Wt.: 320.00 Mol. Wt. (Found): 320.57
 **(3b)**	GCMS (m/z): Cal. Mol. Wt.: 355.01 Mol. Wt. (Found): 354.02
 **(3d)**	^{1}H NMR (ppm): (500 MHz, $CDCl_3$): δ 11.03 (s,1H), 8.40 (d,2H), 8.31-8.32 (d,2H), 7.37-7.40 (t,2H), 7.26-7.27 (d,2H) 6.69-7.00 (d,2H) ,6.02 (s,1H), 3.81 (s,2H), 3.74 (s,3H)
 **(3e)**	GCMS (m/z): Cal. Mol. Wt.: 351.02 Mol. Wt. (Found): 350.35

Table 3: Confirmation of compounds by ^{1}H NMR and GCMS.

Structure and code of product	Confirmation by ^{1}HNMR and GCMS
 **NF1**	^{1}H NMR (ppm): (500 MHz, $CDCl_3$): δ 8.12-8.13 (d,2H), 8.11-8.12 (d,2H), 7.97-7.99 (t,3H), 7.89-7.88 (d,1H), 7.65-7.69 (m,5H), 7.03-7.06 (d,1H), 5.70 (s,1H), 3.64 (s,3H) GCMS (m/z): Cal. Mol. Wt.: 406.04 Mol. Wt. (Found): 405.11
 **NF2**	**GCMS (m/z):** Cal. Mol. Wt.: 440.08 Mol. Wt. (Found): 440.31

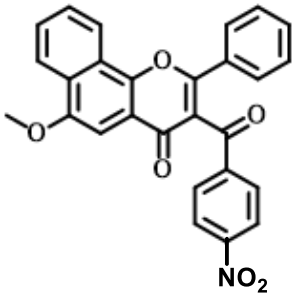
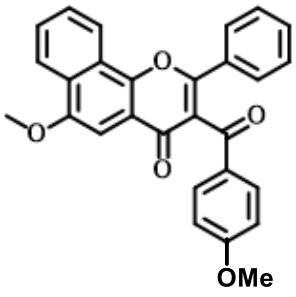
 **NF3**	^{1}H NMR (ppm): (500 MHz, $CDCl_3$): δ 8.32-8.33 (d,2H), 8.29-8.30 (d,2H), 8.12-8.13 (d,2H), 8.11-8.12 (d,2H), 7.89-7.99 (m,4H), 7.65-7.69 (M,1H), 7.03-7.09 (d,2H), 5.70 (s,1H), 3.64 (s,3H)
 **NF4**	**GCMS (m/z):** Cal. Mol. Wt.: 451.11 Mol. Wt. (Found): 450.22

Table 4: % Antioxidant Potential using DPPH Assay Method (Conc. used 1 mg).

Compound Code	R		Antioxidant Potential (%) (Mean±SD)
	R^2	R^3	
NF1	-H	-H	34.265±1.32
NF2	4-Cl	-H	16.552±1.56
NF3	4-Br	-H	30.2.06±2.11
NF4	4-NO_2	-H	18.065±0.55
NF5	4-OCH_3	-H	36.546±1.22
NF6	-H	4-NO_2	12.852±1.45
NF7	4-Cl	4-NO_2	12.323±1.58
NF8	4-Br	4-NO_2	13.121±1.45
NF9	4-NO_2	4-NO_2	39.125±1.14
N10	4-OCH_3	4-NO_2	-
Standard	+Ve Control (Ascorbic acid)		86.78±2.15

*All the data statistically analyzed with mean±SD (n=3)

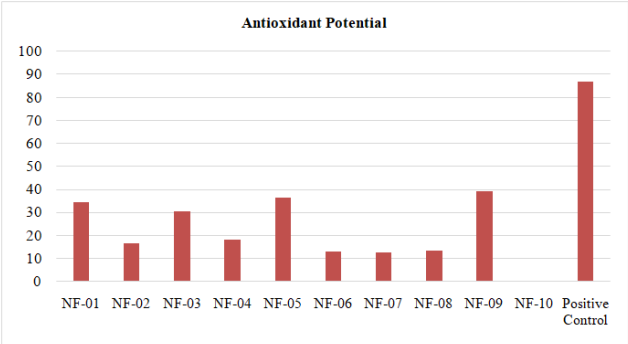


Fig. 5. Graphical representation of antioxidant potential of benzoflavones.

RESULTS AND DISCUSSION

The synthesis of novel 7,8-benzoflavone derivatives was successfully achieved through a multi-step synthetic routes. Structural characterization was carried out using a combination of spectroscopic techniques.

The antioxidant activity of the synthesized 7,8-benzoflavone derivatives was assessed using DPPH assay method. The observed antioxidant activity suggests that the modifications made to the benzoflavone scaffold influence its ability to scavenge free radicals and mitigate oxidative stress.

CONCLUSIONS

In the present work, we investigated that the benzo ring at the C-7 and C-8 positions of the flavone structure is a promising moiety that can synthesize compounds such as 7,8-benzoflavone derivatives that are likely to exhibit promising biological activities. Furthermore, the benzo

ring inflection of the 7,8-benzoflavones structure intentionally incorporation of methoxy (OMe) and hydroxyl (-OH) group over the ring. Which enhances the strong biological activities.

FUTURE SCOPE

On the basis of reported literature and present work, we have synthesized the 7,8-benzoflavone but in future researchers could take the advantages to this protocol to synthesized novel benzoflavones.

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Conflict of Interest. None.

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डॉ. एम. के. नन्नावरे
सहयोगी प्राध्यापक व
अर्थशास्त्र विभाग प्रमुख,
पदव्युत्तर अर्थशास्त्र विभाग,
श्री शिवाजी कला, वाणिज्य
व विज्ञान महाविद्यालय,
आकोट जि. अकोला
(महाराष्ट्र)

गडचिरोली जिल्ह्यातील औद्योगिक विकासाचे वास्तव उपयोजन

ABSTRACT

औद्योगिक विशेषतः सेवा क्षेत्राच्या विकासाचे फलित म्हणजे दरडोई उत्पन्नात वाढ हेच आहे. मेलर यांनी कृषी विकास सिद्धांतात स्पष्ट केले की, कृषीतील वाढती गुंतवणूक ही औद्योगिक विकासाला चालना देते ज्यामुळे विकास प्रक्रियेला गती येतेयासाठी . मागास भागामध्ये कृषी क्षेत्रात गुंतवणूक होणे आवश्यक आहे. अतिमागास भागातील औद्योगिक व सेवा क्षेत्राचा मर्यादित विकास झाल्याने कृषीवर आधारित रोजगार, तसेच कृषी सिंचन कमी असल्याने कृषीचा कमी विकास, परिणामी उत्पन्न वाटा कमी अशी स्थिती आढळतेदरडोई उत्पन्न व राज्य उत्पन्न वाटपात विषमता व असमतोलपणा . .मोठ्या प्रमाणात आहे

संशोधन पद्धती व उद्देश

शोधनिबंध हा विश्लेषणात्मक, गुणात्मक, पद्धती व दुय्यम आधारसामग्रीवर आधारित आहेअर्थ व . सांख्यिकी संचालनालय, महाराष्ट्र शासन या संकेतस्थळावरील सांख्यिकीय माहिती व माहितीचे विश्लेषण करण्यासाठी आकडेवारीचा वापर करुन निष्कर्ष काढून शिफारशी व उपाययोजना केलेल्या आहेतगडचिरोली जिल्ह्यातील औद्योगिक विकासाचा . वास्तव अभ्यास करण्यासाठी शोधनिबंधाचे ऐतिहासिक व नैसर्गिक पार्श्वभूमी, भौगोलिक व लोकसंख्यिकीय, उत्पन्न व रोजगार निर्मिती, औद्योगिक विकास व रोजगाराचे वास्तव याचा अभ्यास करणे इ.उद्देश आहेत .

ऐतिहासिक व नैसर्गिक पार्श्वभूमी

गडचिरोली जिल्ह्याची निर्मिती चंद्रपुर जिल्ह्याचे विभाजन करुन २६ ऑगस्ट १९८२ रोजी झालीशेती . प्रमुख व्यवसाय असला तरी यातून ९६ टक्के भाताचे पीक होत असल्याने भात गिरण्यांची संख्या जास्त आहे. जिल्ह्याचा ८९ टक्के भूभाग वनक्षेत्रात येतो. त्यातील .७५९६ टक्के भाग वनव्याप्त आहेगडचिरोली जिल्हा . .हा घनदाट जंगलासाठी प्रसिद्ध आहे त्यामुळे या ठिकाणी मोठ्या प्रमाणात वनउपज आढळतातदरवर्षी . बांबू, तेंदूपानाच्या व्यवसायामधून शेकडो कोटींची उलाढाल होतेयाशिवाय साग ., बिजा, शिशम, हळदू, मोहफूल, चार, धाबडा, बेहडा, आवळासारख्या असंख्य गौण वनौषधी येथील जंगलात आढळतातअनुसूचित क्षेत्र . (पेसा) कायदयाच्या तरतुदीमुळे ग्रामसभा, वनसमिती वनहक्कसारखे कायदे, संस्था निर्माण करण्यात आल्या . लोहखनिजाचे मुबलक साठे असूनही जिल्ह्यात त्यावर आधारित उद्योग सुरु करता आला नाही. त्यामुळे .गडचिरोलीला मागास जिल्हा अशी ओळख मिळाली

भौगोलिक व लोकसंख्यिकीय वैशिष्ट्ये

२०११च्या जनगणनेनुसार, जिल्ह्याची एकूण लोकसंख्या १०,७१,७९५ असून ३८६७ टक्के लोकसंख्या . .अनुसूचित जमातीची आहेत्यामुळे आदिवासी जिल्हा अशी ओळख आहेलोकसंख्येच्या ८९ टक्के नागरिक . .आजही ग्रामीण भागात राहतात. साक्षरतेचे प्रमाण ७०६० टक्के एवढे आहे.

उत्पन्न व रोजगार निर्मिती

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स्वरुपात नसून ती बुध्दीपुरस्पर म्हणजे वैचारिक स्वरुपात आहे ही जागृती करुन गरिबी विषयीच्या आणि वर्तनाविषयीच्या अध्ययनातून दारिद्य निर्मुलनासाठी प्रयत्न होणे अत्यंत आवश्यक आहे.

४) ग्रामीण रोजगार हमी योजनेची अंबलबजावणी प्रभावीपणे करण्यासाठी प्रशासन यंत्रणा अधिक कार्यक्षम बनविण्याकरिता खेडे, तालुका व जिल्हा स्तरावरील यंत्रणा अधिक सक्षम बनविण्याची गरज आहेदरवर्षी जो . एकूण निधी उपलब्ध करुन दिला जातो त्या निधीचा पुरेपूर वापर करावा त्यामुळे रोजगारात वाढ व ग्रामीण विकास या दोन्ही गोष्टी साध्य करता येतील.

५) गडचिरोली जिल्हयाचा पाहिजे तसा औद्योगिक विकास झालेला नाही अशावेळी या जिल्हयात उद्योग उभारणीसाठी झुकते माप द्यावे जेणेकरुन या जिल्हयांचे दरडोई उत्पन्न वाढेल त्याचबरोबर औद्योगिक विकासात वाढ करण्यासाठी बचत गट व बँकांनी सहकार्य करावे . शेतीला सहाय्यभूत व पूरक असणाऱ्या उद्योगांची व बिन व्याजी किंवा अल्प व्याजदराने भांडवल उभारणी, जास्त अनुदान जसेजसे दुग्ध व्यवसाय -, कुक्कुटपालन, वराहपालन, शेळीपालन, मत्स्यपालन.

६) गडचिरोली व चंद्रपूर जिल्हयात आदिवासी जमातीच्या स्त्रियांसाठी (साक्षरताबाबतशासनाने खास महिला (शिक्षण सुविधा अमलात आणाव्यात त्यातून रोजगार .निर्मितीला चालना मिळेल

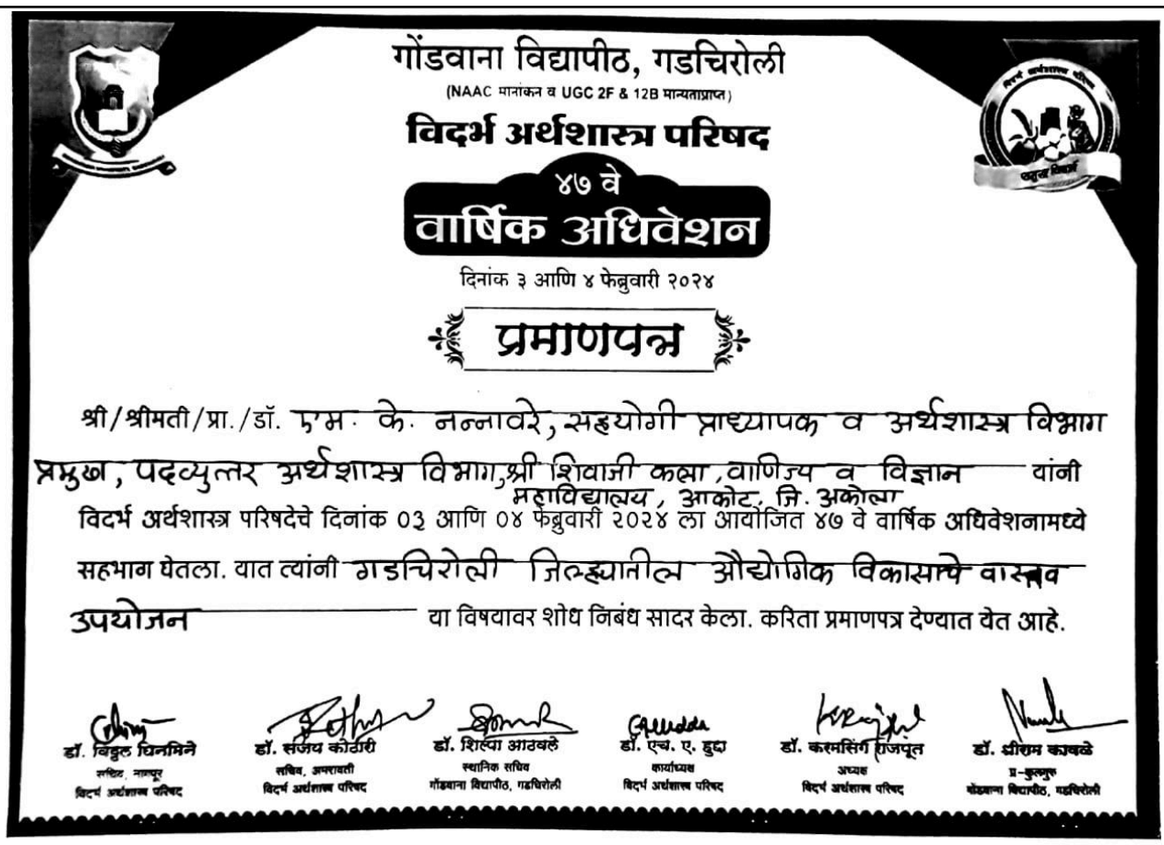
संदर्भ सूची

१) जंगले मंगला महाराष्ट्राची अर्थव्यवस्था प्रशांत पब्लिकेशन, जळगाव, प्रथम आवृत्ती, २०१३

२) Infrastructure Statistics of Maharashtra State Directorate of Economics and Statistics, Government of Maharashtra- .15-2014

३) जिल्हा सामाजिक व आर्थिक समालोचन, महाराष्ट्र शासन- २०२३.

Research Paper



गोंडवाना विद्यापीठ, गडचिरोली

(NAAC मानांकन व UGC 2F & 12B मान्यताप्राप्त)

विदर्भ अर्थशास्त्र परिषद

४७ वे

वार्षिक अधिवेशन

दिनांक ३ आणि ४ फेब्रुवारी २०२४

प्रमाणपत्र

श्री/श्रीमती/प्रा./डॉ. प्रभ. के. नन्नावरे, सहयोगी प्राध्यापक व अर्थशास्त्र विभाग प्रमुख, पदव्युत्तर अर्थशास्त्र विभाग, श्री शिवाजी कला, वाणिज्य व विज्ञान महाविद्यालय, आकोट, जि. अकोला वांनी विदर्भ अर्थशास्त्र परिषदेचे दिनांक 03 आणि 04 फेब्रुवारी २०२४ ला आयोजित ४७ वे वार्षिक अधिवेशनामध्ये सहभाग येतला. यात त्यांनी गडचिरोली जिल्ह्यातील औद्योगिक विकासाचे वास्तव उपयोजन या विषयावर शोध निबंध सादर केला. करिता प्रमाणपत्र देण्यात येत आहे.

डॉ. विनुल धिनमिने	डॉ. संजय कोठारी	डॉ. शिल्पा आठवले	डॉ. एच. ए. हुद्दा	डॉ. करमसिंग राजपूत	डॉ. श्रीराम कावळे
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विदर्भ अर्थशास्त्र परिषद	विदर्भ अर्थशास्त्र परिषद	गोंडवाना विद्यापीठ, गडचिरोली	विदर्भ अर्थशास्त्र परिषद	विदर्भ अर्थशास्त्र परिषद	गोंडवाना विद्यापीठ, गडचिरोली

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या संस्थेचे त्रैमासिक

।। संशोधक।।

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- वर्ष : ९१
- पुरवणी अंक : २

*** प्रकाशक ***

श्री. संजय मुंदडा

कार्याध्यक्ष, इ. वि. का. राजवाडे संशोधन मंडळ, धुळे ४२४००१

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अक्षरजुळणी : सौ. सीमा शिंत्रे, वारजे-माळवाडी, पुणे ५८.

महाराष्ट्र राज्य साहित्य आणि संस्कृती मंडळाने या नियतकालिकेच्या प्रकाशनार्थ अनुदान दिले आहे. या नियतकालिकेतील लेखकांच्या विचारांशी मंडळ व शासन सहमत असेलच असे नाही.

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भारतातील महिला सक्षमीकरणात सामाजिक व आर्थिक स्थितीचे योगदान

डॉ. एम. के. नन्नावरे

सहयोगी प्राध्यापक व अर्थशास्त्र विभाग प्रमुख,

श्री शिवाजी कला, वाणिज्य व विज्ञान महाविद्यालय, आकोट

जि. अकोला (महाराष्ट्र)

सारांश :

महिला सक्षमीकरण ही एक क्रमिक प्रक्रिया आहे. महिलांच्या सामाजिक आणि आर्थिक सक्षमीकरणाचा संबंध बहुतेक वेळा श्रमशक्ती आणि उत्पन्नाशी संबंधित असतो. तथापि, रोजगार आणि उत्पन्नाच्या वाढीवतेमुळे महिलांची सामाजिक, आर्थिक स्थिति आणि निर्णय घेण्याच्या सामर्थ्यात सुधारणा होत नाही. सामाजिक, सांस्कृतिक, शैक्षणिक, आर्थिक आणि राजकीय अशा विविध घटकांना काही G-20 देशांमध्ये सतत लिंग तफावतीसाठी जबाबदार असल्याचे म्हटले जाते. भारतातील महिलांची स्थिती आजही शिक्षण, आरोग्य, रोजगार, निर्णय क्षमतेतील प्रमाण आणि वित्तीय साक्षरता पुरुषांच्या तुलनेत कमी दिसून येते.

बीजशब्द : महिलांची स्थिती, शिक्षण, आरोग्य, रोजगार, निर्णय क्षमतेतील प्रमाण

प्रस्तावना :

सक्षमीकरण ही एक बहुआयामी संकल्पना असून ती लोकांचा सामाजिक विकास तसेच आर्थिक व राजकीय क्षेत्रातील सहभागाशी निगडीत आहे. आर्थिक अभिवृद्धी आणि विकास यांना गती देण्यासाठी महिला सक्षमीकरणाच्या प्रकियेला १९७५ मध्ये चालना मिळाली. सबलीकरण म्हणजे स्त्रियांचे पोषण करणे, त्यांना स्वातंत्र्य देणे आणी त्यांचे दारिद्र्य दूर करणे होय. स्त्री सक्षमीकरणाचा शब्दशः अर्थ स्त्रीयांना पुरूषांच्या बरोबरीने समान विकासाची संधी देणे होय. सक्षमीकरण म्हणजेच दुर्बलता नष्ट करणारी संकल्पना. महिला सक्षमीकरणाचे मोजमाप करण्यासाठी व्यापक स्तरावर अवलंबीलेल्या संकल्पनात्मक-लिंग-निगडीत विकास निर्देशांक, लिंग-आधारीत मानव विकास निर्देशांक आणि लिंग-आधारीत सक्षमीकरण मोजमाप असे काही घटक संयुक्त राष्ट्र विकास कार्यक्रमाने (१९९५) निश्चित केले आहेत आणि सर्वसामान्यपणे याच घटकांचा परिमाण म्हणून वापर केला जात आहे.

जागतिक व भारतसंशोधन साहित्याचा आढावा :

संयुक्त राष्ट्र संघटनेने १९७५ हे वर्ष आंतरराष्ट्रीय महिला वर्ष म्हणून घोषित केले. त्यानंतर बीजिंग येथील चौथ्या (१९९५) जागतिक महिला परिषदेत जगभरातील महिला सक्षमीकरणासाठी नवीन दृष्टी देणाऱ्या एका नव्या पर्वाची सुरुवात झाली. महिला सबलीकरणासाठी १९७५ ते १९८५ पर्यत महिला विकासाचे दशक म्हणून युनोने जाहीर केले. २०१५ मध्ये तुर्की अध्यक्षपदाच्या काळात महिला आर्थिक सक्षमीकरणाला अधिक चालना देण्याच्या उद्देशाने महिला २० (W20) हा एक महत्त्वाचा गट स्थापन करण्यात आला. W20 आणि We-Fi (Women Entrepreneur-Finance Initiative महिला उद्योजक-वित्तीय पुढाकार) हे सर्वात महत्त्वाचे उपक्रम आहेत. ज्याने महिला सक्षमीकरणासाठी सक्षम वातावरण प्रदान केले आहे. W20 ही महिला-पुरुष समानतेवर समन्वय साधण्यासाठी एक महत्त्वाची यंत्रणा आहे. भारतात राष्ट्रीय महिला आयोग कायद्यान्वये (१९९०) महिलांचे हितसंरक्षण करण्याच्या हेतूने ३१ जानेवारी, १९९२ रोजी राष्ट्रीय महिला आयोगाची स्थापना करण्यात आली. भारताने १२ डिसेंबर, २०२२ रोजी थ२० अध्यक्षपदाची सूत्रे स्वीकारल्यानंतर, 'महिला-नेतृत्व व विकास' या माध्यमातून समन्याय (Equity) आणि समानतेचे (Equality) जग निर्माण करण्याचा दृष्टिकोण प्रत्यक्षात आणण्यावर लक्ष केंद्रीत केले आहे. भारताच्या अध्यक्षतेखाली W20 ची पाच प्राधान्य क्षेत्रे-उद्योजकतेतील महिला, तळागाळातील महिला नेतृत्व, लिंग डिजिटल विभाजन, शिक्षण आणि कौशल्य विकास आणि हवामान बदल, कृतीतील सहभाग यांचा समावेश आहे.

संशोधन पद्धती :

शोधनिबंध हा गुणात्मक, संख्यात्मक पद्धती व दुय्यम आधारसामग्रीवर आधारित आहे. भारतातील पुरुष आणि महिलांवरील अहवाल आणि mospi या संकेतस्थळावरील

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कृषी क्रांतीचे प्रणेते - डॉ. पंजाबराव देशमुख

डॉ. एम. के. नन्नावरे
सहयोगी प्राध्यापक व अर्थशास्त्र विभाग प्रमुख पदव्युत्तर अर्थशास्त्र विभाग,श्री शिवाजी कला, वाणिज्य व विज्ञान महाविद्यालय, आकोट जि. अकोला (महाराष्ट्र)मोबा. नं. – ९९२३९४८३८९, ई-मेल – drmknannaware@gmail.com

सारांश

महात्मा गांधी यांनी स्वातंत्र्य मिळवण्यासाठी सत्याग्रहाचा वापर केला. संत गाडगे महाराजांनी समाजाच्या उद्धारासाठी वृक्षाला आपले शस्त्र बनवले. त्याचप्रमाणे भाऊसाहेबांनी शिक्षणाला समाजाच्या उन्नतीचे साधन मानले. शेतकऱ्यांच्या अडचणी दूर करुन शेतीचा विकास करणे हा त्यांचा उद्देश होता. लोकांचे दारिद्र्य आणि अज्ञान दूर करणे आणि भारताचा सर्वांगीण विकास करणे हे त्यांच्या जीवनाचे उद्दिष्ट होते. यातूनच शेती आणि शेतकऱ्यांचा सर्वांगीण विकास साधून कृषीप्रधान भारत मजबूत होऊ शकतो. भारताची जवळपास ८० टक्के लोकसंख्या शेतीवर अवलंबून आहे हे लक्षात घेऊन भाऊसाहेबांनी कृषी विकास हा भारतीय प्रगतीचा एक महत्त्वाचा टप्पा मानला आणि त्यासाठी आयुष्यभर परिश्रम घेतले. त्यांच्या खडतर प्रवासातून आणि अथक परिश्रमातून 'कृषी युग' जन्माला आला.

बीजशब्द : लोकमहर्षी, कर्ज लवाद कायदा, कृषी प्रदर्शन, कृषी युग.

प्रस्तावना

डॉ. पंजाबराव देशमुख यांचा जन्म अमरावती जिल्ह्यातील पापळ या खेड्यात २७ डिसेंबर १८९८ रोजी एका शेतकरी कुटुंबात झाला. गावात शाळा नसल्यामुळे तसेच अनेक संकटांना न जुमानता त्यांनी अमरावती येथून उच्च माध्यमिक शिक्षण पूर्ण केले व महाविद्यालयीन शिक्षणासाठी पुणे येथे गेले. त्यानंतर ते उच्च शिक्षणासाठी इंग्लंड येथील एडिनबर्ग विद्यापीठातून एम.ए. ऑक्सफर्ड विद्यापीठातून पदवी आणि पीएचडी. ची पदवी प्राप्त केली. पुढे ते बॅरिस्टर (बॅरिस्टर-ॲट लॉ) देखील झाले. खेड्यात जन्माला आल्याने त्यांनी स्वतः ग्रामीण जीवनातील अडचणी जवळून पाहिल्या होत्या. डॉ. पंजाबरावांना शेती गहाण ठेवून उच्च शिक्षणासाठी सावकारांकडून कर्ज घेऊन परदेशात जावे लागले. स्वतःला या टप्प्यातून जावे लागले. यासाठी त्यांना शेतकऱ्यांच्या समस्यांची जाण होती. डॉ.पंजाबराव देशमुख कृषी मंत्री असताना त्यांनी शेतकऱ्यांची गरिबी कशी दूर करता येईल याचा सखोल अभ्यास केला. भारतीय शेती आणि शेतकरी यांच्या परिस्थितीमध्ये आमुलाग्र सुधारणा व परिवर्तन करण्यासाठी आवश्यक ते उपाय करण्याचे महान कार्य डॉ. पंजाबरावांनी केले आणि विकासाची दिशा दिली. डॉ. पंजाबराव यांचे भारताच्या कृषीविकासातील योगदान आणि भगीरथ प्रयत्नांचा विश्लेषणात्मक अभ्यास करण्याचा प्रयत्न सदर शोधनिबंधात केला आहे.

शोधनिबंधाची उद्दिष्टे

१) डॉ. पंजाबराव देशमुख यांच्या जीवनातील व सामाजिक विकासातील केलेल्या कार्याचा अभ्यास करणे.
२) डॉ. पंजाबराव देशमुख यांनी कृषी क्षेत्रात केलेल्या सुधारणात्मक कार्याचा आढावा घेणे.

शोधनिबंधाची गृहिते

१) डॉ. पंजाबराव देशमुख यांनी केलेल्या शिक्षण विषयक कार्यामुळे विदर्भ व देशाच्या शैक्षणिक विकासाला प्रगतीपथावर नेण्यास मोलाची मदत झाली.

२) डॉ. पंजाबराव देशमुख यांनी शेतकरी, कृषी व सामाजिक क्षेत्रात केलेले कार्य अद्वितीय असे आहे.

संशोधन पद्धती

या शोधनिबंधासाठी वर्णनात्मक संशोधन पद्धतीचा वापर करण्यात आला असून संशोधनासाठी दुय्यम माहिती स्त्रोताचा वापर करण्यात आलेला आहे. त्यासाठी विविध संदर्भ ग्रंथाचा वापर करण्यात आलेला आहे.

सामाजिक व शैक्षणिक कार्य

सर्वांनी शिक्षण घेऊन राज्याचा, देशाचा विकास साधावा अशी पंजाबराव यांची इच्छा होती. डॉ. पंजाबराव देशमुख अमरावती जिल्हा कौन्सिलचे अध्यक्ष असताना त्यांनी प्राथमिक शिक्षण सर्वांसाठी सक्तीचे केले. तसेच अतिरिक्त कर बसवून त्यामार्गाने गोळा होणारा पैसा शिक्षणासाठी खर्च करण्याची योजना आखली.१९३० मध्ये प्रांतिक सरकारमध्ये शिक्षणमंत्री म्हणून कार्य करताना ग्रामीण भागातील गरीब होतकरू विद्यार्थ्यांना शिक्षण घेता यावे, यासाठी विद्यार्थ्यांकरिता अनेक प्रकारच्या सोयी-सवलती उपलब्ध करून दिल्या. १ जुलै १९३२ रोजी अमरावती येथे

होण्याच्या दृष्टीने कृषी संशोधन झाल्यानंतर ते होणेआवश्यक होते म्हणून १७ नोव्हेंबर १९६० या रोजी पंतनगर (उत्तराखंड) येथे देशातील पहिले कृषी विद्यापीठ डॉ. पंजाबराव देशमुख यांच्या पुढाकाराने स्थापन करण्यात आले या विद्यापीठाच्या डिझेलीकरीता पंतनगर हरितक्रांतीचे शिल्पकार असे वर्णन करण्याचा आंतरिक हरितक्रांतीचे जनक डॉ. स्वामिनाथन यांचे योगदान लाभले होते. पंतनगरचे हे विद्यापीठ म्हणजे भारत आणि अमेरिका यांच्या यशस्वी भागीदारीचे एक मजबूत उदाहरण आहे. यातूनच डॉ. पंजाबराव देशमुख यांनी कृषी क्षेत्रात घेतलेल्यामुळाही निर्णयाची प्रचीती येते.

कृषी हा भारतीय अर्थव्यवस्थेचा कणा असून हाताचे उपजीविकेचे एकमेव साधन होय. निरनिराळ्या संशोधनातून शिरदार शेतीला लाभदायी करण्याकरिता कृषी शिक्षणाची आवश्यकता आहे. कृषी प्रधान भारताला अन्नधान्यासाठी विदेशी आयातीवर अवलंबून राहायला नको, असे भाऊसाहेबांना सारखे वाटत होते. त्यादृष्टीने सुलभ शेती, संकरित बी-बियाणे निर्मिती व पुरवठ्यावर भर दिला. पिक संरक्षणाच्या कार्यावर सुद्धा भर दिला. मालाची साठवणूक यासारख्या अनेक दृष्टिकोनातून त्यांनी अनेक संशोधने करण्यावर भर दिला. अशा कार्यामुळे भारताची खाद्यान्नाची आयात बरीच घटू शकली. डॉ. पंजाबरावांच्या कार्यामुळे कृषक आणि कृषीच्या विविध समस्यांची बऱ्यापैकी सुटका होऊ शकली. भूमी सुधारणा व पगती यांचा मूलभूत पाया घालण्याचे महत्त्वाच्या कार्यातून भारतीय अर्थव्यवस्थेला विकासाची देरणा मिळू शकली. पशुतुल्य जीवन कंठणारा शेतकरी घातकाप्रमाणे विकासाची उंच भरारी मारण्यासाठी तयार होऊ लागला. भ्रष्टाचार विरहित कार्यकाळात (१९५२ ते १९६२) त्यांनी कृषक वर्गाला आणि कृषीला मध्यवर्ती स्थान देऊन दक्ष दिशांनी देशहिताचे कार्य केले.

सहकारी शेती

डॉ. बाबासाहेब आंबेडकर यांच्याप्रमाणेच डॉ. पंजाबराव देशमुख यांनीही सहकारी शेतीवर भर दिला. शेतकऱ्यांनी शेतीशी भावनिक नाते न ठेवता शेतीकडे उत्पादन वाढवण्याच्या दृष्टिकोनातून पाहिले पाहिजे, त्यासाठी शेतीचे छोटे-छोटे तुकडे करणे टाळून त्याची एकात्मता कशी करता येईलयाकडे त्यांनी लक्ष दिले पाहिजे, असे ते म्हणाले. त्यामुळे शेतकऱ्यांचे एकरी उत्पन्न वाढून उत्पादन दर कमी होऊन राष्ट्रीय उत्पन्न वाढेल. आजही सहकारी शेतीची नितांत गरज आहे.

निष्कर्ष

'शेतकरी सुखी तर देश सुखी' या विचारातून डॉ. पंजाबराव देशमुख यांचे कार्य आणि त्यांचे विचाराद्वारे संशोधन आणि विकास उपक्रम, आधुनिक तंत्रज्ञान, वैज्ञानिक शेतीला प्रोत्साहन, शेतकऱ्यांसाठी विस्तार सेवा व आधुनिक कृषी पद्धती या नवीन कृषी युगाची संकल्पना त्या काळात मांडली. जी आजही भारतातल्या प्रत्येकाला पंजाबराव यांचे जीवनचरित्रआवश्यक वाटते. त्यांच्या या कार्यानेच आजच्या शेतकऱ्याला परंपरागत अवस्थेतून काही प्रमाणात का होईना प्रगट अवस्थेपर्यंत नेण्यात भाऊसाहेबांचे मोठे योगदान आहे. आजही अनेक शेतकरी, सावकार, जमीनदार व्यापारी, ठेकेदार, राजकीय व्यक्ती, प्रशासकीय अधिकारी यांच्या अत्याचाराला बळी पडत असलेले दिसतात. त्यावेळी खरोखरच त्या काळातील पंजाबरावांचे विचार आजही किती समर्पक आहेत याची प्रचिती येते. पंजाबराव यांच्या कृषी विचारांचा व धोरणांचा आदर्श घेऊन बदलत्या काळानुसार आजच्या शेतकरी व शेतीचे प्रश्न सोडविण्यासाठी उपाययोजना करून शेतकरी हिताच्या दृष्टीने कृषी क्षेत्राचा विकास व परिवर्तन करणे आवश्यक आहे.

संदर्भसूची

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४) प्रा. अशोक इंगळे (१९९७-१९९८) स्मरणिका शिक्षण महर्षी डॉ. पंजाबराव देशमुख जन्मशताब्दी महोत्सव, डॉ. एच. एन. सिन्हा महाविद्यालय, पातुर.

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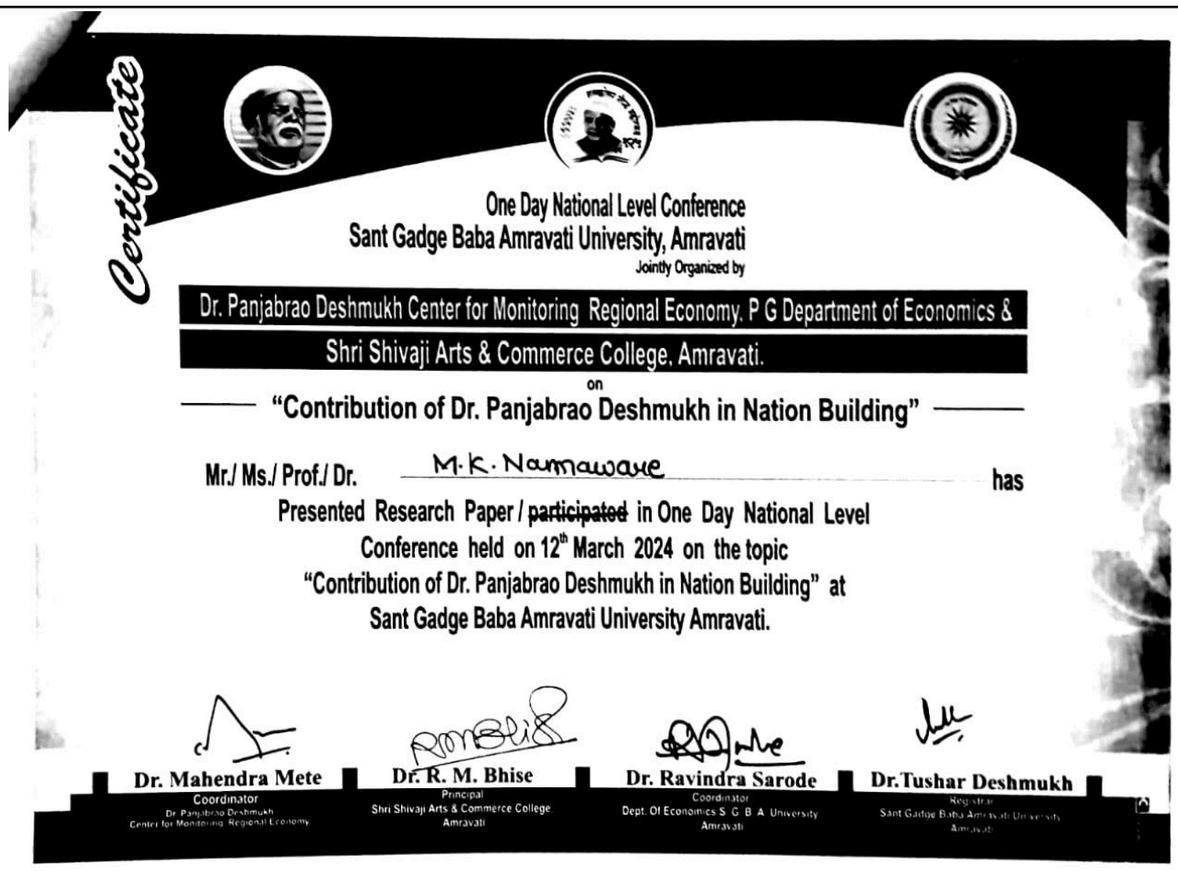
७) लोकमहर्षी भाऊसाहेब देशमुख, गौरव ग्रंथ साहित्य आणि संस्कृती मंडळ मुंबई.



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EXPLORING THE CONFLUENCE OF DIGITAL LITERATURE AND AI: THREATS AND OPPORTUNITIES

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ABSTRACT:

In an increasingly digitized world, the intersection of artificial intelligence (AI) and literature has emerged as a captivating domain, offering both transformative opportunities and unprecedented challenges. This paper delves into the confluence of digital literature and AI, scrutinizing the evolving landscape and its profound implications for the future of literary expression and consumption. The paper begins by charting the trajectory of digital literature, tracing its evolution from hypertext narratives to interactive storytelling and immersive experiences. Simultaneously, it examines the advancements in AI technologies, including natural language processing, machine learning, and generative models, that have enabled AI's foray into creative processes and literary creation. It also dissects the symbiotic relationship between digital literature and AI, elucidating how AI can augment authorship, create interactive narratives, and personalize reading experiences. While AI presents a plethora of opportunities, it also raises pressing concerns. This paper addresses the ethical dilemmas surrounding AI-generated content, exploring issues such as authorship attribution, plagiarism, and the potential homogenization of literary voices. Additionally, it scrutinizes the biases embedded in AI models and their implications for diverse and inclusive storytelling. Furthermore, the paper delves into the implications of AI on the consumption of digital literature, analyzing how recommender systems and personalized content delivery can both enhance and potentially limit readers' exposure to diverse literary perspectives. The potential for AI to perpetuate echo chambers and homogenize literary preferences is a significant concern explored in this research.

Key words: Digital Literature, AI, Opportunities, Threats, Authorship, Creativity

Introduction

In the rapidly evolving landscape of the digital age, two powerful forces are converging to reshape the very essence of literature as we know it: Digital Literature and Artificial Intelligence (AI). For Karl Schroeder: "AI is more a cultural than a technological revolution – one that requires reflection on ethical, governance and legislation issues" (Schroeder). The emergence of these intertwined realms marks a profound inflection point in the world of storytelling, offering a dynamic synergy that transcends traditional boundaries. This article embarks on a compelling journey into the heart of this confluence, where the ancient art of literature merges with cutting-edge technology, presenting us with an intricate tapestry of both threats and opportunities. The allure of literature has always rested in its ability to transport us to distant worlds, evoke profound emotions, and illuminate the human condition. With the advent of digital literature, this timeless art form has undergone a metamorphosis, expanding beyond the confines of printed pages and into a realm where stories come alive through interactive experiences, multimedia elements, and reader engagement. Simultaneously, AI has emerged as a formidable creative collaborator, capable of generating, analyzing, and enhancing the written word in ways previously unimaginable.

This convergence raises pivotal questions that resonate at the very core of human creativity, expression, and imagination. Can algorithms truly replicate the depth and authenticity of human storytelling? How do we navigate the ethical, legal, and philosophical complexities surrounding AI-generated content? What doors does this digital literary frontier open for both authors and readers, and how do we ensure that it remains an avenue for enriching the world of literature rather than diminishing it? This article undertakes a comprehensive exploration of the captivating intersection between Digital Literature and AI. It delves into the fascinating world of interactive narratives, AI-authored novels, and immersive literary experiences. Along the way, it uncovers the potential threats that loom on the horizon, from concerns about dehumanization to privacy challenges, as well as the extraordinary opportunities that beckon towards innovation, accessibility, and creativity.

The Rise of Digital Literature

Digital literature is also known as electronic literature. John Cayley defines it as "writing in networked and programmable media" (Scott 04). It has emerged as a transformative force, fundamentally altering the landscape of storytelling. Unlike its traditional print counterpart, digital literature harnesses the power of digital technology to craft immersive and interactive reading experiences. It includes "hypertext fiction and poetry, kinetic poetry in flash…chatterbots, interactive literature, literary apps, literary performances on web" (Scott 07). In this realm, literature transcends the confines of static text, encompassing a diverse range of media, from hypertext fiction to interactive narratives found in video games. One of the defining features of digital literature is its malleability. It grants readers a unique agency, often inviting them to take on the role of co-creators in the narrative journey. In this dynamic space, stories evolve beyond linear structures, offering branching pathways that allow readers to make choices that directly shape the plot's development. Each reader's interaction with the narrative becomes a distinctive adventure, akin to navigating a labyrinth of possibilities. This transformation extends beyond mere interactivity; it blurs the line separating author and reader. No longer passive consumers of a predetermined story, readers become active

participants, influencing the trajectory of the plot through their decisions. The sense of ownership and connection between readers and the narratives they explore is a hallmark of digital literature. Furthermore, digital literature embraces multimedia to enrich storytelling. It seamlessly integrates images, audio, and video into the narrative fabric, creating a multi-sensory reading experience. This fusion of various art forms blurs the boundaries between literature, visual art, and soundscapes, adding depth and richness to the reading encounter.

Some digital literary platforms take collaboration to a new level, permitting readers to contribute their own content to the story. This collaborative approach transforms narratives into living entities that evolve with each participant's input. It's akin to a communal storytelling circle, where every voice adds a layer to the ongoing tale. Thus digital literature signifies a profound evolution in how stories are expressed and consumed. It liberates literature from the constraints of printed pages, offering a dynamic, participatory, and multimedia-rich experience. As technology continues to advance, the horizons for digital literature remain limitless, marking an exciting frontier where creativity knows no bounds. In this realm, the reader is not merely an observer but an active collaborator in the ongoing evolution of storytelling, where the only limit is the boundless expanse of human imagination.

The Power of Artificial Intelligence

Artificial intelligence technology, which is an important landmark in computer science, is "a field of study which focuses on forming smart machines performing tasks that naturally necessitate human intelligence" (Celik). Artificial intelligence, with its cornerstone technologies like natural language processing (NLP) and machine learning, stands at the forefront of this transformative literary evolution. AI algorithms, fueled by the capability to process vast datasets of text, possess the remarkable capacity to identify patterns and generate coherent and contextually relevant content. This newfound capability has given birth to a plethora of AI-driven literary endeavors. One striking manifestation of AI's creative prowess is AI-authored literature. These algorithms can craft prose and poetry, producing works that often blur the line between human and machine authorship. The result is a body of literature that challenges our notions of creativity and authorial identity. Whether it's a novel penned by a collaborative effort between human and AI or poetry that elicits genuine emotional responses, AI-authored content has carved a niche in the literary landscape.

AI's reach extends even further into literature. Chatbots, imbued with AI capabilities, engage in conversations with readers, mimicking the writing style of famous authors or creating entirely unique dialogues. These literary chatbots offer readers an immersive experience, allowing them to interact with fictional characters or literary personas in unprecedented ways. Moreover, recommendation algorithms, another facet of AI, play a pivotal role in guiding readers on their literary journeys. By analyzing readers' preferences, past choices, and reading patterns, these algorithms curate personalized reading lists. This not only simplifies the process of discovering new books but also ensures that readers are more likely to encounter literature that resonates with their tastes. In essence, AI has made literary exploration more accessible and enjoyable, serving as a literary compass in the vast ocean of literature. Thus, the power of artificial intelligence in literature is multifaceted. AI-authored content challenges our understanding of creativity and authorship, while literary chatbots provide interactive and engaging reading experiences. Furthermore, recommendation algorithms

elevate the accessibility and enjoyment of literature, ensuring that readers can embark on literary adventures tailored to their preferences. As AI continues to advance, its role in shaping the future of literature is poised to become increasingly significant, promising both innovation and new horizons for literary expression and engagement.

The Threats: Dehumanization and Privacy Concerns

Yet, beneath the promising façade of digital literature and AI lies a shadow of potential threats, ones that demand our careful consideration.

Dehumanization of Literature

As AI takes on a more prominent role in content creation, a nagging question lingers: Can artificial intelligence authentically capture the depth of human emotions, experiences, and cultural subtleties that have defined literature for centuries? There's a legitimate concern that the soul of literature, the essence that has connected generations of readers to stories, may be diluted in the pursuit of efficiency and novelty. The risk of homogenization looms large. AI-generated content, while technically proficient, might lack the diversity, the idiosyncrasies, and the raw, unfiltered emotions that make human-created works resonate so profoundly. In this brave new literary world, there's a danger that the richness and complexity of human storytelling could be reduced to a formulaic exercise driven by algorithms.

Privacy in the Digital Literary Realm

Privacy, too, emerges as a pressing concern in this digital literary realm. The power of AI, particularly in the form of recommendation algorithms, lies in its ability to sift through vast amounts of data, including readers' preferences, browsing habits, and personal information. This data-driven approach enhances the reading experience by tailoring book recommendations to individual tastes, but it also raises serious privacy questions. The line between providing personalized reading suggestions and intrusive surveillance is a fine one. Without proper safeguards and ethical guidelines, the vast reservoir of personal data gathered in the name of enhancing the reading experience could be misused or exposed, leading to privacy breaches and potential exploitation. Navigating these treacherous waters requires a delicate balance. While embracing the transformative potential of AI and digital literature, we must remain vigilant in protecting the essence of literature's humanity and the sanctity of individuals' private lives. Ethical considerations, robust regulations, and a vigilant eye on the evolving landscape are imperative to ensure that these threats do not overshadow the immense opportunities that this convergence offers to the world of storytelling.

The Opportunities: Expanding Creativity and Accessibility

However, within the blend of digital literature and AI, lies a wealth of opportunities, ready to be harnessed for the enrichment of literature and its accessibility to a broader audience.

AI as a Creative Ally

Artificial intelligence, when employed as a creative ally, can be a powerful asset for authors. It can catalyze the creative process by assisting authors in generating ideas, refining writing quality, and automating repetitive tasks. By analyzing vast datasets and identifying patterns in language and storytelling, AI can provide valuable insights and suggestions that serve as a wellspring of inspiration for authors. This symbiotic relationship between human creativity and AI-driven assistance has the potential to spark a new era of literary innovation. Moreover, AI's proficiency in language translation is a game-changer for authors seeking to reach a global readership. With remarkable accuracy, AI can translate literary works into multiple languages, preserving the nuances and beauty of the original prose. This not only broadens an author's reach but also fosters cultural exchange and appreciation by breaking down language barriers.

Enhanced Accessibility

Digital literature and AI have the power to make literature more inclusive and accessible than ever before. For visually impaired readers, AI-driven tools can provide audio descriptions, rendering literature as an auditory experience, ensuring that everyone, regardless of visual ability, can immerse themselves in the world of stories. Language is no longer a barrier to literary exploration. AI can offer real-time translation services, enabling readers to access content in their preferred language, broadening literary horizons and fostering cross-cultural understanding. Furthermore, AI can create customizable reading experiences tailored to individual preferences and accessibility needs. Readers can adjust fonts, text sizes, and even the pacing of audiobooks, ensuring that literature adapts to their unique requirements. In essence, the fusion of digital literature and AI heralds a future where creativity flourishes, borders dissolve, and literature becomes a universal and inclusive art form. By embracing these opportunities, we not only enrich the world of storytelling but also ensure that literature remains a vibrant and accessible medium for all.

The Future of Literature in the Digital Age

As we stand at this crossroads of digital literature and AI, we must acknowledge the complexity of this evolving landscape. The threats of dehumanization and privacy invasion are real, and they demand thoughtful regulation and ethical considerations. However, the opportunities to expand creativity, accessibility, and literary exploration are equally significant. The future of literature in the digital age is likely to be a hybrid one, where human creativity and AI-driven assistance work in tandem. Authors will harness AI as a tool to enhance their craft, and readers will continue to be active participants in the narrative process.

Conclusion

In conclusion, the confluence of digital literature and AI is an exciting frontier that offers both perilous pitfalls and boundless promise. It challenges us to rethink the very essence of literature and storytelling, urging us to explore new horizons while safeguarding the fundamental human elements that make literature a timeless art form. As we navigate this

uncharted territory, our choices and regulations will determine whether this confluence ultimately enriches our literary world or diminishes its soul. The future of literature in the digital age is in our hands, waiting to be crafted into a masterpiece of human and artificial creativity. The promise lies in the potential to redefine storytelling, making it more engaging, immersive, and accessible. AI, as a tool, can assist authors, broaden literary experimentation, and enhance readers' experiences. Yet, there are significant threats to authenticity and creativity. AI-generated content may lack the profound human insights that make literature a reflection of the human condition. Ethical dilemmas surrounding authorship, ownership, and copyright must be addressed, and safeguards should be established to ensure AI augments human creativity rather than replaces it.

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NARRATIVE ALCHEMY: THE TRANSFORMATIVE POWER OF MAHASWETA DEVI'S *'RUDALI'* IN SHAPING PERSONALITY

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ABSTRACT:

The intersection of literature and psychology has long fascinated scholars, revealing how narratives can wield a profound impact on an individual's personality development. This paper delves into the transformative potency of Mahasweta Devi's literary gem, 'Rudali,' and its influence on shaping personalities. By analyzing the intricate interplay of characters, themes, and narrative structure, we explore how this novella transcends conventional storytelling norms to evoke deep-seated emotions and catalyze introspection. The narrative journey in 'Rudali' goes beyond mere entertainment, unveiling a psychological expedition where characters grapple with their inner struggles. This exploration becomes a mirror for readers, reflecting their own complexities and vulnerabilities. The unconventional narrative structure provides a unique vantage point to contemplate the multifaceted nature of human psychology, opening avenues for self-discovery and personal evolution. The paper investigates how 'Rudali' acts as a catalyst for personality transformation by delving into characters' responses to life's adversities. Through intricate character development, Mahasweta Devi's narrative expertise showcases the malleability of personalities when confronted with challenges. This analysis underscores the narrative's potential to evoke catharsis and inspire personal growth. Ultimately, this paper aims to shed light on the transformative prowess of literature, exemplified by 'Rudali,' and its role in shaping personalities. By delving into the alchemical fusion of narrative elements, it contributes to the discourse on the symbiotic relationship between literature and psychological development. The presentation seeks to inspire a deeper appreciation for the written word's capacity to initiate introspection, emotional resonance, and profound transformation in individuals.

Keywords: Narrative, Transformative Power, Personality, Psychological Development, Self-Discovery.

Introduction:

Literature has always held the power to influence and shape the development of an individual's personality. Through its narratives, characters, and themes, literature can inspire

introspection, empathy, and personal growth. One such remarkable example is Mahasweta Devi's poignant work, 'Rudali,' which transcends traditional literary boundaries and serves as an innovative catalyst for personality development.'Rudali' exemplifies how literature can go beyond its role as mere entertainment and become a transformative force in shaping an individual's personality and worldview. The novel's intricate narratives, vivid characters, and profound themes provide readers with a unique opportunity for introspection, empathy, and personal growth.

'Rudali' explores the lives of marginalized women in rural India who are known as professional mourners. Through the story of Sanichari, the protagonist, Mahasweta Devi delves deep into the complexities of human emotions, societal norms, and the struggles faced by those living on the fringes of society. As readers engage with the characters' experiences and challenges, they are compelled to confront their own assumptions, biases, and privileges. This confrontation serves as a catalyst for introspection, encouraging readers to reevaluate their own lives, beliefs, and values.Empathy is a central theme in 'Rudali.' By portraying the harsh realities of Sanichari and other rudalis, Mahasweta Devi encourages readers to step into the shoes of these characters and view the world from their perspectives. This empathetic engagement has the power to break down barriers of prejudice and narrow-mindedness, fostering a greater understanding of the human condition as well as the complexities of societal hierarchies. Readers are prompted to extend their empathy not only to the characters in the novel but also to real-life individuals facing similar struggles.

The personal growth that 'Rudali' can inspire is rooted in its ability to challenge conventional norms and prompt readers to question the status quo. The characters' resilience in the face of adversity can serve as a source of inspiration, motivating readers to reconsider their own challenges and setbacks. Moreover, the novel's exploration of themes such as gender roles, caste discrimination, and economic disparities can push readers to become more socially conscious and engaged citizens, driving them to advocate for a more just and equitable society.'Rudali' also transcends traditional literary boundaries through its innovative narrative techniques and evocative language. The novel's narrative structure and style encourage readers to think critically and engage deeply with the text, leading to a heightened sense of intellectual curiosity and a willingness to explore new perspectives. This engagement with the text can, in turn, contribute to the expansion of one's intellectual horizons and personal growth.

Unveiling Empathy through Character Identification:

In 'Rudali,' Mahasweta Devi ingeniously crafts characters that evoke deep emotional connections with readers. The story centresaroundShanichari, a woman from a marginalized community, whose life is marked by tragedy and hardship. Readers find themselves immersed in her struggles, fears, and aspirations, fostering an empathetic bond that encourages introspection into their own lives. This identification with characters from diverse backgrounds promotes a broader worldview and nurtures the growth of compassion and understanding within the reader's personality.

Shanichari, stands as a remarkable embodiment of the marginalized and oppressed, leading readers to introspectively reflect on their own lives and the broader human experience.

Shanichari's journey through tragedy and adversity resonates deeply with readers, regardless of their personal backgrounds. Her struggles, fears, and aspirations become a mirror through which readers can examine their own challenges and triumphs. This connection prompts readers to consider how they might respond in the face of similar difficulties, encouraging a more profound introspection into their own lives and motivations.The power of literature lies in its capacity to transport readers into the lives of characters who inhabit worlds different from their own. Through the eyes of Shanichari and other characters in 'Rudali,' readers gain insights into the realities faced by marginalized communities. This immersive experience broadens their worldview, breaking down barriers of ignorance and prejudice. As readers step into Shanichari's shoes, they develop a heightened sensitivity to the struggles of others and cultivate a more compassionate and empathetic outlook.

The act of identifying with characters from diverse backgrounds inherently nurtures a sense of understanding and compassion within readers. As they witness Shanichari's resilience, they are inspired to reflect on their own capacity for strength in the face of adversity. This recognition of shared humanity encourages personal growth, prompting readers to expand their capacity for empathy and their ability to connect with people from various walks of life.By evoking such emotional connections, 'Rudali' becomes a transformative tool that encourages readers to reflect on their own attitudes, biases, and privileges. The story invites readers to engage with uncomfortable truths about societal inequalities and injustices, fostering a desire for positive change. This engagement is crucial for the development of a well-rounded personality that seeks to contribute to a more equitable and just world.

Catharsis and Emotional Resonance:

Mahasweta Devi's narrative prowess in 'Rudali' goes beyond mere character identification, delving into the profound territories of catharsis and emotional resonance. The novel's portrayal of grief, loss, and societal oppression serves as a reflective surface, inviting readers to explore their own emotional landscapes and life experiences. Through this process of empathy and self-reflection, readers undergo a parallel journey of self-discovery that has the potential to be deeply transformative.

The depiction of grief and loss in 'Rudali' resonates with readers on a universal level. The characters' experiences of pain and sorrow evoke a sense of shared human vulnerability, reminding readers of their own encounters with suffering. This shared emotional experience encourages readers to process their own feelings of grief and loss, facilitating catharsis—a release of pent-up emotions. By engaging with the characters' emotional struggles, readers are prompted to confront their own emotional wounds and, in doing so, initiate a healing process.

Moreover, the portrayal of societal oppression and injustice in the novel acts as a mirror that reflects not only the characters' experiences but also prompts readers to examine the injustices in their own societies. This reflection encourages readers to consider their own role in perpetuating or challenging these systemic issues. In this way, 'Rudali' becomes a catalyst for readers to confront uncomfortable truths and question their own complicity or agency in shaping the world around them.

As readers empathize with the characters' emotional journeys, they develop a heightened emotional intelligence—an ability to recognize, understand, and manage their own emotions as well as those of others. This emotional resonance nurtures empathy, a critical aspect of personal growth and interpersonal relationships. By vicariously experiencing the characters' emotions, readers expand their emotional vocabulary and gain insights into the diverse ways that people cope with and express their feelings.

The emotional resonance achieved through 'Rudali' becomes a transformative tool for readers to navigate their own emotional landscapes and develop a deeper understanding of themselves. It encourages readers to confront their vulnerabilities, fears, and aspirations, leading to enhanced self-awareness. This, in turn, contributes to the development of a more well-rounded personality—one that is attuned to both its own emotions and the emotions of those around them.

Exploration of Complex Themes:

'Rudali' stands as a testament to Mahasweta Devi's ability to transcend literary conventions by delving into intricate and thought-provoking themes such as gender inequality, social injustice, and the resilience of the human spirit. This multifaceted exploration challenges readers to engage in critical analysis of societal norms and their own convictions, leading to intellectual stimulation and the cultivation of a sense of agency that can profoundly shape their personalities.The novel's unflinching examination of gender inequality and social injustice serves as a powerful lens through which readers can scrutinize the inequities present in their own societies. By portraying the harsh realities faced by marginalized women like Shanichari, 'Rudali' encourages readers to question deeply ingrained biases and assumptions. This process of introspection and critical analysis prompts readers to reevaluate the status quo and consider their own roles in perpetuating or challenging oppressive systems.

The intertwining of these themes in the novel fosters an environment where readers are inspired to think beyond surface-level narratives and delve into the complexities of societal structures. As they engage with the intricate interplay of gender, class, and power dynamics, readers are prompted to challenge their preconceptions and expand their intellectual horizons. This intellectual stimulation encourages a deeper understanding of the world and a willingness to seek out diverse perspectives.

Through the characters' resilience in the face of adversity, 'Rudali' highlights the indomitable human spirit's capacity to overcome challenges. This portrayal serves as a source of inspiration for readers, prompting them to reflect on their own sources of strength and resilience. This reflection can foster a sense of agency—a belief in their own capacity to effect positive change. By witnessing characters navigate and confront adversity, readers are empowered to contribute actively to society and become agents of change themselves.

The themes explored in 'Rudali' not only challenge readers' intellect but also evoke an emotional response. This emotional engagement deepens the impact of the novel's themes, driving readers to consider their own values and convictions. The resulting introspection can lead to a transformation of beliefs and attitudes, as readers grapple with the ethical implications of the issues presented in the novel.Incorporating such complex themes and encouraging critical analysis in 'Rudali' equips readers with the tools to be more than passive consumers of literature. It empowers them to be active participants in shaping their own

personalities around values of justice, equality, and empathy. By confronting societal issues head-on and engaging in these conversations, readers are better prepared to contribute positively to their communities and advocate for meaningful change.

Metaphorical Reflections and Symbolism:

The innovative use of metaphors and symbolism in 'Rudali' adds a layer of depth that invites readers to engage in metaphorical thinking. Through the symbolism of the "rudali" (professional mourners), readers are prompted to consider the performative aspects of their own lives – the masks they wear and the roles they play. This introspection fuels personal growth by encouraging readers to align their actions with their true selves, ultimately shaping a more authentic and integrated personality.

Interactive Reading Experience:

Integrating digital platforms to enhance the impact of 'Rudali' on personality development is a brilliant idea that can leverage technology to create a more immersive and interactive reading experience? Augmented reality (AR) and virtual discussions can undoubtedly elevate the transformative power of the novel, fostering a deeper connection between readers, characters, and themes.

Augmented Reality (AR) Interaction:

By using AR, readers could access a new dimension of engagement with the characters and settings of 'Rudali.' Through a dedicated app or platform, readers could scan certain pages or images in the book to trigger interactive AR elements. For instance, scenes could come to life with visual and audio effects, enhancing the emotional impact of the story. Readers could virtually walk through the village, witness characters' expressions and actions, and even experience pivotal moments from different perspectives.

Character Interaction and Empathy:

AR could enable readers to engage with the characters on a more personal level. By visualizing the characters in 3D, readers might feel a stronger connection and empathy towards their struggles. This technology could provide a profound immersive experience, enabling readers to virtually accompany characters through their journeys and emotional arcs.

Virtual Discussions and Forums:

Creating virtual spaces for readers to engage in discussions, share insights, and exchange perspectives can foster a sense of community around the novel. Virtual forums could be facilitated through social media, dedicated websites, or even within the AR app itself. Readers from different backgrounds and cultures could come together to share their thoughts, interpretations, and personal reflections, enriching the overall reading experience.

Access to Supplementary Content:

Digital platforms could host supplementary materials such as interviews, documentaries, or multimedia content related to the themes of the novel. This content could enhance readers' understanding of the societal issues explored in 'Rudali,' prompting them to consider the real-world implications of the narrative.

Collaborative Projects:

Digital tools could enable collaborative projects where readers contribute their own creative interpretations of the story. This could include art, music, short films, or written pieces inspired by 'Rudali.' Such projects could serve as an outlet for readers to express their emotional and intellectual responses to the novel.

By incorporating these digital elements, the reading experience of 'Rudali' could be transformed into an interactive and multi-dimensional journey. The integration of AR and virtual discussions not only modernizes the way literature is engaged with but also amplifies the novel's potential to shape personality development. This approach combines the power of technology with the timeless impact of literature, ultimately encouraging readers to explore their emotions, expand their perspectives, and contribute positively to society.

Conclusion:

Mahasweta Devi's 'Rudali' transcends the boundaries of traditional literature, offering an innovative approach to personality development. Through character identification, emotional resonance, exploration of complex themes, and metaphorical reflections, the narrative acts as a catalyst for self-discovery, empathy, and personal growth. By leveraging technology for an interactive reading experience, the transformative power of 'Rudali' can be amplified, fostering a generation of individuals with enriched and evolved personalities.In conclusion, Mahasweta Devi's 'Rudali' exemplifies how literature can play a pivotal role in shaping an individual's personality and development. Through its narratives, characters, and themes, the novel encourages introspection, empathy, and personal growth. By challenging assumptions, fostering empathy, and inspiring readers to think critically about societal issues, 'Rudali' stands as a testament to the transformative power of literature in expanding one's understanding of the world and fostering positive personal change.

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Jyotiba Phule : Architect of Human Rights in India's Modern Revival

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Abstract :

Jyotiba Phule (1827-1890) catalyzed a profound societal transformation in nineteenth-century India, particularly in Maharashtra, through his humanistic deeds and philosophy. Amidst a backdrop of nationalism, caste divisions, and gender inequalities, this era witnessed a surge in societal criticism and revolutionary fervor. Reformers, including Phule, directed their efforts towards addressing pressing issues such as female infanticide, child marriage, and restrictions on women's education, Sati, widow tonsure, and the prohibition of widow remarriage. Concurrently, there was a growing focus on reforming family and marriage institutions to enhance the rights and status of women. Phule's pioneering contributions were centered on challenging gender and caste-based injustices. He vehemently opposed the oppressive caste system and the egregious human rights violations it perpetuated over centuries. His rebellion against the caste hierarchy was accompanied by extensive social and religious reforms grounded in principles of equality and humanity. Phule emerged as a prominent leader championing the cause of the oppressed classes in Maharashtra, earning recognition as a leader of India's marginalized communities nationwide. Inspired by the ideals espoused in Thomas Paine's "Rights of Man," Phule's advocacy for human rights was instrumental in igniting a movement towards social justice and equality. His legacy continues to resonate as a beacon of hope and empowerment for marginalized groups, underscoring the enduring relevance of his visionary principles in the ongoing struggle for societal reform and human dignity.

This research paper explores the pivotal role of JyotibaPhule as an architect of human rights in India's modern revival. Against the backdrop of a society entrenched in caste-based discrimination and social hierarchies, Phule emerged as a beacon of reform and egalitarianism during the 19th century. Through an interdisciplinary examination of historical texts, primary sources, and scholarly analyses, this paper investigates Phule's visionary contributions to dismantling oppressive structures and advocating for the rights of marginalized communities. It investigates Phule's strategies for social transformation, including his educational initiatives, literary works, and grassroots activism, which challenged traditional norms and fostered a spirit of social justice. Furthermore, this paper evaluates the enduring impact of Phule's ideas on contemporary discourse surrounding human rights in India, highlighting his enduring relevance as a trailblazer in the on-going struggle for equality and dignity.

Keywords :

Human Rights, caste system, gender inequality, women's rights, oppressed classes, equality, humanity, Jyotiba Phule Life.

During JyotibhaPhule's father's era, the Peshwas' authority and grandeur had significantly waned. In the twilight of the Peshwas' rule, fairness in governance was abandoned, favoring Brahmins over meritocracy. Brahmins received lenient punishments for various offenses compared to what the law dictated, often enjoying reduced property taxes. Bajirao II's reign saw Brahmins being generously treated with charity and extravagant feasts while farmers suffered under the weight of Brahmin-dominated moneylenders.

Throughout the eighteenth and nineteenth centuries, Brahmins held sway over society as the sole recipients of education, denying other castes equal opportunities and privileges. The specter of untouchability loomed large for Shudras and Atishudras, ostracizing them from mainstream society. Prevalent social biases and the exploitation of lower castes and women further exacerbated societal

disparities.

Dhananjay Keer observed that during the 19th century Peshwa rule in Maharashtra, Brahmins began to perceive themselves as the privileged ruling class, enjoying rights and exemptions that were absent during Shivaji's reign. Unlike before, under the earlier Peshwa administration, Brahmin-owned lands were assessed at significantly lower rates compared to those of other social classes. Additionally, Brahmin wrongdoers were often spared from the severest penalties prescribed by the law. (47)

The ancestral lineage of JyotibaPhule traces back to One Shetiba, with Khanavali serving as the ancestral village in the Purandar subdivision of Pune district. Shetiba's three sons-Panoji, Govinda, and Krishna-originally bore the surname Gorhe but later adopted the name JyotibaPhule after establishing a floral business. During the declining days of the Peshwa rule, JyotibaPhule's ancestors supplied the Peshwas with various floral products, including mattresses, pillows, and clothing, which earned them a garden and 35 acres of land as a gift. Originally engaged in greengrocery, Jyotiba's forefathers gradually transitioned into floristry, leading to the adoption of the surname 'Phule,' signifying their occupation as flower merchants.

JyotibaGovindraoPhule was born on April 11, 1827, in Katgun village, Khatavtaluka, Satara district, Maharashtra. He belonged to the Mali caste, traditionally involved in gardening and vegetable cultivation. His grandfather, ShetibaGorhay, sold flowers and garlands at religious and social gatherings in Pune, while his uncles worked as florists for the Peshwas, solidifying the family's association with the floral trade. Jyotiba's father, Govindrao, continued the family business after Chimnabai, Jyotiba's mother, passed away when he was nine months old. He was married to Savitribai at the age of thirteen.

Growing up, Jyotiba witnessed the discrimination inherent in the caste system when he was ostracized at a Brahmin wedding due to his lower caste status. This experience fueled his determination to fight against caste-based oppression and societal injustices. Inspired by Thomas Paine's "Rights of Man" and biographies of figures like ChhatrapatiShivaji and George Washington, Phule advocated for the education and empowerment of lower castes and women to dismantle the oppressive social order and religious dogma prevalent in Hindu society.

Phule's philosophy is encapsulated in several seminal works :

1) "BrahmanachaKasab (1969)": Exposes the exploitation of the oppressed by Brahmin priests.
2) "Gulamgiri (1873)": Provides a historical account of caste-based enslavement and warns against exploitation under the guise of religion.
3) "ShetkaryanchaAsud (1883)": Details the exploitation of peasants.
4) "SarvajanikSatyadharmaPustak (1891)": Introduces the concept of a universal religion and critiques blind religious practices.

JyotibaPhule's literary style in each of his works was marked by strength and courage, serving as a bold reaction against the social and religious establishment in Maharashtra. He vehemently asserted that the upper castes held sway over the social hierarchy, reaping exclusive privileges while perpetuating disparities based on caste and gender. In Phule's view, the oppressed were denied basic human rights, subjected instead to enduring hardship, discrimination, injustice, and exploitation. He criticized the religious texts such as the Puranas and Vedas for upholding such unequal social structures and actively opposed them. Phule's mission was to forge a new societal ethos rooted in principles of equality, justice, and humanity. Through his writings and activism, he sought to challenge and overturn the prevailing social order, advocating for a culture that embraced inclusivity and fairness for all members of society, regardless of caste or gender.

Concept of Human Rights :

The concept of human rights pertains to the

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fundamental rights and freedoms inherent to all human beings, regardless of nationality, ethnicity, religion, gender, or any other status. These rights are considered essential for individuals to live with dignity, equality, and respect. Human rights encompass a wide range of principles and protections, including civil, political, economic, social, and cultural rights. Civil and political rights encompass freedoms such as the right to life, liberty, and security of person; freedom of expression, assembly, and association; the right to a fair trial and due process of law; and the right to participate in governance through free and fair elections. Economic, social, and cultural rights include the right to work and receive fair wages; the right to education, healthcare, and social security; the right to housing and adequate standard of living; and the right to participate in cultural and artistic life.

The concept of human rights is enshrined in various international documents, including the Universal Declaration of Human Rights (UDHR), adopted by the United Nations General Assembly in 1948, which serves as a foundational instrument outlining the basic rights and freedoms to which all individuals are entitled. Human rights are not only universal but also indivisible, interrelated, and interdependent. This means that the fulfillment of one set of rights often depends on the fulfillment of others, and all rights are equally important and should be upheld without discrimination. The promotion and protection of human rights are essential for fostering peace, justice, and sustainable development within societies. Governments, international organizations, civil society, and individuals all play crucial roles in ensuring that human rights are respected, protected, and fulfilled for everyone.

Trailblazing Advocate for Human Rights in the Modern Indian Renaissance :

Phule articulated compelling arguments for the complete abolition of the caste system and untouchability, challenging the centuries-old injustices that had oppressed millions. He rebelled against a caste system that deprived Dalits of political, social, educational, and economic rights. Denouncing the dual morality inherent in the Brahmanical system, he advocated for equal opportunities and affirmed the inherent freedom and equality of all individuals. Phule emerged as a staunch defender of human rights for the oppressed. Inspired by his wife, SavitribaiPhule, Phule's commitment to the cause was strengthened. Savitribai actively engaged in the struggles of Mahatma Phule's mission, and following his passing, she assumed leadership of the movement.

Phule'sSatyashodhakSamaj was established in 1873, marking a significant development alongside other influential reform organizations such as the PrarthanaSamaj and the AryaSamaj. Despite the non-Brahman movement's later mass support, the SatyashodhakSamaj's formation paralleled elite political bodies, emerging just two years after Maharashtra's first political organization, the Poona SarvajanikSabha, and over a decade before the Indian National Congress. This mutual impact reflected the broader process of the "Indian renaissance," where early Indian intellectuals sought to address Western challenges and reinvigorate their society. Phule highlighted the denial of human rights to women and Shudras by Brahminical schemes, stressing the gender disparities prevalent in religious texts. Despite advocating for a non-idolatrous approach to religion, Phule rejected elaborate rituals and intermediary roles between individuals and the divine. He championed gender equality, opposed hierarchical structures, and advocated for education as a means to uplift marginalized communities and counter societal decline.

Education, according to Phule, was paramount for societal advancement and empowerment. He and SavitribaiPhule viewed education as a catalyst for social consciousness and transformation, advocating for reforms in women's education, vocational training, curriculum restructuring, agricultural and technical education, and teacher training. Their belief in education as a tool for social

betterment underscored their commitment to uplifting the socially underprivileged and fostering a more just and equitable society. Phule's philosophy rejected notions of sin, afterlife, and rebirth, urging individuals to rely on rational faculties to navigate life's challenges. His teachings emphasized truthfulness, conscientiousness, and the importance of using education to liberate individuals from societal constraints and foster critical thinking.

In his book "SarvajanikSatya-Dharma Pustaka," Mahatma Phule challenged the authenticity of religious writings, asserting that they were authored by men and often manipulated to suit specific agendas. He criticized the caste system for perpetuating inequality and advocated for equal opportunities and inherent rights for all individuals, regardless of caste or gender. Phule's ideology centered on humanism, emphasizing the unity of humanity and the importance of moral conduct and virtuous behavior.

Phule rejected idolatry, ritualism, and fatalism, advocating for a religion based on equality and freedom, which he termed "SarvajanikSatya Dharma." He condemned Hinduism's caste-based hierarchy and sought to replace it with a faith grounded in truth and independence. While influenced by Christianity's critique of traditional religions, Phule did not advocate for conversion but rather promoted a liberal, worldly religion that embraced diversity of beliefs within families.

Phule also criticized government support for Hindu temple grants, arguing against tolerating barbaric religious practices. He rejected communalism and advocated for active engagement in religious questions, asserting that unjust neutrality was unacceptable. Ultimately, Phule's vision encompassed a society where individuals were free to practice their own religions, acknowledging the potential truth in various religious teachings while striving for social justice and equality.

Contemporary Relevance of Phule :

Jyotirao Phule's legacy reverberates through contemporary Indian society, resonating in ongoing struggles against deep-rooted social injustices. His staunch opposition to the caste system remains highly relevant today, as caste-based discrimination continues to plague various spheres of Indian life. Despite legal measures to combat caste discrimination, social hierarchies persist, affecting access to education, employment, and political representation. Phule's call for the annihilation of caste serves as a guiding principle for movements advocating for social equality and the empowerment of marginalized communities. Furthermore, Phule's pioneering efforts in championing women's rights continue to inspire contemporary feminist movements in India. His advocacy for gender equality and women's education challenged patriarchal norms and laid the groundwork for on-going struggles for women's empowerment. In a society where gender-based discrimination and violence remain pervasive, Phule's vision of gender equality serves as a beacon of hope for those fighting against entrenched gender biases and injustices. Education was a central tenet of Phule's vision for social reform, and his emphasis on universal education as a means of emancipation remains pertinent today. Despite progress in increasing access to education, disparities persist, particularly for marginalized communities. Phule's advocacy for education for all underscores the importance of addressing inequities in education and ensuring that every individual, regardless of caste or social status, has access to quality education as a fundamental right.

Phule's commitment to social justice and human rights continues to inspire contemporary movements for equality and justice. His unwavering belief in the inherent dignity and rights of all individuals, irrespective of caste, gender, or social background, serves as a guiding principle for those advocating for marginalized communities' rights. In a world grappling with systemic inequalities and injustices, Phule's legacy reminds us of the ongoing struggle for human rights and the importance of collective action in challenging oppression and discrimination.

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Finally, Phule's critique of religious orthodoxy and his advocacy for a rational, inclusive approach to religion hold relevance in contemporary debates on secularism and religious reform. His vision of a universal religion based on equality and freedom provides insights into navigating religious diversity and fostering tolerance and pluralism in modern societies. In a world marked by religious conflicts and fundamentalism, Phule's message of unity and inclusivity resonates as a powerful antidote to divisive forces, reminding us of the enduring importance of religious harmony and mutual respect.

Conclusion :

In conclusion, JyotiraoPhule's ideas and activism continue to reverberate in contemporary Indian society, offering invaluable insights and inspiration for on-going struggles against social injustices. His relentless advocacy against the caste system, his pioneering efforts in championing women's rights, his emphasis on education as a tool for empowerment, and his unwavering commitment to social justice and human rights serve as guiding principles for movements striving for equality, justice, and dignity for all individuals. Moreover, Phule's critique of religious orthodoxy and his vision of a universal religion based on equality and freedom offer valuable perspectives on navigating religious diversity and fostering tolerance in modern societies. As we confront the challenges of our times, Phule's legacy reminds us of the importance of collective action, solidarity, and unwavering commitment to the pursuit of a more just and inclusive society.

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EMBRACING CHALLENGES, UNVEILING OPPORTUNITIES IN THE NEW LEARNING CULTURE OF ENGLISH LANGUAGE TEACHING IN GLOBALIZED WORLD

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Abstract
The present research article contemplates the transformative landscape of the twenty-first century, marked by unprecedented advancements in information and communication technologies. In the context of English Language Teaching, this research explores the shifting dynamics brought about by this new learning culture, which dismisses conventional resources such as books, traditional classrooms, and even the traditional role of teachers. Critical questions arise: Does the contemporary classroom maintain its significance in the face of these changes, or is it becoming obsolete? How does the role of teachers adapt to this evolving landscape, and is there still room for the essential element of hard work within the framework of enjoyable and playful learning experiences? The research article also aims to unravel these complexities and provide a nuanced understanding of the challenges and opportunities inherent in the new culture of learning within the field of English Language Teaching. In a globalized world where technology serves as a catalyst for change, this study offers insights into the intersection between learning culture, technology, and language teaching and learning. This dynamic exploration seeks to understand the evolving relationship between educational practices and the technological landscape, shedding light on the multifaceted impact of this intersection.
Keywords: learning culture, technology, language teaching and learning, globalized world, conventional resources

Introduction

In the contemporary era, technology permeates every facet of our daily lives, offering unparalleled significance and enjoyment. The expanding digital infrastructure, characterized by interconnected networks, grants us access to an abundance of remarkable resources. According to Khan (2015), "the convergence of information technology and advancements in learning science presents an opportunity to create well-designed, learner-centered, interactive, affordable, efficient, flexible e-learning environments". (Khan 01). Web-based technologies and robust internet connections, as highlighted by Sarica and Cavus, introduce a plethora of possibilities and cutting-edge trends for both educators and learners (434). However, the nature of learning in the wake of technological progress diverges significantly from traditional forms of education.

In the twenty-first century, the traditional confines of classrooms no longer define the learning landscape. Learning transcends these boundaries, unfolding dynamically and powerfully in every corner of our surroundings. This lifelong learning, constantly renewed and redefined, embodies what Thomas and Brown (2011) refer to as the "new culture of learning." (01). This contemporary learning paradigm operates devoid of traditional tools such as books, teachers, and classrooms, acknowledging everyone and everything as potential resources for the learning journey.

Exploring the Roles of Classrooms and Teachers

In the dynamic landscape of today's classrooms, teachers shoulder a multitude of responsibilities. Their pivotal role involves creating an environment conducive to learning, where students not only acquire knowledge but also cultivate essential skills. Embracing a holistic approach, students are encouraged to contemplate how to leverage available resources for profound exploration. To facilitate this, educators employ diverse teaching methodologies such as content-based and project-based approaches, alongside collaborative methods like co-teaching, team-teaching, and partnerships with fellow teachers. Mr. Sun underscores the benefits of these methods, providing educators with

valuable resources and opportunities. Navigating the ever-evolving educational landscape, teachers must remain open to embracing new ideas to effectively cater to the needs of our rapidly changing societies. (35)

Despite the transformative nature of the contemporary learning environment, it is crucial to recognize that the newfound freedom in learning doesn't equate to unrestricted access to information. Granting students access to the vast expanse of the Internet and encouraging pursuit of their interests might lead to aimless wandering, with students gathering fragments of information and hopping from one topic to another (Thomas & Brown 7). Interestingly, many students today possess a level of technological proficiency that surpasses that of their teachers, immersing themselves in a digital world in ways unprecedented for previous generations. However, amid this technological fluency, students still rely on guidance from their teachers to navigate the vast sea of information. Teachers play a pivotal role in helping students develop the skills to select, analyze, and utilize information and resources effectively, steering them toward the accomplishment of their learning goals in this new era of education.

Revolutionized Learning Culture within the Realm of English Language Teaching and Learning

The successful integration of technology across various domains has proven highly beneficial for educators, particularly in the realm of education and foreign language acquisition. In English Language Teaching and Learning, the ongoing advancement of web-based language instructional activities remains a dynamic and expanding frontier. While experts in computer programming, instructional design, and computational linguistics continuously push the boundaries of the field, language instructors can effectively utilize basic internet tools.

Language education extends beyond the confines of the classroom and should persist beyond formal instructional hours. Therefore, both students and teachers should consistently leverage technological devices. Internet connections and mobile devices, serving as mediums for interaction between language learners, teachers, and peers, stand out as popular and effective tools in language education. Consequently, it can be proposed that accessing resources through the internet offers an alternative method for studying English.

While technology has introduced more engaging and enjoyable methods for language acquisition, the essential need for continuous practice and hard work remains unchanged. Reflecting on Gladwell's "10,000-hour rule," which equates fluency to expertise in language proficiency, it becomes apparent that substantial investment in language studies is required to achieve fluency. Although the prospect of dedicating such extensive time and effort to attain fluency may seem daunting, it is essential to acknowledge the significant challenges associated with learning another language. Ultimately, achieving fluency demands persistent and remarkable effort over an extended duration. Worldwide, countless individuals have attained varying degrees of fluency in foreign languages through their sustained dedication, emphasizing the necessity of hard work in the language learning process.

Embracing Evolving Objectives in English Language Teaching and Learning

Change serves as both a motivator and a challenge, and the new culture of learning encourages embracing change rather than resisting it. To embrace change is to anticipate what lies ahead, viewing the future not as a force that compels us to adapt but as a realm of opportunities. The contemporary language classroom starkly contrasts with its predecessors, with a shift from a primary focus on grammar, memorization, and language skills to a more holistic approach.

Educators underscore that language is now perceived as a means of learning about the world, with learners using language and cultural knowledge to connect globally. Advancements in technology have dismantled geographical and physical boundaries, enabling students to engage with the world using their language and cultural skills to establish meaningful connections. The purpose of English learning has evolved beyond merely developing language skills and imitating native speakers.

Instead, the emphasis is on equipping learners with the skills and strategies to be effective and competent communicators in a globalized workforce. For English teachers, this shift implies moving away from traditional approaches centered on verbs and vocabulary lists. The focus is now on recognizing students' abilities to understand, use, and produce language across diverse forms and purposes. English learners should be provided with opportunities to vividly demonstrate the impact of English language learning on their lives.

Furthermore, the goals of English Language Teaching (ELT) have transcended the exclusive focus on mimicking "inner circle" speakers. There is a paradigm shift toward fostering a sense of social responsibility in students. Recent research and educational programs prioritize the development of English speakers as fully competent language users, critical thinkers, and constructive social change agents. We can observe discussions in keynotes and conference sessions highlighting the moral dimension of English teaching and the need for an educational approach that nurtures a sense of social responsibility. It is underscored that English teaching cannot be deemed successful if students, despite linguistic fluency, remain ignorant of global issues, lack social conscience, or misuse their communication skills for nefarious purposes.

Challenges and Opportunities

Technology is changing really quickly, and now teachers can use things like cell phones and other devices to get a lot of information. It's not just a small change - the whole system has grown to make these changes possible. Things like the Internet and e-books are made to help teachers plan lessons and activities easily. With just a quick search on Google, teachers can find free lesson plans, activities, exercises, and videos. Teachers can make the class more interesting by using these ready-made materials. But, for today's students, just watching videos, playing internet games, or using an interactive whiteboard might not be enough. Students need access to different tools and activities using technology that make them think, solve problems, work in teams, and be creative.

Using technology in class helps students use language in different ways and brings real-world problems into the classroom. So, it's important that English teachers are ready for quick changes and using technology in English teaching and learning. But, using technology isn't just about using it for the sake of using it. It's about using it to help students learn and show what they know. As Eaton says, "students are the creators, not just users, of technology and projects made with technology" (33). They are using their creativity to express themselves and show what they know using technology. They can also connect with and share ideas with learners from different parts of the world through technology. So, the challenge for teachers in the 21st century is to find the right technologies for this.

In the last few years, technology has changed the way people learn languages. Online lessons using programs like Skype or Google Hangouts are becoming more popular. The big advantage of online lessons is that they are flexible. Neither the teacher nor the student needs to travel to a specific place for the lesson. They only need basic equipment like a laptop and an internet connection, which most people have. Online learners can also talk to people from all over the world. Even though online lessons have some problems, like missing face-to-face interaction, now language learners have another choice besides traditional in-person courses. So, teachers of traditional or online programs need to focus on what the other one is not good at.

Conclusion

In conclusion, the rapid pace of global change has instigated a transformative shift in education. The traditional, rigid methods of teaching are gradually giving way to more collaborative and flexible approaches that recognize the evolving needs of learners in the 21st century. Today's youth actively seek guidance, coaching, and mentorship, displaying a keen curiosity about the world and a strong awareness that learning is an ongoing and integral part of their lives. With the advent of technology, the educational landscape has expanded, granting learners unparalleled access to a wealth of

information. This technological integration necessitates a paradigm shift in how we approach teaching, with an emphasis on leveraging technology to encourage continuous learning at every life stage. Recognizing technology as an inherent part of our lives, both a ubiquitous presence and a vital tool, becomes imperative. Embracing this reality positions us to navigate the challenges and opportunities presented by technology, ensuring that learning remains a dynamic and engaging process for students and educators alike. Moreover, the trends in English language learning propel us toward a future where students are not merely acquiring language skills but are also being empowered to communicate globally and effect positive change. The shift from focusing solely on language proficiency to nurturing students as potential social change agents underscores the evolving culture of English language teaching and learning. This paradigm envisions English language education as a vehicle for developing not just linguistic competence but also fostering a sense of social responsibility, thereby contributing to the creation of a more interconnected and compassionate global community. In this ever-evolving landscape, the role of English language educators becomes pivotal, guiding students to not only master a language but also become active contributors to a brighter, more inclusive future.

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Bama's Karukku and Sangati: A Study of Autobiographical Narrative and Linguistic Revolt

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Abstract :

This paper examines the narrative strategy and language style employed by Indian Dalit writer Bama in her novels "Karukku" and "Sangati." Bama's autobiographical works differ from traditional narratives, as she adopts a testimonial autobiography style that gives voice to the silenced experiences of the Dalit community. By using a distinct narrative approach, Bama transforms conventional literary techniques to accommodate the stories of marginalized individuals and create a unique social experience for readers. She utilizes folk language and challenges conventional etiquette and grammar to convey the traditions and experiences of her community. Bama, also known as Karukku Bama, is a Tamil writer, teacher, and social activist who has made significant contributions to Dalit literature. Her novels focus on caste and gender discrimination within Christianity and Hinduism, celebrating the inner strength of subaltern women. Through her conversational writing style and use of marginalized language, Bama breaks away from elitist literary norms and provides a platform for the oppressed to articulate their lives. Bama's writing serves as a political act, challenging prevailing perceptions and narratives of Dalit women's lives. By exploring the close connection between education, writing, and empowerment, Bama aims to free Dalit women from perpetual repression and contribute to the establishment of a casteless society. "Karukku" serves as a testimony not only to Bama's personal experiences but also to the struggles faced by the Dalit community as a whole. The novel offers insights into the social, cultural, and familial life of Dalits, portraying their everyday existence and challenging oppressive norms. In addition, Bama's unconventional linguistic style rebels against the dominant upper-caste Tamil language and incorporates elements of an oral tradition, resulting in a fresh aesthetic that aligns with her political views. This paper recognizes Bama as a powerful voice of the subaltern woman, emphasizing the importance of a moral response to the subaltern's narrative and the creation of a space for their voices to be heard. Overall, Bama's works, particularly "Karukku," stand as a testament to the resilience and dignity of the marginalized, providing a platform for their stories to be acknowledged and celebrated.

Key words :

Karukku, Sangati, Testimonial autobiography, Marginalized community, Narrative strategy, Language style, Folk language, Caste discrimination, Gender discrimination, Christianity, Hinduism, Social activism,

Introduction :

Bama, also known as Faustina Mary Fatima Rani, is a prominent Indian writer and activist. Born into a Dalit family in Tamil Nadu, India, Bama has emerged as a powerful voice representing the marginalized communities in Indian society. She has made significant contributions to literature by shedding light on the experiences of Dalits, particularly Dalit women, and by advocating for social justice and equality. Bama's literary works have garnered critical acclaim and have played a pivotal role in challenging prevalent social norms and perceptions. Her writings provide an insight into the lives of individuals from marginalized communities, highlighting their struggles, aspirations, and resilience. One of Bama's most renowned works

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is "Karukku", a groundbreaking semi-autobiographical novel published in 1992. "Karukku" narrates Bama's personal experiences as a Dalit woman, exploring the intersecting issues of caste, gender, and religion. It delves into the challenges faced by Dalit communities and exposes the deeply entrenched caste discrimination prevalent in Indian society. Another notable work by Bama is "Sangati" (1994), a collection of short stories that offer a vivid portrayal of the lives of Dalit women in rural Tamil Nadu. Through these narratives, Bama captures the everyday realities, social injustices, and struggles faced by Dalit women, shedding light on the intersectional nature of oppression and discrimination. Bama's works often incorporate testimonial autobiography as a narrative strategy, drawing from her own experiences and those of others within her community. Her writing style reflects the use of folk language, rooted in the traditions and oral culture of Dalit communities. This language choice not only adds authenticity to her narratives but also challenges the elitist literary norms that have traditionally marginalized voices from oppressed communities. Furthermore, Bama's works explore the complex dynamics between religion and social activism. As a Christian woman from a marginalized background, she reflects on her own experiences and critiques the hierarchical structures within Hinduism while promoting social justice and equality as core tenets of Christianity. Through her writings and activism, Bama aims to empower marginalized communities, challenge oppressive systems, and foster a casteless society where individuals are treated with dignity and equality. Her works have become a source of inspiration for many, and her powerful voice continues to resonate in the fight against discrimination and social injustice.

Discussion :

"Karukku can be regarded as an autobiographical memoir by Bama, encapsulating the joys and struggles experienced by her community, who endure oppression due to their lower social status in India. The book reflects various events that unfolded throughout her life. Born into a disadvantaged Dalit family, her grandmother and mother toiled in the fields and homes of Naicker landowners. Despite the bleak circumstances, Bama had a carefree childhood. Her brother, Raj Gauthaman, himself an author, introduced her to the world of literature and encouraged her writing endeavors. While in school, she began composing poetry and later transitioned to fiction writing. Following her education, she pursued a career as a teacher. Bama vividly portrays the discrimination she faced both as a student and as an educator. She acknowledges that her intellectual prowess and teaching abilities allowed her to partially escape the harsh persecution. However, her life took a significant turn when she, at the age of 26, took the vows to become a nun. Yet, in the theological college and later within the religious community, Bama realized the stark reality that the plight of Dalits would persist. As a result, seven years later, in 1992, Bama decided to leave the religious order. Outside the convent, she encountered numerous challenges and faced relentless scrutiny. It was her decision to recount these experiences in her autobiography that saved her from succumbing to despair amidst her struggles. Consequently, with the publication of Karukku, Bama rose to immediate fame and gained recognition within intellectual circles.

On the other hand, Sangati offers a compelling glimpse into the lives of Dalit women who face the dual burdens of caste and gender discrimination. Written in an informal style, the original Tamil version challenges the established norms and aesthetics of upper-caste privileged Tamil literature and culture, thereby projecting a positive social identity for Dalits in general and Dalit women in particular. Sangati defies conventional expectations of a novel, eschewing a traditional plot structure. Instead, it delves into the inner world of a Dalit woman who ventures beyond her small-town community only to confront a hierarchical and oppressive society that persistently questions her social standing. Realizing that leaving her community does not provide an

escape, she must navigate life as an educated, economically independent woman living alone. In narrating this story, Bama transforms Sangati into a narrative that encompasses not only one individual's experiences but also the collective struggle of an ostracized community. The themes of arduous labour and economic instability are central, and Bama fearlessly explores the culture of violence that emerges as a result. She also depicts the harsh treatment of women by their fathers, husbands, and brothers, as well as the open confrontations that occur within households, where women occasionally fight back. Bama's language differs markedly from that of other female Indian writers, as she freely incorporates Dalit Tamil slangs. She addresses the women of the town by adding "amma" (mother) to their names. From the names of places, months, festivals, rituals, customs, utensils, jewellery, clothing, food, games, and more, to the terms used to address family members, ghosts, spirits, and the like, Bama consistently employs various Tamil words."

Testimony of the Dalit Community :

The term "testimony" and "testify" originate from the Latin word "testis," which translates to "witness." Testimonial Literature refers to oral or written autobiographical narratives, particularly those that provide evidence of human rights abuses, injustices, wars, and living conditions under social oppression. George Yudice, as cited in Worldlitonlinenet, defines Testimonio as "an authentic narrative told by a witness who is compelled to narrate due to the urgency of a situation such as war, oppression, revolution, etc." (22). In the case of Bama's Karukku, it not only serves as her autobiography but also becomes the testimony of a community. The term "Dalit" originates from the Marathi language and is derived from Sanskrit, where "dala" means "of the soil or the earth," implying a connection to the land. Another meaning of Dalit is "that which is rooted in the soil." Karukku is considered a compilation of Bama's childhood memories, which not only depict joys and sorrows but also shed light on her community's oppression by higher castes in India. "As a woman and as a Dalit Christian, Bama's act of expression can be viewed as a subaltern expression." Karukku emerged as a resistance against continuous caste and gender oppression and ultimately became a testimony of a Dalit Christian woman's harrowing experiences. Her act of witnessing became a source of inspiration for her fellow writers. Bama's memoir collection stands apart from conventional styles and can be categorized as a subaltern testimonial autobiography. Thus, it is relevant to study a content that documents the oppression faced by a subaltern Dalit woman. While Karukku focuses on the self and identity, Sangati revolves around a group of characters. Both novels discuss the Paraiya community, which faces double oppression. In Gayatri Spivak's seminal work "Can the Subaltern Speak?," an essential contribution to the theory of subalternity, she explores the necessity of giving voice to the radical Other to express their experiences. According to Spivak, the Subaltern is someone who lacks position or power outside the discourse that constructs them as a subject. She argues that accessing a 'pure' subaltern consciousness is impossible because the subaltern cannot speak in a discourse where they have minimal control. Furthermore, there is always someone who represents the Subaltern. It is through the recognition by the Western world that the subaltern finds an identity. However, Spivak opposes the attempt by intellectuals to recover the voice of the Subaltern because in such an endeavor, the intellectual becomes merely a conduit through which the subaltern's voice emerges. Only the subaltern themselves can fully articulate their poignant experiences, and when others speak on their behalf, it will only capture half of their lives. There is a crucial need for an ethical response to the subaltern's voice, as Spivak argues that "the subaltern can be represented only in an ethical relation where there is the deliberate creation of a space, a room for the voice of the radical Other" (171-172). In Karukku, Bama emerges and establishes herself as a powerful

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voice of the subaltern woman. Thus, in Karukku, the "subaltern speaks." Bama effectively portrays the social, cultural, and familial lives of Dalits. The narrative goes beyond the depiction of persecution and the harsh realities faced by Dalits. It intricately describes the everyday life, language, naming traditions, religion, culture, festivals, food habits, entertainment, games, teasing songs, and relationships within the Paraya community. Regarding religion, Bama discusses the cultural significance of drumming, which is highlighted in their celebration of "Pusai." Karukku

Revolt in Linguistic style :

Bama employs a Dalit style of language that challenges and subverts the adopted high society, upper-caste Tamil. She deliberately breaks the conventions of written grammar and spelling, omitting words and rearranging them to create a new and distinct reading pattern. Moreover, Karukku utilizes an informal discourse style that establishes an intimate connection with the reader. Bama openly addresses her identity as a Dalit and Christian, demystifying religious conflicts and presenting her choice as a matter of personal conviction.

In addition to the subversion of standardized Tamil, Dalit writing is characterized by other notable features. It draws inspiration from and remains closely tied to an oral tradition comprising work chants, folk songs, songs sung at rites of passage, and proverbs, with certain elements specifically associated with women's experiences. Karukku, in its unique manner, also recounts the story of Tamil Dalit Catholicism through the vocabulary it employs, particularly in the central section that describes the protagonist's spiritual journey from childhood faith to eventual return after leaving the religious community. There is often a layering of meaning in specific words, as Tamilized Sanskrit words take on new Catholic connotations. For example, the Tamil word "mantiram" (derived from Sanskrit "mantra") becomes synonymous with "catechism" in the context of Catholic usage. Hence, there are shifts and slippages in how Catholicism is naturalized into the Tamil language of the text.

It is noteworthy that Bama consistently uses the language of popular Catholicism. Additionally, the games played by children are gender-segregated. As the narrator recalls in Sangati, boys do not allow girls to participate in their games. Girls are limited to playing house, pretending to be married off, or even pretending to be beaten by their husbands (Sangati 56). In Karukku, the narrator provides a detailed account of the games played by children in a Pariyar village. Boys assume the roles of Naickers (upper-caste landlords), while girls enact the roles of Pannaiyaals (farmhands).

Dalit girls who are fortunate enough to attend school regularly, like Bama, face caste-based discrimination at various stages of their educational journey. Bama vividly describes in Karukku that she came to "realize, recognize, and feel humiliated" about her untouchable status when she was in the third grade. However, the journey back home from school was always enjoyable for Bama and her friends. They would walk through the marketplace, observe various forms of rural entertainment such as monkey dances and the skills of snake charmers, and experience the aromas emanating from food stalls. They would also interact with vendors selling beads and strings and occasionally witness magic shows, "Therukootu" performances, or listen to political speakers extolling the virtues and grandeur of their leaders. This joyous journey, filled with innocent pleasures, was likely a common experience in the daily lives of rural children.

Conclusion :

Bama's use of language in her writing reflects a decisiveness, freedom, passion, and responsiveness that goes beyond the constraints of scholarly language expected in standard literature. Dalit life possesses its own style, vernacular, culture, and identity, and Bama captures these intricate details in her narratives. Bama provides ample and valid reasons for the harshness of their language, which serves as a shield to protect them. At times, the sharp tongues and offensive words used by

women help them escape from severe physical violence inflicted by men and shame them in return. In other instances, Bama suggests that such language may arise from a deep-rooted lack of peace and joy in their lives.

Bama explores various aspects of Dalit language in her stories, enriching her narratives with a unique ingredient found in Dalit language-mockery, parody, and subtle irony. She uses language to evoke the reader's emotions directly, providing an experience that resonates with those who live among Dalits or enabling Dalits to connect with the experiences depicted in her works. Through her language, Bama asserts her own distinct identity as well as the life and stature of the Dalit characters around whom her stories revolve. Ultimately, her work demonstrates that Bama possesses a refined taste of her own, and her characters are by no means lacking in aesthetics or crude in nature. By employing the language of resistance and rebellion, Bama attempts to weave the language of Dalits into her writing.

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EMPOWERING FEMINIST DISCOURSE: UNRAVELLING SOCIETAL STRUGGLES IN MAHASWETA DEVI'S *MOTHER OF 1084*

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ABSTRACT

This paper delves into the empowering feminist perspectives found within Mahasweta Devi's critically acclaimed novel, Mother of 1084. As a prominent feminist writer in Indian English Literature, Devi skillfully weaves a tapestry of human values and complex relationships, while also confronting the societal struggles for self-identity, self-assertion, individuality, and freedom faced by women. Her literary work is deeply rooted in sociological and cultural contexts and driven by a strong feminist ideology that profoundly influences her storytelling. Drawing from Mother of 1084, this paper explores how Devi utilizes female characters as powerful devices to expose and challenge a society that perpetuates discrimination and victimization of women. By highlighting the multifaceted barriers, including cultural norms, legal constraints, political dynamics, and social restrictions, Devi offers a profound critique of the patriarchal structures that constrain women's agency and opportunities for self-actualization.

Key words: *empowering, transformative dialogue, societal norms, gender dynamics, discrimination, victimization,*

INTRODUCTION

Feminist writers have long harnessed the power of fiction to give voice to their inner struggles, championing themes of self-identity, self-assertion, individuality, and freedom. These literary works draw strength from the sociological and cultural contexts in which they emerge, underpinned by the core tenets of feminist ideology. Among the luminous voices in this realm, Mahasweta Devi occupies a revered position in the landscape of Indian English Literature. Her literary contributions delve beyond the realm of storytelling, probing human values and intricate relationships with profound insight. In her renowned novel, Mother of 1084, Devi artfully employs female characters as vehicles to lay bare a society that perpetuates discrimination and victimization of women. With unwavering courage, she illuminates the multifaceted struggles faced by women, exposing the patriarchal structures and norms that circumscribe their lives. Beyond mere storytelling, Devi's narratives function as powerful social commentaries, unearthing the cultural, legal, political, and social barriers that constrict women's agency. One of Devi's remarkable abilities is to draw parallel narratives that highlight the symbiotic relationship between the struggle for women's rights and the pursuit of political empowerment. By intertwining the narratives of her female protagonists with political struggles, she underscores the inseparable link between women's liberation and broader societal progress. In this way, Devi portrays the pivotal role that women novel in shaping the destiny of their communities and nation.

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This paper delves into the empowering feminist perspectives found within Mahasweta Devi's critically acclaimed novel, Mother of 1084. As a prominent feminist writer in Indian English Literature, Devi skillfully weaves a tapestry of human values and complex relationships, while also confronting the societal struggles for self-identity, self-assertion, individuality, and freedom faced by women. Her literary work is deeply rooted in sociological and cultural contexts and driven by a strong feminist ideology that profoundly influences her storytelling. Drawing from Mother of 1084, this paper explores how Devi utilizes female characters as powerful devices to expose and challenge a society that perpetuates discrimination and victimization of women. By highlighting the multifaceted barriers, including cultural norms, legal constraints, political dynamics, and social restrictions, Devi offers a profound critique of the patriarchal structures that constrain women's agency and opportunities for self-actualization.

Indian society grapples with profound conflicts and contradictions, particularly in its treatment of women. Females find themselves on the periphery of family dynamics, both in their parental homes and within their marital households. They lack the agency to determine their roots, and their societal status remains precarious, leaving them with a pervasive sense of insecurity. Devi, as a woman, explores the multifaceted challenges faced by every woman in this hypocritical society. They are compelled to occupy a secondary role while simultaneously expected to be the linchpin holding families together. This dichotomy inflicts a profound psychological toll, as it forces women to grapple with the clash between their intrinsic knowledge and the expectations imposed upon them by their environment. In "*Mother of 1084*," Devi skillfully portrays the inner turmoil experienced by women as they navigate this internal conflict.

In "Mother of 1084," Sujatha, a grieving mother, comes to a profound realization about why her murdered son, Brati, chose to join a violent uprising. The narrative skillfully blends indigenous oral histories with contemporary events to delve into the bitter and often bloody relationship between tribal communities and India's dominant classes and systems. Alongside this exploration, it sensitively portrays the intricate emotions of a mother.

The novel draws its strength from a rich tapestry of history, folk myths, and the stark realities of the present day. Devi uses a recent historical event as a lens through which to comment on the present, presenting it as a cautionary fiction that universalizes the human experience, a narrative that sheds light on what drives many sons to martyrdom. On one level, the novel might seem like a straightforward account of the brutal suppression of an apolitical woman in the role of a mother. However, it ultimately reveals her awakening to a deeper truth about martyrdom, transcending the specific circumstances to touch upon broader themes of sacrifice and devotion.

The novel "Mother of 1084" unfolds within the span of a single day in the life of its central character, Sujata. She is the mother of Brati, also known as corpse number 1084, and hails from a relatively affluent middle-class family. Despite being a sensitive wife and a loving mother, Sujata feels like a stranger within her own household, where her role has been reduced to that of a mere cog in the machinery. She finds solace and a sense of belonging in the company of her younger son, Brati Chatterjee. Unlike her other children, Brati is a man of ideals, and it is his life and activities that Sujata struggles to comprehend. The absence of understanding between them adds to the tragic depth of the novel. It's only when Sujata pieces together the fragments of her son's life that she can find a moral rationale for his involvement in the uprising, and this process of discovery continues until the novel's conclusion.

Sujata, a traditional and subjugated woman, reflects on her life two years prior when she prepared to bring Brati into the world. She faced the challenges of pregnancy alone, without any support, and Brati was born on the dawn of January 17, 1948. Her life became a misery due to her husband's lustful behaviour and her overbearing mother-in-law. As a traditional wife, she continues to coexist with her husband, who is the family's primary breadwinner and caretaker of their children. However, the patriarchal norms of society prevent women from breaking free from the entanglements of family ties. Sujata's husband, Dibyanath, treats her as a mere childbearing machine, mirroring her mother-in-law's attitude. She is not even allowed to care for her children, Jyothi, Neepa, and Tuli, and they grow up inheriting the same character as their grandmother. Sujata finds no fulfillment in her marital life, leading to frustration and disillusionment, causing her to forget her self-worth as a woman.

In contrast to her other children, Brati has a special affection for his mother. He is the only son who yearns for her and cries for her when she is away working at the bank. He revels in her presence. Sujata reminisces about the fateful night when she received a phone call in her sleep, delivering the devastating news of her beloved son's death. She is not only shattered by this news but also by her husband's callousness. Dibyanath denies Sujata the use of his car on the day of Brati's death, fearing that it might tarnish his social standing. He even goes to great lengths to prevent Brati's name from being published in newspapers, attempting to erase Brati's existence from their home by relocating his picture, old shoes, and raincoat from the common areas to a room on the second floor.

Brati's death leaves a profound void in Sujata's life, and even two years after his passing, his memories continue to haunt her. She is determined to uncover the reasons behind her son's sacrifice. Despite the deep emotional connection between Sujata and Brati, she remains largely unaware of his ideology and his activities. As she reflects, "Brati was the soul of my life, yet I know so little about him" (Devi 8).

Sujata's quest for understanding leads her into a series of encounters with individuals who shared Brati's cause. This learning process continues until she gradually aligns herself with her son's ideology. Her interactions with Somu's mother and Nandhini open her eyes to a different facet of life to which she had previously been a stranger. She begins to identify with the suffering of humanity and transitions from her previous position as an apolitical mother to becoming socially conscious.

Nandhini, an activist and devoted follower of Brati, provides Sujata with insight into a part of her son's life and helps her realize the distressing social realities. Sujata's confrontation with Somu's mother, who lost her son to a mob's outrage, fills Sujata with a deep sense of empathy. It is profoundly moving to witness people entrusted with the responsibility of upholding human values acting callously toward the innocent. This contrast is especially evident when comparing Brati's father with Somu's father. Somu's father's futile attempt to seek help from the police station and his subsequent return with shattered hopes underline the inhumanity of the situation. Somu's mother's heart-wrenching cry upon identifying her son in the police morgue shocks even those who may have appeared stone-hearted.

Mahasweta Devi's literary works predominantly feature female protagonists and serve as a powerful vehicle to expose the societal injustices and discrimination faced by women. Her writings have garnered political support from various quarters. Devi firmly believes that women and society are interconnected, with both being essential for the well-being of the people. She emphasizes the cultural, legal, political, and social restrictions that limit women's freedoms and seeks to liberate them from being mere appendages or shadows of men. Her literary heroines are often portrayed as courageous intellectuals who challenge the prevailing norms that victimize women.

Throughout her writings, Mahasweta Devi vividly depicts the lives of ordinary women, particularly tribal women. She explores the simple joys and sorrows they experience, the exploitation and suffering they endure, and the abject poverty that often defines their existence. Her treatment of women in her works is imbued with empathy, and her profound humanism reflects a deep-seated love for humanity, particularly for those who are suffering. Most of her short stories and novels shed light on the lives of oppressed and neglected tribal women who are subjugated by society and exploited by the greed, narrow-mindedness, and selfishness of men.

Mahasweta Devi's prominence in contemporary literature is a testament to her ongoing efforts to bring the struggles of oppressed communities to the forefront. Her works have contributed to the emergence of these communities from the shackles of subjugation, slavery, and oppression. She continues to be a beacon of hope and a voice for those who have long been marginalized and silenced.

CONCLUSION:

The history of the world is fundamentally a narrative of conflict between two distinct communities: the community of oppressors and the oppressed often referred to as the subalterns. When these two communities, each embodying opposing value systems, coexist, the one with political, economic, and technological dominance tends to subjugate the other. Mahasweta Devi's unique literary approach involves taking unconventional themes from contemporary life and transforming them into works of artistic excellence. At the core of her creative endeavours is the central message of survival through struggle. Consequently, her writing vividly portrays the authentic and harrowing details of abject poverty through the lives of real subaltern characters with their unique histories. Driven by a profound social concern, she is compelled to write about the plight of the impoverished, shedding light on their struggles and suffering.

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महानुभाव पंथाचा स्त्रीविषयक दृष्टीकोन: एक चिकित्सक अध्ययन

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तेराव्या शतकाच्या उत्तरार्धात महाराष्ट्र महानुभाव पंथाची स्थापना श्री चक्रधर स्वामी यांनी केली. समाजातील तत्कालीन परिस्थितीचा विचार करता महानुभाव पंथाने स्त्रियांच्या संदर्भात स्वीकारलेली औदार्यपूर्ण भूमिका वैशिष्टयपूर्ण मानावी लागेल. पंथ संस्थापक श्री चक्रधर स्वामी, त्यांचे गुरु श्रीगोविंद प्रभू आणि चक्रधर स्वामीच्या पश्चात त्यांच्या अनुयायांनी स्त्रियांच्या बाबतीत उदार दृष्टिकोन बाळगलेला दिसून येतो. सनातनी समाजाच्या विरोधाला न जुमानता स्त्रियांना पंथाने संन्यास धारण करण्याचा व आध्यात्मिक कार्याचा अधिकार प्राप्त करून दिला. पंथ धुरीनांनी व त्यांच्या अनुयायांनी स्त्रियांचा वेळोवेळी केलेला आदर सन्मान विविध प्रसंगातून प्रतिबिंबित होतो. पंथात प्रविष्ट झाल्यानंतर स्त्रियांच्या जीवनात कमालीचे परिवर्तन घडवून आल्याचे दिसते. पंथात स्त्रियांना पुरुषाच्या बरोबरीचा दर्जा प्राप्त झाला. एक स्त्री म्हणून नव्हे तर माणूस म्हणून जगण्याचा अधिकार व त्या दृष्टीने मिळालेले व्यक्ती स्वातंत्र्य या विशेष उल्लेखनीय बाबी सांगता येतील. व्रत वैकल्ये, तीर्थाटन, उपासतापास यामध्ये अडकलेल्या स्त्रियांना नवीन विचार देण्याचा प्रयत्न महानुभव पंथाने केला. पंथीय स्त्रियांची घेतली गेलेली काळजी, त्यांच्या संरक्षणाच्या दृष्टीने योजलेले उपाय, तसेच त्यांना मिळालेल्या अंगभूत गुणाची जाणीव इत्यादी स्त्रियांच्या उद्धाराच्या दृष्टीने महत्त्वपूर्ण बाबी ठरल्या. तथापि स्वातंत्र्याबरोबरच योग्य त्या शिस्तीचे धडे देखील स्त्रियांना पंथात प्राप्त झाले. विविध सण उत्सव साजरे करण्याचे स्वातंत्र्य तसेच गायन, चित्रकला, नृत्य यासारख्या कलाप्रकाराचे अभिव्यक्ती स्वातंत्र्य आणि प्रेरणा महनुभाव पंथातील स्त्रियांना मुक्तपणे मिळाली. एक संन्यासप्रवण पंथ असताना देखील महानुभाव पंथाने स्त्रियांबाबत बाळगलेला दृष्टिकोन महानुभाव साहित्यातून ठिकठिकाणी प्रतिबिंबित झालेला दिसून येतो.महानुभाव पंथाच्या वाङ्मयांमध्ये काही पंथीय स्त्रियांचा वारंवार उल्लेख येतो.लीळांमध्ये या स्त्रियांची कार्य कधी कधी दिसून येतात. त्याचबरोबर पंथप्रमुखाचा त्यांच्याबद्दलचा दृष्टिकोनही प्रतीत होतो. प्रस्तुत संशोधन लेखात महानुभाव पंथाच्या स्त्री विषयक दृष्टिकोनावर प्रकाश टाकण्याचा प्रयत्न करण्यात आला आहे.

आध्यात्मिक अधिकार:-

महानुभाव पंथाच्या काही शतका अगोदर जैन धर्माचा प्रभाव महाराष्ट्रात होता. दहाव्या शतकाच्या उत्तरार्धात नाथ आणि वीरशैव या उदार विचारसरणीच्या पंथाचा प्रसार महाराष्ट्रात झालेला होता. या काळात महाराष्ट्रात नाना प्रकारची देवदैवते, मंत्रतंत्र,व्रतवैकल्ये इत्यादींचा सुकाळ माजलेला होता. स्त्रियांचा समाजातील दर्जा घसरलेला होता. या पार्श्वभूमीवर वीरशैवांनी स्त्रियांबद्दल उदारपूर्ण दृष्टिकोन स्वीकारून त्यांना व्यक्ती स्वातंत्र्य प्रदान केले. वीरशैवांच्या या विचारांचा प्रभाव महानुभाव पंथाच्या स्त्रीविषयक दृष्टिकोनावर झालेला दिसून येतो. स्त्री ही शूद्र आहे अशी भावना बाळगणाऱ्या त्या काळात महात्मा बसवेश्वरांनी तिला इष्टलिंग दीक्षा देऊन आत्मोन्नतीचा मार्ग दाखविला. पुरुषांप्रमाणे स्त्रीलाही समान हक्क दिला'.[1] हाच दृष्टिकोन महानुभाव पंथ संस्थापक श्री चक्रधरांचा होता. श्री चक्रधर स्वामी यांनी आपली मतप्रणाली पंथाच्या रूपाने महाराष्ट्रात रुजविण्यापूर्वी बरीच वर्ष एकाकी भ्रमण केले. या भ्रमणातच त्यांची बोणेबाई या स्त्रीशी भेट झाली. पुढे बोणेबाई सोबत पैठणला स्वामींचे वास्तव्य असताना त्यांची भेट नागुबाई उर्फ नागांबीकाशी झाली.'पैठण हे यादवकालीन अतिशय संपन्न विशाल व वैभवशाली नगर होते. येथे सकलशास्त्र, कोविंद ब्राह्मण, धार्मिक व गृहस्थवर्ग, संन्याशी आदी विविध स्तरातील व्यक्तींचे वास्तव्य होते.'[2]नागांबीका ही विधवा स्त्री होती.नागांबीका हिने कर्मकांड,भ्रामकल्पना,व्रतवैकल्य यात स्वतःला गुंतवून घेतले होते. स्वामींनी तिला निरर्थक, भ्रामक समजुती मधून बाहेर काढण्याचे काम केले.वि.भी.. कोलते यांनी चक्रधर चरित्रात म्हटल्याप्रमाणे 'सिंहस्थ शके ११८९ ला येतो याच साली श्री चक्रधर स्वामींनी बाईसाला भेट देऊन प्रेमसंचार केला.'[3]प्रेमसंचार म्हणजे भक्तीचा नवा मार्ग सांगितला. हीच नागुबाई उर्फ बाईसा इथपासून स्वामींच्या पूर्वार्धकाळातील प्रथम स्त्री शिष्य होय. चक्रधर स्वामींनी पंथप्रसाराची मुहूर्तमेढ एक स्त्रीला संन्यास धारण करण्याच्या अधिकार प्राप्त करून देऊन केलेली दिसून येते.

महानुभव पंथात स्त्री आणि पुरुष अनुयायांना समान पद्धतीने संन्यास दीक्षा दिली जाई. पंथाचे प्रथम आचार्य नागदेवाचार्य उर्फ भटोबास यांनी श्री चक्रधरांकडे संन्यास दीक्षा घेतली. त्याचे वर्णन लीळाचरित्रात आले आहे. पैठण येथून पंथ विचारांच्या प्रचारास चक्रधर स्वामींनी सुरुवात केली. महाराष्ट्रातील बराचशा भागात त्यांनी परिभ्रमण केले. हा त्यांच्या आयुष्याचा पूर्वार्ध काळ म्हणून ओळखला जातो. वैधव्य प्राप्त झालेल्या, परित्यकता स्त्रिया या काळात चक्रधरांना अनुसरल्या. या काळात वैधव्य प्राप्त झालेल्या स्त्रियांची स्थिती अत्यंत बिकट होती. महादाईसा ही

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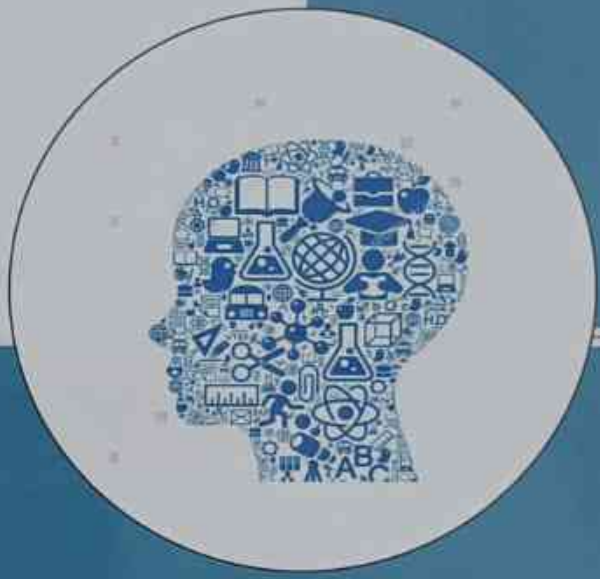

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भारतीय शास्त्रीय संगीतात गुरु शिष्य परंपरेचे महत्व

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सारांश –
भारतीय संगीतामध्ये गुरुंचे महत्वाचे स्थान आहे . गुरुशिष्य परंपरा संगीत शिक्षणामध्ये सर्वात प्राचीन आणि सर्वश्रेष्ठ प्रणाली मानल्या जाते. वैदिक काळापासूनच संगीत शिक्षण हे गुरु मुखातून दिल्या जात होते . गुरुकुलातच राहुन गुरुंनी ठरवून दिलेल्या कठोर नियमांचे पालन, संयमित जिवन जगून गुरुंच्या मार्गदर्शनाखाली मिळालेले शिक्षण साधना व तप करून ग्रहण करणे हेच साधन होते . प्राचीन काळापासून मध्यकाळाच्या अंतापर्यंत ज्ञान प्राप्तीचे एकमेव साधन केवळ गुरुमुख हेच होते. त्या काळातील ज्ञानाचे भांडार हे वेदशास्त्र , दर्शन आणि कला या चार प्रकारांमध्ये विभाजित केले होते . ग्रंथनिर्मितीचा अभाव असल्याकारणाने विद्यार्थ्यांना आपला अभ्यास मुखोदगत करावा लागत असे . विद्यादानाचे हे काम समाजातील विव्दान , त्यागी , सदाचरणी गुरुजनांव्दारे केल्या जात असे . ज्ञान प्राप्तीचे एकमेव मार्ग गुरु असल्या कारणाने प्राचीन आणि मध्यकालामध्ये गुरुजनांना अतिशय महत्वाचे स्थान होते . एखादा मुर्तिकार ज्याप्रमाणे मातीच्या गोळ्यापासून किंवा एखादया दगडापासून एक सुंदर मुर्ती तयार करतो अगदी त्याचप्रमाणे एखादा साधारण व्यक्ती गुरुंच्या संस्कार आणि मिळालेल्या ज्ञानातून असाधारण आणि गुणसंपन्न व्यक्ती घडतो . खरंतर ही गुरुंची महिमाच म्हणावी लागेल . संपूर्ण विश्वामध्ये हिंदूस्थानी शास्त्रीय संगीताला कलेचा उत्कृष्ट नमुना म्हणुन मानल्या जाते आणि हा कलेचा ठेवा गुरुशिष्य परंपरेमुळे आजपर्यंत सुरक्षित आहे परंतू काळानुरूप यामध्ये परिवर्तन होत गेले. आणि आज आपण त्याच संगीताचे परिवर्तीत रुप बघत किंवा अनुभवत आहोत ज्याला आमच्या पुर्वजांनी जतन करुन त्याला समृद्ध केले. प्रस्तुत शोध निबंधामध्ये यावर सविस्तर चर्चा केलेली आहे .

प्रस्तावना :-

शिक्षणाचे मुख्य कार्य संस्कृती आणि सभ्यतेला सुरक्षित ठेवणे . संगीत हे मानव समाजातील कला संस्कृती व परंपरेचे मूर्तिमंत प्रतीक आहे.संस्कृती व परंपरेला एका पिढीपासून दुसऱ्या पिढीपर्यंत पोहोचविण्याचे कार्य हे संगीत करते. कला ही संस्कृतीचा आरसा असून संस्कृती ही कलेची प्रेरणा होय . संगीत व संस्कृतीचा विकास एक दुसऱ्याशी निगडित आहे मानवाचा सम्यक विचार , उत्कृष्ट चरित्र निर्माण , नियमित व अनुशासित बौद्धिक विकास , तसेच सामाजिक उत्थाना प्रति जागरूक राहून प्रेरित करणे हे संगीत शिक्षणाचे उद्देश मानल्या गेले आहे. अशाप्रकारे भारतीय संस्कृतीमध्ये प्राचीन काळापासूनच संगीत शिक्षणाचे महत्त्व दिसून येते . शिक्षणाचा अर्थ ज्ञानार्जन करणे होय . या शिक्षणाच्या प्रक्रियेमध्ये विद्यार्थी हा गुरुंच्या जवळ राहून अध्ययन करतो आणि त्यानंतर देखील संपूर्ण आयुष्यभर तो विदयार्थी काही ना काही शिकतच असतो व आपलं व्यक्तिमत्व घडवत असतो . शिक्षणाच्या माध्यमातूनच मानवाचा शारीरिक , मानसिक , सामाजिक व आध्यात्मिक विकास होतो यावर वैदिक काळातच शिक्कामोर्तब झालेले आहे . प्राचीन शिक्षण पद्धतीवर कुठल्याही राज्य सरकार राजनैतिक किंवा सांप्रदायिक संस्थेचे नियंत्रण नसल्यामुळे शिक्षण हे केवळ गुरुंच्या नेतृत्वातच दिल्या जात असे . वैदिक काळातील लिहिलेल्या ग्रंथांमध्ये संगीत जगतातील गुरु शिष्य पद्धती ही सर्वात प्राचीन मानल्या जाते तेव्हा ही पद्धती कशी होती हे जाणुन घेणे महत्त्वाचे आहे.

प्राचीन शिक्षण प्रणाली :- संगीत एक अशी कला आहे जी बुद्धी द्वारे कमी आणि हृदयाद्वारे अधिक ग्राह्य आहे. तेव्हा मौखिक रूपाने प्राप्त तसेच अभ्यास आणि साधना द्वारा परिपूर्ण ही विद्या योगाप्रमाणे साधन व साध्य बनुन संगीताला आध्यात्मिक उंचीपर्यंत पोहोचवते . वैदिक काळापासूनच संगीत शिक्षणामध्ये आध्यात्मिक बाबींवर अधिक भर दिल्या जात असे , साम संगीताचे शिक्षण देताना सुरुवातीला आर्चिक आणि नंतर ग्रंथाचे शिक्षण दिल्या जात होते . ज्यामुळे ऋचांचे गायन कंठस्थ होऊन त्यानंतरच योग्य ते परिवर्तन आणि परिवर्धन करण्याचे शिक्षण दिल्या जात असे . यातून प्रेरणा घेऊनच संगीत शिक्षणामध्ये आधी

बंदीश शिकवून रागाची प्रतिमा उतरवल्या जात असे आणि त्यानंतर बंदीशीमध्ये राग अनुकूल रूप , भेद , परिवर्तन व राग विस्तार इत्यादी करण्याचे शिक्षण हे श्रेष्ठ संगीतकार द्वारे होत असे . रामायणामध्ये दशरथाने आपल्या चारही मुलांना आणि महाभारतात पांडव आणि कौरवांनी आश्रमामध्ये राहून वरील पद्धतीने शिक्षण घेतले आश्रमामध्ये गुरुद्वारा वेदांचे पठण व इतर विषयांसोबत संगीत देखील शिकविल्या जात असे . मुनी वाल्मिकी द्वारा लव आणि कुश ला दिल्या गेलेल्या स्वर , पद , ताल , प्रमाण , मुर्छना इत्यादींच्या उदाहरणाने हे लक्षात येते की त्या काळात संगीत शिक्षणाचे स्वरूप हे व्यवस्थित होते ज्या अंतर्गत संगीतातील शास्त्र आणि क्रियात्मक दोन्ही समाविष्ट होते . महाभारतात देखील बिंधबंधु गांधर्वाच्या परंपरेने अर्जुनाने गीत वाद्य व नृत्याचे प्रशिक्षण घेऊन गांधर्व विशारद पूर्ण केले अशाप्रकारे वेदाचे पठण - पाठण हा उद्देश असल्यामुळे गायन व वादन विद्येचे ज्ञान आवश्यक मानल्या जात होते.

कालांतराने संगीतामध्ये परिवर्तन होत गेले जे संगीत पूर्वी धार्मिक उद्देश सफल करण्यासाठी उपयोगात येत असे त्याचा वापर नंतर मनोरंजनासाठी होऊ लागला याला कारण म्हणजे प्राचीन परंपरेने चालत आलेल्या व्यवस्थेवर विदेशी आक्रमण होऊन देशी आणि विदेशी सभ्यतेच्या मिश्रणामुळे एक नवीन समाज म्हणून वेगळी शिक्षण पद्धती तसेच राजनैतिक परिस्थिती बदलल्यामुळे जनजीवन आणि शिक्षण पद्धतीमध्ये आमुलाग्र बदल झाला . तेव्हा या परिवर्तनाचा प्रभाव संगीत शिक्षणावर देखील झाला . त्या काळात राजा आणि नवाब आपल्या दरबारात श्रेष्ठ गुरुंना आमंत्रित करून स्वतः सोबत सर्व दरबारीना संगीत शिक्षण घेण्यासाठी प्रेरित करीत असत यातून गुरु आणि शिष्याचे आदान-प्रदान दिसून येत होते . परंतु या काळात संगीत शिक्षण विशिष्ट वर्गापुरते मर्यादित होते अर्थात ब्राह्मण क्षत्रिय इत्यादींना संगीत शिक्षणाची मुभा होती आणि ही परंपरा पुढे घराण्याच्या स्वरूपात दिसू लागली .

घराणे पद्धतीतील संगीत शिक्षण :- संगीत शिक्षण हे घराण्याच्या रूपात परिवर्तित झाले जिथे गुरु आपल्या शिष्याला संगीत शिक्षण तर देत असे परंतु यामध्ये शिष्यांचे वेगवेगळे वर्ग केल्या जात होते या संबंधात डॉक्टर अमरेशचंद्र चौबेजी लिहितात की घराण्यांमध्ये मुख्यरूपात शिष्यांचे तीन प्रकार असत ज्यांना गुरुचे ऐकूनच अधिकाधिक शिक्षण प्राप्त करावे लागत असे ते सामान्य अर्थात गुरु आपल्या शिष्यावर व्यक्तिगत लक्ष ठेवत नसत . दुसऱ्या क्रमांकाचे शिष्यांमध्ये असे शिष्य असत की ज्यांच्यावर गुरुंना विश्वास असायचा ते शिष्य म्हणजे गुरुची शैली आत्मसात करून वेळोवेळी विशेष तालीम मिळवत असत याव्यतिरिक्त या शिष्यांना बरेचदा गुरुसोबत साथसंगत करण्याची संधी मिळत असे त्याचप्रमाणे वैयक्तिक शिक्षणासोबत गाणे वाजविणे वगैरे होत असे . तर शिष्य वर्ग खास-उल-खास या नावाने परिचित होता हे शिष्य वंशज होते, शिष्य परिवार आपली गुरु सेवा आणि वैयक्तिक प्रगतीच्या भरवशावर गुरुकृपा प्राप्त करीत असे अशि ही शिष्य पट्ट शिष्य म्हणून ओळखल्या जात हे पट्टशिष्य यांचे वंशजांना सीना - ब - सीना तालीम दिल्या जात असे . यावरून सांगता येईल की पट्टशिष्य गुरुचा उत्तराधिकारी बनत असून त्यांच्यामुळेच घराण्याचा मान आणि मर्यादा सुरक्षित राहत असे .अशाप्रकारे गुरु शिष्य परंपरेतून घराण्याचा शिरकाव झाला आणि या माध्यमातून संगीत शिक्षण होऊ लागले. परंतु कालांतराने यामध्ये काही अडचणी दिसून आल्या त्या काळात शिक्षणाचा प्रचार प्रसार कमी असल्यामुळे ,शिष्यांमध्ये असलेल्या शिक्षणाच्या अभावामुळे गुरुंनी सांगितले तिच पूर्व दिशा असायची, गुरुंना प्रति प्रश्न करण्याची सोय नव्हती, गुरुंना एखादे उत्तर न आल्यास त्याचा अपमान वाटत असे आणि यामुळे दुसऱ्या जाण्याचा मार्ग बंद होत असून गुरुंच्या मर्जीप्रमाणे संगीत बसूनच शिष्यांना आपले शिक्षण घ्यावे लागत असे गुरु यांचे असलेले दोष स्वीकारुन अध्ययन करावे लागायचे सारे त्यावेळी गुरुकुल पद्धती शिवाय पर्याय नव्हता . अवघ्या काळामध्ये सर्व सुखाचा त्याग करून गुरु गृही राहून आपले संपूर्ण आयुष्य केवळ संगीत शिकणारा शिष्य दिसून येत नाही ,त्याचप्रमाणे शिष्याला आपल्या घरी मुक्कामी ठेवून सर्व जबाबदारी घेऊन संगीत शिक्षण देणारा गुरु सुद्धा दिसून येत नाही.

विद्यालयीन शिक्षण पद्धती :- गुरु शिष्य पद्धतीमधील काही घटकांमुळे संगीत विकासामध्ये अडचणी निर्माण झाल्या ब्रिटिश शासन काळामध्ये संगीत शिक्षणामध्ये बदल होत गेले पश्चिम संस्कृती मुक्त जीवनशैली तसेच सामाजिक शिक्षण संस्थांची निर्मिती या सर्वांमुळे सर्व विषयांचा शिक्षण पद्धतीमध्ये परिवर्तन येऊ लागले अशा काळात दोन महापुरुष महाराष्ट्रात जन्माला आले पं.वि.ना. भातखंडे आणि पं.वि.दि.पलुस्कर. संगीत ही उच्च दर्जाची कला आहे शास्त्रशुद्ध व तर्कसंगत पद्धतीने संगीताचे अध्ययन व्हायला हवे हा विचार दोन्ही विष्णुद्वयांचा होता .समाजाकडे या विचारांना मान्यता मिळून याचे रूपांतर विद्यालयीन शिक्षण पद्धतीमध्ये झाले लाहोर येथे गायन महाविद्यालयाची स्थापना मॉरिस कॉलेज , माधव संगीत विद्यालय , भारतीय संगीत विद्यालय अशा विद्यालयांची सुरुवात झाली या पद्धतीमुळे साचेबद्ध अभ्यासक्रम आणि योग्य व नियमितपणे शिकविणारे शिक्षक परीक्षा पद्धती तसेच वेळेवर होणारे मूल्यमापन प्रमाणपत्र अशा किती गोष्टी अगदी व्यवस्थित होऊ लागल्या यामुळे क्रियात्मक आणि शास्त्र दोन्हींना महत्त्व दिल्या गेले

शास्त्रशुद्ध स्वर लेखन करून ग्रंथांची निर्मिती केली स्वरलिपीची निर्मिती करून भारतीय संगीत जिवंत ठेवले अशाप्रकारे विषयाला उच्च स्थानी नेऊन पोहोचवले . गुरु शिष्य परंपरा किंवा गुरुकुल पद्धतीचा उद्देश हा फक्त कलाकार तयार करणे हा होता परंतु विद्यालयीन संगीत पद्धतीचा केवळ हाच उद्देश नसून जो शिष्य कलाकार बनू शकला नाही तो शिक्षक नाहीतर कमीत कमी चांगला श्रोता तरी होईल हा आहे. पदवी प्राप्त करून नोकरी मिळवण्याच्या आशेने तसेच फक्त छंद म्हणून संगीत शिकणारे याच शिक्षण पद्धतीची उपज आहे त्याचप्रमाणे विद्यालयीन संगीत शिक्षण पद्धतीमध्ये संगीताचा प्रचार व प्रसार होऊन सन्मान मिळवणे हा देखील उद्देश आहे परंतु विद्यालयीन शिक्षण पद्धतीमध्ये विद्यार्थ्यांची संख्या वाढली असून या विद्यार्थ्यांच्या प्रमाणात गुरुंची संख्या देखील वाढली गुरु शिष्यप्रणाली मध्ये गुरु हे स्वतः कलाकार असणे आवश्यक होते किंबहुना गुरुंना मान सन्मान देखील असायचा परंतु विद्यालयीन संगीत शिक्षणामध्ये वरील बाबींचे महत्त्व कमी होत असल्याचे दिसते अशा प्रकारे दोन्ही पद्धतींची तुलना केल्यास विद्यालयीन संगीत पद्धतीमध्ये काही कमतरता दिसून येते .

आधुनिक काळाचा विचार केल्यास प्राचीन गुरु शिष्य प्रणाली ही आवश्यक असून त्या प्रणालीमध्ये आधुनिक काळातील परिस्थिती , सामाजिक स्वरूप लक्षात घेऊन संगीत शिक्षण प्रणाली मध्ये वैज्ञानिक व सुनियोजित रूप देण्याची आवश्यकता आहे या पद्धतीनुसार गुरु शिष्य परंपरेला पुनर्जीवित करण्याचे काम अनेक संस्था करीत आहेत प्राचीन काळातील गुरुकुल प्रमाणे वातावरण तयार करून विश्वविद्यालयात प्रवेशित विद्यार्थी आपल्याला योग्य वाटेल अशा गुरुंची निवड करून अधिकाधिक गुरुंच्या सहवासात राहून संगीताचे सखोल अध्ययन करीत आहेत.

निष्कर्ष:-

भारतीय शास्त्रीय संगीताच्या विकासामध्ये गुरुशिष्य परंपरेने विशेष आणि महत्त्वपूर्ण भूमिका बजविलेली आहे . आधुनिक काळात संस्थागत आणि महाविद्यालय संगीत पद्धती असून सुद्धा संपूर्ण भारतभर गुरुकुल संगीत पद्धती टिकून आहे आणि त्याचं महत्त्व देखील पहिल्याप्रमाणेच आहे ज्या विद्यार्थ्यांला यशस्वी कलाकार व्हायचे आहे त्यांच्या करीता ही गुरुशिष्य संगीत पद्धती अधिक फायदेशीर ठरत आहे . अशा प्रकारे वैदिक काळापासून आधुनिक काळातील संगीत व्यवस्थेचे अध्ययन केले असता आपल्याला सुदृढ गुरुशिष्य परंपरेचे दर्शन होते . प्राचीन काळापासून आधुनिक काळा पर्यंत संगीत प्रस्तुतीकरणामध्ये परिवर्तन होत गेले परंतु गुरु शिष्य परंपरेचा इतिहास कायम आहे.

संदर्भ सूची :-

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प्रस्तावना

"गायन, वादन आणि नर्तन या तीनही कलांच्या समूहास संगीताचे म्हणतात. संगीत कलेच्या उत्पत्ती बद्दल मतमतांतरे आहेत. विविध धर्माच्या धर्मग्रंथात संगीताची उत्पत्ती वेगवेगळी सांगितलेली आहे. हिंदू धर्म ग्रंथानुसार संगीताची निर्मिती ब्रह्मदेवाकडून झाली आणि ब्रम्हांनी ही कला शिवांना दिली शिवाकडून ही कला सरस्वतीला प्राप्त झाली म्हणूनच सरस्वतीला विणा-पुस्तक-धारिणी असे म्हणतात"शिवप्रदोषस्तोत मध्ये वर्णिले की पार्वतीच्या शयनमुद्राहून पार्वतीच्या अंगप्रत्यंगाच्या आधारावर अद्रविणा तयार केली व पाच राग निर्माण केले. सरस्वतीने संगीत कलेचे ज्ञान नरदाला दिले व नारदाने अप्सरा किन्नर यांना व नंतर भूतलावर संगीत अवतरले काही संगीत तज्ञ सात स्वरांची उत्पत्ती पशुपक्ष्यांपासून झाली असे मानतात पारसी विद्वानांच्या मते मुंसा फकीराने आपल्या हातातील "आसा"नावाचे शस्त्र दगडावर मारले त्या दगडाचे सात तुकडे झाले व त्या दगडांच्या सात तुकड्यातून सात पाण्याच्या आधारा वाहू लागल्या व त्यातूनच सात स्वर निर्माण झाले असे मानतात. पाश्चात्य तत्त्वज्ञ फ्रॉईड यांच्या मतानुसार लहान मुलांच्या मानसशास्त्रीय आधारावर म्हणजेच मुलांचे रडणे, हसणे इत्यादी क्रियांवरून संगीत निर्माण झाले ह्या सर्व मतांवरून संगीता ची निर्मिती कशी झाली हे सांगू शकत नाही परंतु जेम्स लोग व डार्विनचा उत्क्रांतीवादाचा सिद्धांत हा महत्त्वाचा आहे असे वाटते. मानवाच्या जीवन विकासाच्या इतिहासात विचार केल्यास मानव जस जसा उत्क्रांत होत गेला त्याचप्रमाणे भाषा, स्वतःचे संरक्षण करण्यासाठी शस्त्रे , करमणुकीसाठी वाद्य निर्माण करणे त्याचबरोबर गायन व वादन सादर करणे इत्यादी गोष्टी विकसित होत गेल्या.

भारतीय संस्कृतिचा अविभाज्य घटक असलेल्या संगीता सारख्या अभिजात कलेने कालपरत्वे अनेक संकटांना तोंड देत आजही भारतीय संगीताचे विशेष स्थान टिकवून ठेवले आहे. संपूर्ण विश्वाचा मानाचा मुजरा स्वीकारत आज 21 व्या शतकाच्या उंबरठ्यावर जुन्या नव्यांचा मेळ घालत भारतीय संगीत निरंतर ताठ मानेने उभे आहे. कला कोणतीही असो ती मानवी विचार व भावभावना व्यक्त करण्याचे साधन होय मानवी कल्पनांच्या प्रगतीचे दुसरे नाव म्हणजेच कला हे म्हणणे ही चुकीचे होणार नाही. वैविध्य,उत्स्फूर्तता आणि समृद्धी या तीन विषयांच्या आधारेच भारतीय संगीताचा अखंड प्रवाह सुरू आहे. कोट्यावधी रसिकांच्या कानामनात भारतीय संगीताने अनेक पिढ्यांवर एक सर्जनशील संस्कार करण्याचे कार्य एक व्यापक दृष्टिकोन ठेवून व नवनवीन प्रयोगाद्वारे केले व संगीताची अनंतता सिद्ध केली आहे. संगीतात मन, आत्मा व शरीर बलवान करण्याचे सामर्थ्य असल्याने त्याचा, मानसिक, आत्मिक व शारीरिक विकासाच्या दृष्टीने मानवाच्या जीवनावर परिणाम होतो. मानवाच्या एकूण विकासात संगीताचे स्थान अत्यंत महत्त्वपूर्ण आहे. स्वर्गीय सौंदर्याचे साकार व सजीव रूप संगीत असल्याने सुसंस्कृत भारताचे ते भूषण आहे. आजही भारतीय

संस्कृतीचे मानदंड समजले जाणारे चार वेद त्यांच्या विशुद्ध स्वरूपात उपलब्ध आहेत. भारतीय संगीताचा प्रवास वेदकालापासून मानला जातो आणि भारतीय संगीताचा जन्म तर देवदेवतांच्या काळापासून मानतात. जसे सरस्वतीची विणा, शंकराचे डमरू, श्रीकृष्णाची बासरी, गंधर्वाचे गायन, मेनका उर्वशीचे नृत्य. जेव्हा भाषा अविकसित होती तेव्हाही संगीताचा प्रभाव या जीवसृष्टीवर होता. आजही संगीत ही विश्वभाषा समजली जाते 'रवींद्रनाथ टागोरांना' तर शब्दाचा शेवट हा संगीताचा आरंभ वाटतो. परमोच्च आनंदाची प्राप्ती संगीतातून होत असल्याने मनुष्याच्या आत्म्याचा विकास करून जीवनाच्या पूर्णत्वाकडे नेण्याचे साधन म्हणून संगीताकडे पाहिले जाते.

प्राचीन काळापासून भारतात गुरुकुल पद्धती प्रचारात होती. ऋग्वेदातील ऋचा जसाच्या तशा जतन करण्यासाठी ऋषीमुनींनी कष्ट घेतले. हा अलौकिक ज्ञानाचा ठेवा शुद्ध स्वरूपात लोकांपर्यंत पोहोचतानाच भारतीय गुरु शिष्य परंपरा अस्तित्वात आली सामगायन रंजक व्हावे म्हणून तत, वितत, घन, सुषिर अशा वाद्यांचा उपयोग सामगायनामध्ये होऊ लागला आणि या गायक वादकांना योग्य पद्धतीने शिक्षण देताना ज्या पद्धतीचा उपयोग ऋषीमुनींनी केला तिलाच भारतीय संगीत शिक्षणाचे गुरुकुल पद्धती म्हणावे लागेल. संगीतात गुरु शिष्य परंपरेला फार महत्त्व आहे पूर्वी हे लिखित स्वरूपात नसल्याने शिष्याने गुरु पुढे बसून ते गातील ते सांगतील ते शिकावे लागे. गुरुगृही राहून गुरूंची हरतऱ्हेची सेवा करून त्यांची मर्जी संपादन करून कला आत्मसात करावी लागे. गुरु लहरी अथवा रागीट असेल तरी शिष्य आपला मान अपमान बाजूला ठेवून गुरूंना खुश ठेवून विद्या संपादित करीत अर्थात यात गुरु शिष्य या दोघांमध्ये प्रेमाचे बंध ही निर्माण होत. गुरु आपली सर्व गायन विद्या मुक्तहस्ताने देत असत परंपरेने ती गायन शैली जपली जात असते.

19 व्या शतकाच्या शेवटी व 20 व्या शतकाच्या प्रारंभी भारतीय संगीत क्षेत्रात क्रांती झाली ते पं. विष्णू नारायण भातखंडे व पं. विष्णू दिगंबर पलुस्कर यांच्या कार्यामुळे या दोन सांगीतिक महामानवांनी भारतीय शास्त्रीय संगीताचे पुनर्जीवन केले. त्यांनी भारतीय शास्त्रीय संगीताचे नवीन शास्त्र निर्माण केले विष्णूदवयांच्या कार्यामुळे संगीताला लागलेले अशुद्ध वळण दूर झाले संगीत संमेलने व चर्चा सत्राला सुरुवात झाली.दहा थाटांची निर्मिती करून नवीन रागाची निर्मिती केली संगीताचा प्रचार प्रसार व्हावा यासाठी संगीत विद्यालय व महाविद्यालयाची स्थापना केली त्यामुळे सर्वसामान्य लोक संगीत शिकू लागले. हे सर्व विद्यार्थी ग्वाल्हेर, किराणा, आग्रा, जयपूर, अतरौली, सहसवान, भेंडी बाजार, मेवाती, अशा विविध घराण्याचे शिक्षण घेऊ लागले. आज भारतीय शास्त्रीय संगीताचा प्रचार प्रसार प्रदेशात सुद्धा होऊ लागला आज भारतीय संगीताच्या प्रदेशात 80 च्या वर व देशात 350 वर (अंदाजे) प्रमुख संस्था आपापल्या स्तरावरून संगीत शिक्षण देतात 1952 मध्ये आकाशवाणीमुळे तर भारतीय संगीताचा सर्वदूर प्रचार प्रसार झाला, याच काळात भारतीय शास्त्रीय संगीत, भक्ती संगीत, स्वतंत्र ख्याल गायन, तालवादन, सतार, वीणा वादन, पखवाज वादन, नृत्य, सुगम संगीत, लोकसंगीत गझल, चित्रपट संगीत असा विकास झाला. जसे मुस्लिम संगीत व भारतीय शास्त्रीय संगीताच्या मिलनाने तराणा, ख्याल, गझल, सतार, तबला, निर्माण झाले त्याचप्रमाणे आधुनिक भारतीय शास्त्रीय संगीत व पाश्चात्त्य संगीताच्या संयोगाने भारतामध्ये फ्युजन संगीत निर्माण झाले व संगीतात फ्युजन वादन, फ्युजन गायन, फ्युजन नृत्याचा विकास होत आहे. भारतीय संगीतातील फ्युजन काही दशकापूर्वी अली अकबर खाँ यांनी 1950 मध्ये सुरु केले असे आपण म्हणतो. परंतु 13 व्या शतकाच्या उत्तरार्धात फारसी,

अरबी, तुर्की आणि भारतीय गायन परंपरा एकत्र आणण्याचे श्रेय अमीर खुसरो यांना दिले जाते. आणि त्यांनी सर्वात लोकप्रिय संगीत प्रकार तयार केला जो फ्युजन मधून जन्माला आला होता तो म्हणजे कव्वाली. हा सुफी भक्ती गीताचा एक प्रकार आहे . आणि असे हे संगीत आज भारतातील सर्व मोठ मोठे गायक, वादक, या संगीताला आवडीने सादर करतात.

आज रेडिओ, टी.व्ही, रेकॉर्डर इंटरनेट इत्यादी आधुनिक प्रसार माध्यमांमुळे कुठलीही गायकी घराण्यांच्या चाकोरीत राहणे मुश्कील आहे शिवाय आज संगीत शिक्षण पद्धतीतील मोठे बदल घडत आहेत. विद्यालय आणि विद्यापीठे कोणत्याही घराण्याचा शिक्का लावू शकत नाहीत. आजचा तरुण संगीत साधक संगीताला पूर्णपणे वाहून घेऊन साधना करू शकत नाही. संगीत हे पूर्णपणे उपजीविकेची साधन होऊ शकत नाही किंवा होऊ शकेल याची खात्री देता येत नाही म्हणून नोकरी पेशा सांभाळून संगीत साधना करणारा वर्ग आज निर्माण होत आहे. यात बुद्धिमान, मिळकत चांगली असणारे तरुण तरुणी पुढे सरसावत आहेत परंतु यांनाही यापुढे वेगवेगळ्या प्रभावांचा स्वीकार करून आपले गाणे बनवावे लागणार आहे. विद्यापीठातून संगीताची पदवी प्राप्त करणाऱ्या स्नातकांनाही याच मार्गाने जावयाचे आहे. आजचे शास्त्रीय संगीत वैचारिक गोंधळातून वाट काढत आहे. प्रगत विज्ञानाचे फायदे होत आहेत. भारतीय संगीत जागतिक स्तरावर दाखल झाले आहे व जनमानसात देखील ओळखीचे झाले आहे आज शास्त्रीय संगीताला प्रायोजकांचा आधार मिळत आहे व त्या व्यापारी परिमाण लाभलेले आहे प्रसारमाध्यमांच्या विपुलते मुळे प्रसिद्धी पैसा जगमगीतपणा याला महत्त्व प्राप्त झालेले आहे. संगीत विषयक विविध मासिकांमधून लिखाण तसेच इंटरनेट सारख्या साधनांमुळे विविध प्रकारचे संगीत तसेच नवनवीन गायक वादकांचे कार्यक्रम सहजपणे ऐकणे सोयीचे झाले आहे.

दूरदर्शन वरील सारेगम, इंडियन आयडल, सुर नवा ध्यास नवा इत्यादी सारख्या रियालिटी शो मुळे नविन कलाकारांना प्रोत्साहन मिळत आहे. विविध इलेक्ट्रॉनिक उपकरणे आज उपलब्ध आहेत जसे विविध प्रकारचे इलेक्ट्रॉनिक तानपुरे, इलेक्ट्रॉनिक तबला, मोबाईल इ. तसेच रेकॉर्डिंग चे नवनवीन टेक्निक्स विकसित होत आहेत नवोदित तरुण गायक कलावंतांना सर्व सोयीमुळे पूर्वीसारखी एखादी नवीन बंदीश शिकायला जी मेहनत घ्यावी लागत असे ती आता घ्यावी लागत नाही. थोडक्यात सांगावयाचे झाल्यास 20 व्या शतकाच्या प्रारंभी विज्ञान आणि तंत्रज्ञानाच्या विकासात संगीत स्वरलिपी, ध्वनिमुद्रण ध्वनि संग्रहामध्ये क्रांतिकारी शोध लागून आश्चर्यकारक बदलांचे नवे प्रवाह संगीत रसिक श्रोत्यांना उपलब्ध करून दिले. आज संगणक इंटरनेटच्या माध्यमातून संगीत शिक्षण घरबसल्या घेता येते. विविध वेबसाईट, विविध मल्टीमीडिया, वेब नेट इत्यादी अनेक दूरसंचार माध्यमातून संगीत शिक्षणात सुलभता निर्माण होऊन संगीताचा विकास झाल्याचे आढळते.

विज्ञान व तंत्रज्ञानाने प्रसार माध्यमात क्रांती घडवून आणल्यामुळे संगीताचे रूप बदललेले आहे. रेडिओमुळे ख्याल आटोपशीर झाला. गायकांना अर्धा तास ख्याल आणि पाच मिनिटे चीज अशी गावयाची सवय लागली. त्यामुळे मैफीलही आटोपशीर झाली. माईक मुळे विशेषतः पातळ आवाजाच्या गायकांना आपले सादरीकरण आत्मविश्वासाने करता येऊ लागले. ध्वनीवर्धकाच्या वापरामुळे अस्सल आवाजाच्या श्रवणाला पारखे झालो आहोत. त्याचप्रमाणे आज संगीतावरील आधुनिक प्रयोगाचा एक महत्त्वाचा भाग म्हणजे संगीतोपचार ही नवी उपचार पद्धती सध्या सर्व देशभर मूळ धरू लागली आहे. आज सर्व जगाचे लक्ष भारतीय शास्त्रीय

संगीताकडे आहे. शास्त्रीय संगीताचा मनोरंजन हा एकमेव हेतू न राहता रोगोपचार, अध्यात्म योग साधना हे मुख्य हेतू आहेत त्या दृष्टीने सर्व दूर यशस्वी प्रयोग होत आहेत. त्यामुळे मानवी जीवनाच्या समृद्धीकरिता ज्या आवश्यक गोष्टी असतात त्यामध्ये संगीताचे विशिष्ट असे स्थान आहे.

संगीताची उत्पत्ती ओंकारातून मानली जाते संगीत म्हणजे भारतीय आत्म्याचा इतिहास आहे आणि वैदिक धार्मिक सांस्कृतिक प्रक्रिया दर्शविणारा आरसा होय. अभिजात शास्त्रीय संगीतामध्ये फार मोठी ताकद आणि सामर्थ्य आहे, याची जाणीव तरुण गायक कलावंतांना असणे आवश्यक आहे. नवोदित कलाकारांनी संगीत ही साधना आहे, उपासना आहे, हे विसरता कामा नये.आज झटपट प्रसिद्धी आणि भौतिक वादामुळे शास्त्रीय संगीताची वैशिष्ट्यपूर्ण शैली मागे पडत चालली आहे, नुसती नक्कल राहिली आहे. खऱ्या अर्थाने साधक कलावंत निर्माण होण्याची गरज आहे . संगीताचे साधक उपासक निर्माण होण्याची गरज आहे. पूर्वीची भूगंधर्व, अल्लादिया खाँ, मल्लिकार्जुन मन्सूर यांची जी संगीत तज्ञांची फळी होती त्यानंतर पं. जसराज, पं.भीमसेन जोशी, रविशंकर, किशोरी आमोणकर, परविन सुल्ताना, मालिनी लाजूरकर, वीणा सहस्त्रबुद्धे, कौशिकी चक्रवर्ती, महेश काळे या कलाकारांची फळी निर्माण झाली त्यानंतर अशी जबरदस्त शास्त्रीय संगीत साधक कलाकारांची फळी निर्माण होईल की नाही याची शंका निश्चितपणे भेडसावू लागली आहे.अभिजात संगीत टिकण्यासाठी नुसती जाण असून पुरणार नाही तर त्याचे जतन होण्यासाठी प्रत्येकाने प्रयत्न करणे आवश्यक आहे आज तरुण गायक कलावंतावर अभिजात शास्त्रीय संगीताचे जतन करण्याची फार मोठी जबाबदारी आहे त्यासाठी त्यांनी जुन्या तज्ञ गायकांकडून तालीम घेण्याची गरज आहे.अर्थात या सर्व गोष्टींसाठी जुन्या तज्ञ कलावंतांकडूनही नवोदित कलाकारांना सर्वतोपरी सहकार्य मिळणे आवश्यक आहे. गुरु तसेच शिष्य या दोघांनी मिळून अभिजात शास्त्रीय संगीताचे जतन संगोपन संवर्धन करणे आवश्यक आहे यासाठी पालकांकडूनही त्यांच्या पाल्याला म्हणजे आपल्या संगीताचे शिक्षण घेणाऱ्या मुलाला सहकार्य करणे आवश्यक आहे. आपला मुलगा,मुलगी जर वाद्य गायनाचे धडे घेत असेल तर तो लगेच स्टेजवर कसा येईल, झटपट प्रसिद्धी, पैसा त्याला कसा मिळेल याचा विचार न करता त्याला गायकीवर मेहनत करायला वेळ द्यावा, त्या दृष्टीने त्याची मानसिकता तयार करायला मदत करावी कारण आज त्याने मेहनत केली तर त्याचे गायन वादन हे अधिक प्रगल्भ कायम स्वरूपाचे टिकणारे राहील असेच संस्कार आपल्या मुलावर करावे सर्वार्थाने त्याला व्यवस्थित प्रोत्साहन व मार्गदर्शन करावे त्याचा फार मोठा उपयोग अभिजात शास्त्रीय संगीताचे संरक्षण संगोपन करण्याकरिता होईल.

निष्कर्ष

पूर्वीच्या तुलनेत भारतीय संगीताचा विकास होऊन मोठ्या प्रमाणात बदल घडून आले. विज्ञान तंत्रज्ञानामुळे सुलभता आली प्रत्येक गोष्टीत आधुनिक तंत्रज्ञान आल्यामुळे एकीकडे जर विकास झपाट्याने होत असला तरी दुसरीकडे मात्र काही बाबींमध्ये विकास खुंटलेला दिसतो उदा. प्रसिद्धीच्या मागे लागलेला कलावंत संपूर्ण अंगांनी सखोल अध्ययन करताना दिसत नाही. तेव्हा शास्त्र आणि कला यांची सांगड घातल्यास खऱ्या अर्थाने प्रगती अथवा विकास झाला असे म्हणता येईल कारण भारतीय संगीतामध्ये फार मोठे सामर्थ्य आहे संगीत कलाही सर्वश्रेष्ठ कला आहे धर्म, जात, पंथ, प्रदेश यांच्या पलीकडे जाऊन रंजन करणारी संगीतकला ही एकमेव

कला मानावी लागेल ही एक वैश्विक कला आहे . सर्व जगात सर्व मानवी कंठात सुर तेच आहेत स्वरांवर कुठलेही विपरीत , वाईट संस्कार होऊ शकत नाही. स्वरातून फक्त आनंद निर्मिती होते. जगातील सर्व भांडण तंटे मिटवून सामंजस्य, शांतता निर्माण करण्यासाठी शेवटी सर्वांना संगीत कलेचाच आधार घ्यावा लागणार आहे. नादब्रह्मा मध्ये फार मोठी शक्ती आहे भारतीय संगीत या सप्त शब्दांमध्ये सप्तस्वरांइतके सामर्थ्य आहे, सखोलता आहे तो अमोल ठेवा जपणे हे आपल्या सर्वांचे कर्तव्य आहे .शेवटी वि. वि. चिपळूणकर यांच्या शब्दात एवढेच सांगणे योग्य ठरेल की 'सामर्थ्य आहे शिक्षणाचे, जो जो उमजेल तयाचे परंतु तेथे व्रतस्थवृत्तीचे अधिष्ठान पाहिजे यानेच भारतीय संगीत अपेक्षित उंची गाठू शकेल.

संदर्भसूची

1. संगीत शोध निबंध – डॉ.लक्ष्मीनारायण गर्ग
2. मधुकर द. गोडसे - संगीत शास्त्र परिचय
3. अशोक दा रानडे – संगीत विचार
4. संगीत शिक्षणाच्या विविध पद्धती - पं ना.द.कशाळकर

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Vacuum Ultraviolet Spectroscopic Properties in Gd^{3+}-Eu^{3+} Ions Pair Doped MYF_4 (M = Li, Na, and K)

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Vacuum Ultraviolet Spectroscopic Properties in Gd^{3+}-Eu^{3+} Ions Pair Doped MYF_4 (M = Li, Na, and K)

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Abstract. $LiYF_4$, $NaYF_4$, and KYF_4 doped with Gd^{3+}-Eu^{3+} ion pairs synthesised by soft route (wet) chemical technique tracked by Reactive Atmosphere Process (RAP). The phase purity of every synthesized material is verified using the X-ray Diffraction (XRD) method. The photoluminescence excitation (PLE) and photoluminescence emission (PL) properties are examined in ultra-violet (UV) and vacuum ultraviolet (VUV) regions. A new type of photon harvesting (cutting) process is studied in the synthesized phosphors. The Quantum Cutting (QC) is observed only in host $LiYF_4$ doped with Gd^{3+}-Eu^{3+} Phosphor.

Keywords: Visible Quantum Cutting, Down-Conversion (DC), Mercury-Free Fluorescent Lamps (MFFL), Quantum Efficiency (QE)

1. Introduction

Visible QC through DC is the process in which gain more than one visible photon for respectively absorbed VUV Photon by the materials. Subsequently, it results to luminescence QE larger than unity (100%) and recover energy proficiency in illumination devices or 3D display [1]. The Dexter was projected primary possibility and far ahead on confirmed in YF_3:Pr^{3+} with absorption at 185 nm wavelength in the VUV region and QE around 140% [2-4]. In the succeeding research, the Quantum-Cutting (QC) phenomenon was found in case of luminescent materials doped by rare-earth ions such as Gd^{3+}, Tm^{3+}, or Pr^{3+} [5-6]. According to the prediction of Judd–Ofelt theory and experimental results it has also been concluded that utilizing a single ion activator system cannot further improve the efficiency of the QC phosphors [5]. In further surveys, it was found that the Gd^{3+} - Eu^{3+} pair in the appropriate host matrix results QE larger than unity under the excitation of VUV [7–8]. Jaiswal et al also showed the visible QC in Gd^{3+}, Eu^{3+} doped YF_3 phosphor synthesised by the wet chemical method trailed by RAP [9].

In this research report, possibility of visible QC with Gd^{3+}- Eu^{3+} pair in the yttrium fluoride host matrix with alkali metal ions is explored. This paper presents, for the first time, an analysis of the quantum harvesting and energy transfer process in the MYF_4:Gd^{3+}, Eu^{3+} (Li, Na, K) phosphor.

2. Experimental

The MYF_4 phosphor (where M = Li, Na, K) doped with Gd^{3+} and Eu^{3+} ions were synthesised via the soft route (wet) chemical, followed by heating in a RAP. In the preparation, A. R. grade precursors such as Oxide (Y_2O_3) and nitrates MNO_3 (M=Li, Na, K) were used. In the least amount of HNO_3 the combination of stoichiometric quantities of nitrates of Y, Gd, and Eu were got by liquifying the corresponding oxides. The stoichiometric quantity of lithium nitrate ($LiNO_3$) was added to the combination. A small quantity of double distilled (DD) water was introduced into a complete nitrate mixture and stirred for 30 minutes. The dropwise hydrofluoric acid (HF) was added to the mixture to get a whitish paste. The paste undertook washing, filtered, and subsequent drying using under the filament/IR light. After the dried, the powder was heated at 500 ˚C for 1 hour in the wrapped/sealed glass test tube under reactive gas environment which was formed by appropriate quantity of ammonium

fluoride (NH_4F). It was then heated for 4 hours in the pre-heated graphite crucible at 800 ˚C temperature and then abruptly quenched to normal (25˚C) temperature [9-11]. After cooling the sample was crushed in a mortar pestle to make a white fine powder of $LiYF_4$: Gd^{3+}, Eu^{3+} Phosphor.

The identical procedure was replicated for the Gd^{3+}, Eu^{3+}-doped $NaYF_4$ and KYF_4 phosphors. The fig.1 shows the flow map of the synthesis process.

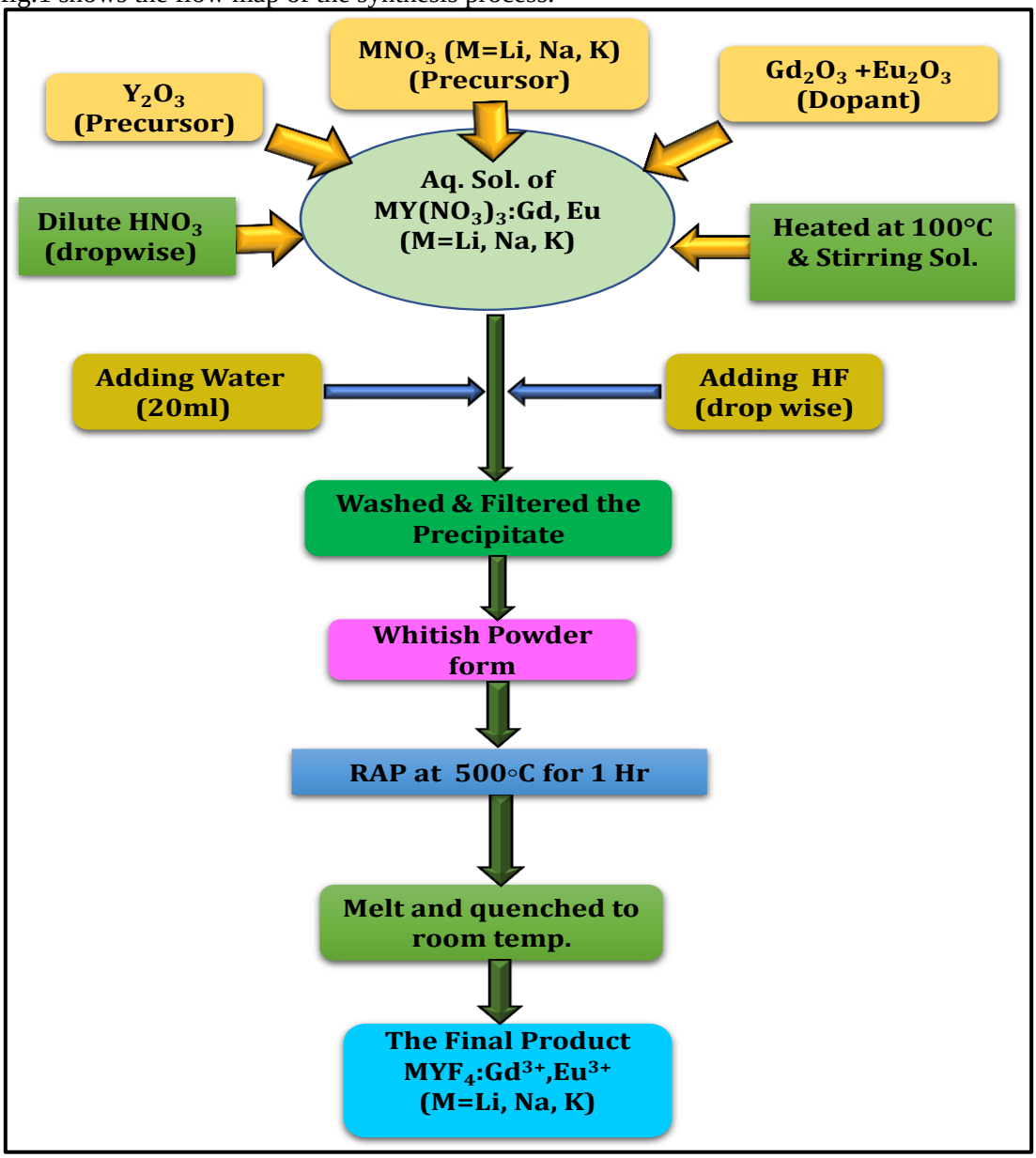
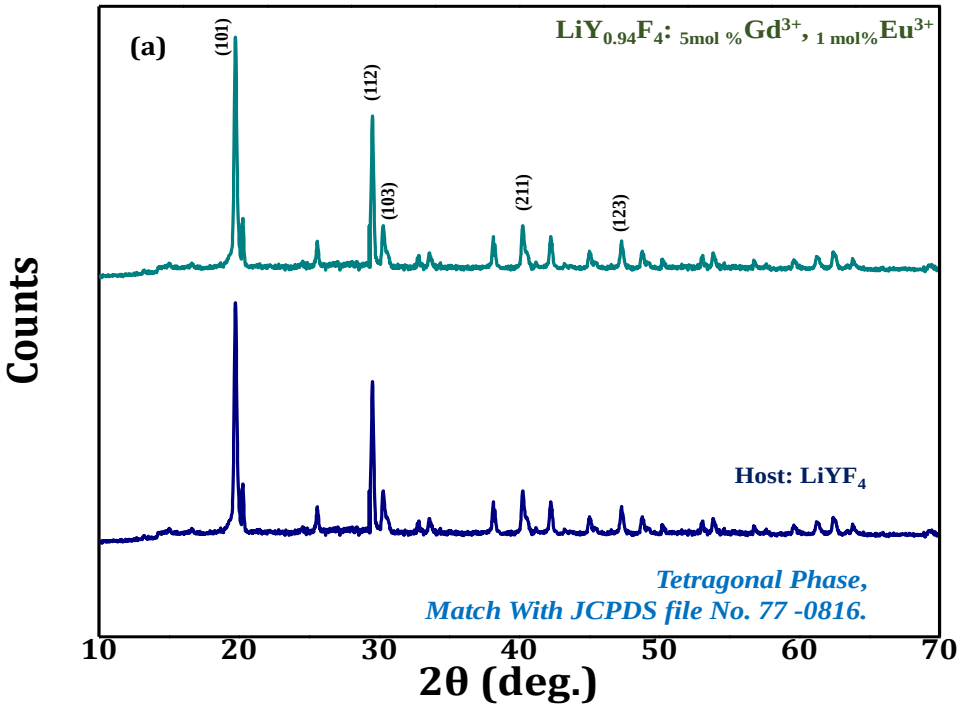


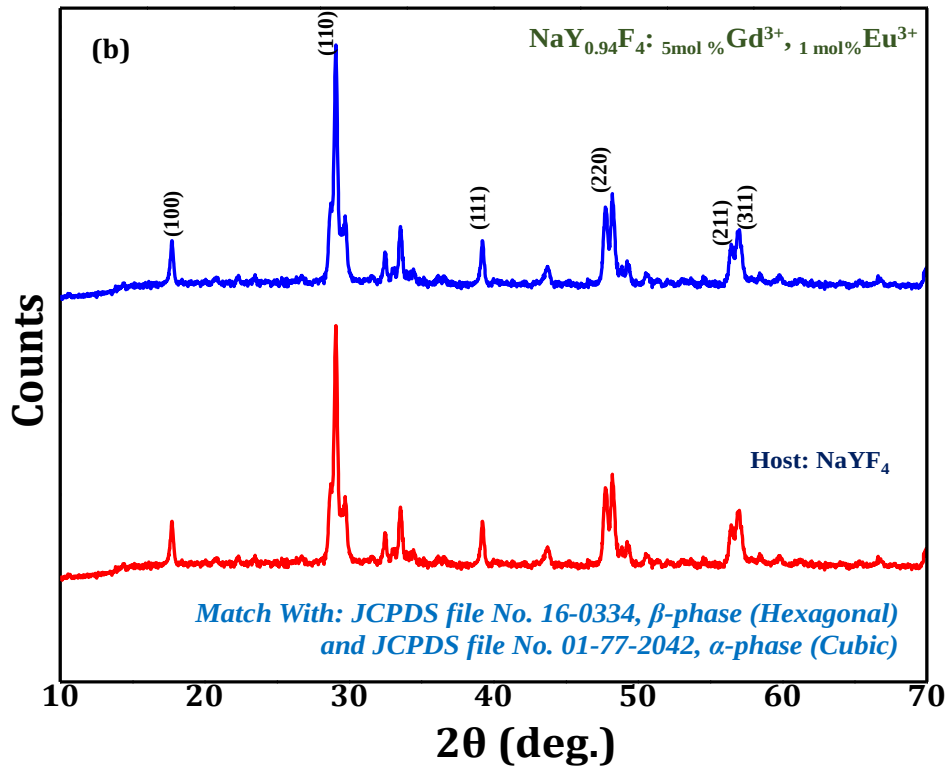
Figure 1. Flow map of the complete synthesis procedure

3. Outcomes & Argument

3.1 The study of XRD

The fig. 2 represents detailed XRD pattern of doped-undoped MYF_4 (M= Li, Na, K) phosphor.


(a)
LiY0.94F4: 5mol %Gd3+, 1 mol%Eu3+
(101)
(112)
(103)
(211)
(123)
Host: LiYF4
Tetragonal Phase,
Match With JCPDS file No. 77 -0816.
Counts
10
20
30
40
50
60
70
2θ (deg.)


(b)
NaY0.94F4: 5mol %Gd3+, 1 mol%Eu3+
(100)
(110)
(111)
(220)
(211)
(311)
Host: NaYF4
Match With: JCPDS file No. 16-0334, β-phase (Hexagonal)
and JCPDS file No. 01-77-2042, α-phase (Cubic)
Counts
10
20
30
40
50
60
70
2θ (deg.)

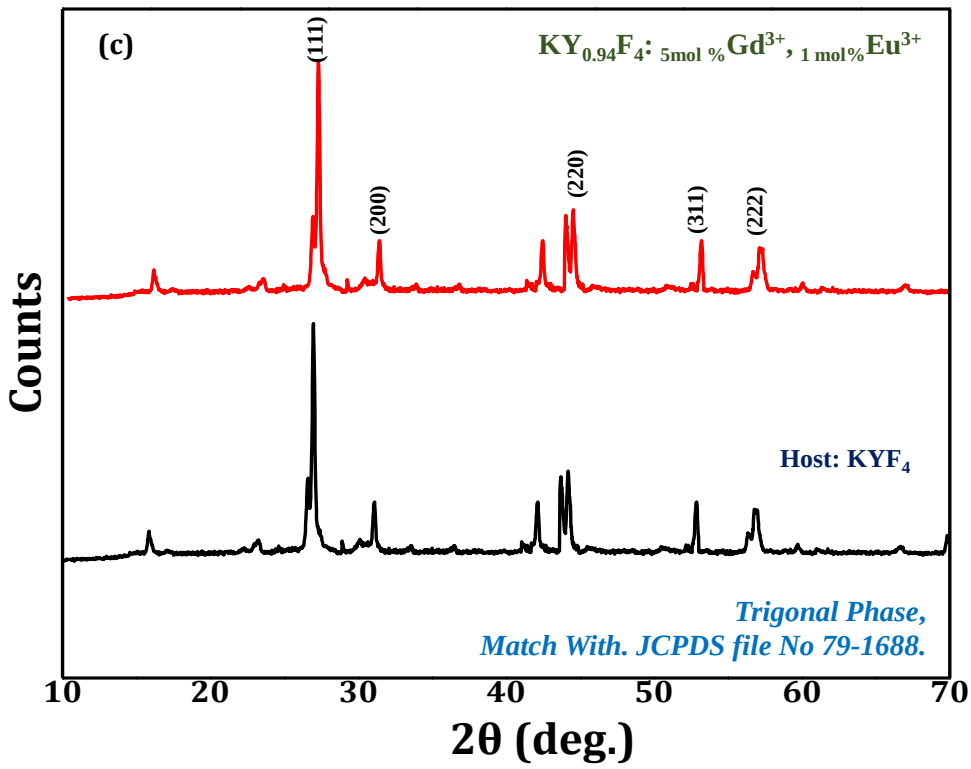


Figure 2. (a), (b), and (c): XRD pattern of doped-undoped MYF_4 (M= Li, Na and K) phosphors

The purity of phase of resulting synthesized products doped and undoped MYF_4 (M= Li, Na, K) were verified by XRD on a Rigaku D/max-2400 powder diffractometer with CuKa radiation. In the XRD pattern, all major diffraction peaks for doped and undoped $LiYF_4$ match well with the JCPDS file No. 77 -0816 [12] and has a tetragonal structure. The XRD pattern of $NaYF_4$ doped and undoped shows the hexagonal phase match with the β-phase of JCPDS file no.16-0334 [13], while quite a few puny scattered crests correspond to the cubic phase match with α-phase of JCPDS file no. 01-77-2042 [14]. The XRD pattern of the doped and undoped KYF_4 phosphors proves a close match between all diffraction peaks of the standard PDF card no. 79-1688, confirming that the synthesised KYF_4 samples exhibit a hexagonal structure [15].

3.2 Photoluminescence Analysis:

The concentration quenching of sensitizer Gd^{3+} in the MYF_4 (M = Li, Na, K) i.e., Li $Y_{(1-x)}$ F_4: xGd^{3+}, Na $Y_{(1-x)}$ F_4: xGd^{3+}, and K $Y_{(1-x)}$ F_4: xGd^{3+} ($0.01 \leq x \leq 0.09$) host related was unbendable. The largest energy difference amongst the ground level $^8S_{7/2}$ and the first excited level $^6P_{7/2}$ was found in Gd^{3+} ion among trivalent RE ions. The luminescent intensity rises with an intensification in the concentration of Gd^{3+} ions lacking concentration quenching up to x = 0.05 at 311 nm. The quenching starts when there is an adequate drop in the average distance among activators due to increase in its concentration in the host lattice to favour nonradiative energy transfer (ET). In this case concentration quenching starts when concentration of Gd^{3+} exceeds over 0.05. In the PL emission spectrum, we got a sharp peak at 311 nm is attributed to the $^6P_{7/2}$ to $^8S_{7/2}$ transitions of Gd^{3+} ions. Apart from that, a small peak at 306 nm is ascribed to the $^6P_{5/2}$ to $^8S_{7/2}$ transitions of Gd^{3+} ions [16]. From Fig.3 (a), 3 (b), and 3 (c) it can be encounter that at 0.05 moles of Gd^{3+} ions in the MYF_4 host illustrate the bigger intensity peak at 311 nm under the excitation of 274 nm.

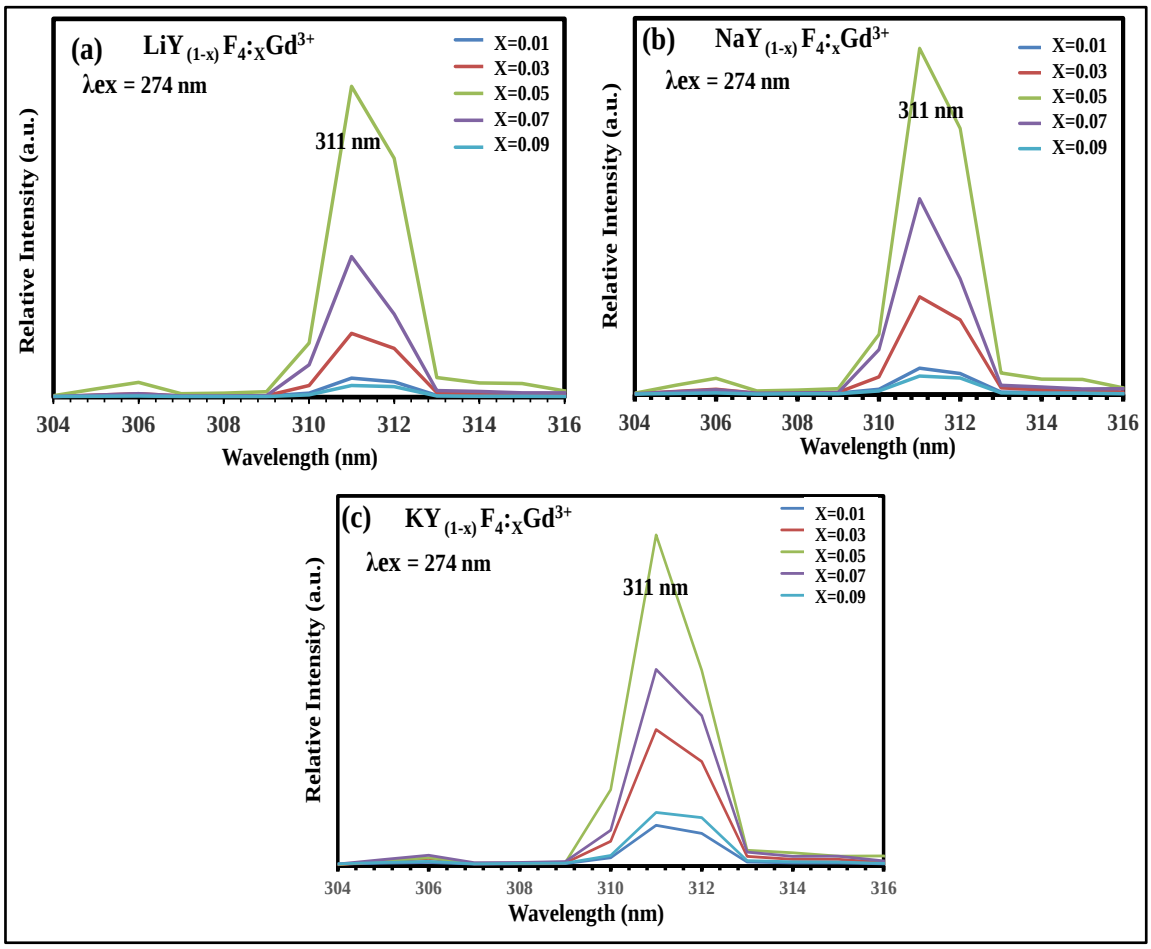


Figure 3 (a), 3 (b), and 3 (c) are emission spectra of Li $Y_{(1-x)}F_4$: xGd^{3+}, Na $Y_{(1-x)}F_4$: xGd^{3+}, and K $Y_{(1-x)}F_4$: xGd^{3+} ($0.005 \leq x \leq 0.07$) shows maximum intensity peak (311 nm)

3.3 PL Excitation and Emission Spectra:

Excitation spectra of $MY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$ (M = Li, Na, K) phosphor monitor at 593 nm emission wavelength shown in fig. 4. The excitation lines peak maximum at about 154 is accredited to the charge transfer band [17] and peaks at 273, 236 and 201 nm might be attributed to the transitions $^8S_{7/2} \rightarrow {}^6I_J$, ^6D_J and ^6G_J of Gd^{3+} respectively. As we have seen in the excitation spectra, here we compare the intensity peaks at 154 nm of the CT band and the peak at 273 nm of $^8S_{7/2}$ to ^6I_J shift of Gd^{3+}. The excitation spectra show the intensity peaks at 154 nm are decreasing and the peaks at 273/274 nm are increasing while we replace Li, Na, K in the host lattice. The intensity of peak at 154 nm in $LiY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$ phosphor is optimum as compared to $NaY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$ and $KY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$ phosphor.

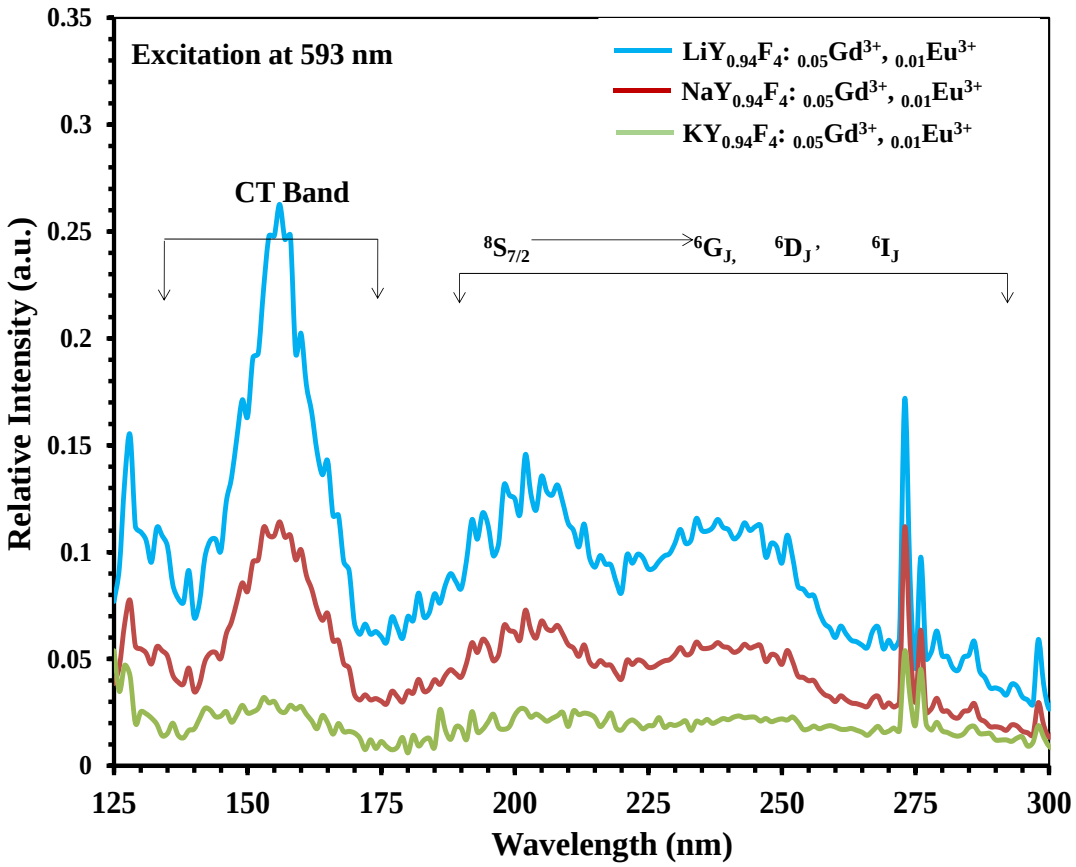


Figure 4. Excitation spectra of $MY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$ (M = Li, Na, K) phosphor monitor at 593 nm.

The fig. 5 illustrates the spectra of PL emission of $MY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$ (M = Li, Na, K) phosphors monitored in the series of 450 to 750 nm at 154 nm excitation wavelength. The PL emission lines of Eu^{3+} peak at about 593, 614, 649, 691, and 701 nm conforming to $^5D_0 \rightarrow {}^7F_{J=1, 2, 3, 4}$ transitions respectively, and the $^5D_{J=0, 1, 2, 3} \rightarrow {}^7F_J$ conversion peaks of Eu^{3+} are far punier than those of $^5D_0 \rightarrow {}^7F_J$ transition are shown in the fig 5. The figure express that the intensities of emission spectra vary with the replacement of Li, Na, K in the crystal lattice. It was found to be optimum in the $LiY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$ phosphor. No additional change was detected in both the PL emission and excitation spectra excepting the intensity. The inorganic luminescent phosphors are normally exaggerated by the factors such as lattice faults, crystal filed, and charge disparity. Due to the point defects in the crystal, growths the non- radiative process resulting in the decrease of the PL emission intensity [18,19]. To improve the PL intensity of the phosphors, the alkaline metal ions such as Li, Na and K are combined in the phosphors. These alkali metal ions are univalent cations which interim as a charge compensator. From the emission intensity outline, it was noted that the PL intensity amplified ($K^+ < Na^+ < Li^+$). It may occur due to the unalike ionic radii of Li, Na, and K. So that host lattice which may reason a consequence on luminescence intensity.

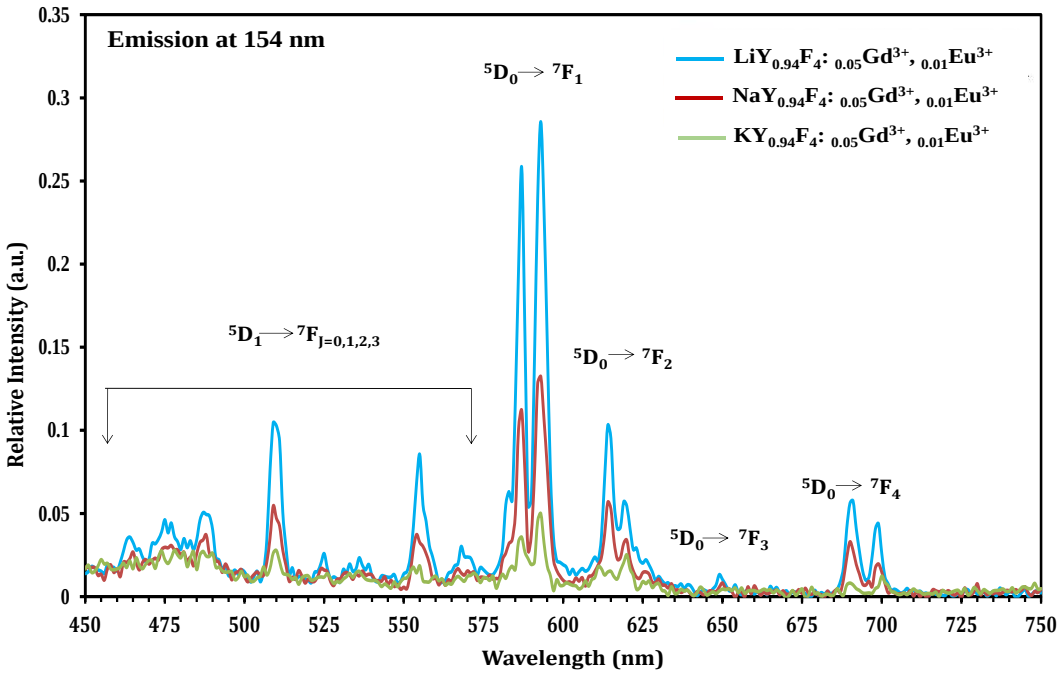


Figure 5. PL emission spectrum of $MY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$ (M = Li, Na, K) phosphors monitored at 154 nm.

4. Study of ET and QC Process

Blend of Gd^{3+}- Eu^{3+} ion pairs in the host lattice plays an energetic role in delivering the luminescence QE of the phosphor greater than100%. In the process of ET, the one high energy VUV photon absorb by the Gd^{3+} ion in the host crystal, transmission of energy to two Eu^{3+} ions leading to ^7F_J to $^5D_0$ shifts, and got two visible photons emissions via ^5D_J to ^7F_J transition of Eu^{3+} ions. Fig. 7 represent Cross Relaxation Energy Transfer (CRET) process via energy level diagram of Eu^{3+} and Gd^{3+}.
The figures 6(a), (b), and (c) represent PL emission spectra of $LiY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$, $NaY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$, and $KY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$ in the wavelength of visible range observed at 154 and 274 nm excitation, to confirm an ET process and QC.

The 154 and 273 nm excitations of Gd^{3+} corresponds to ^6G_J and ^6I_J states respectively. The QC is intolerable due to the excitation at ^6I_J states. So, the emission corresponds to ^5D_J to ^7F_J transitions of Eu^{3+} have a characteristic branching ratio between $^5D_0$ and others ^5D_J states. The QC can happen via two-step energy transfer at 154 nm excitation wavelength of ^6G_J states. Its growths $^5D_0$ emissions over the typical branching ratio between $^5D_0$ and other ^5D_J states. This circumstance is utilised to determine the luminesce QE of the phosphor using the equation (1) projected by Wegh [20-30] as follows:

$$\frac{P_{CR}}{P_{CR}+P_{DT}} = \frac{R(^5D_0 / {}^5D_{1,2,3})_{^6G_J} - R(^5D_0 / {}^5D_{1,2,3})_{^6I_J}}{R(^5D_0 / {}^5D_{1,2,3})_{^6I_J} + 1} \quad \ldots\ldots\ldots\ldots (1)$$

Where, P_{CR} = possibility for cross-relaxation, P_{DT} = possibility for the direct energy transfer from Gd^{3+} to Eu^{3+}. R ($^5D_0/^5D_{1,2,3}$) is the proportion of the $^5D_0$ and $^5D_{1,2,3}$ emission integral intensities. The subscript ^6G_J and ^6I_J denotes the level of excitation for which the ratio is observed.

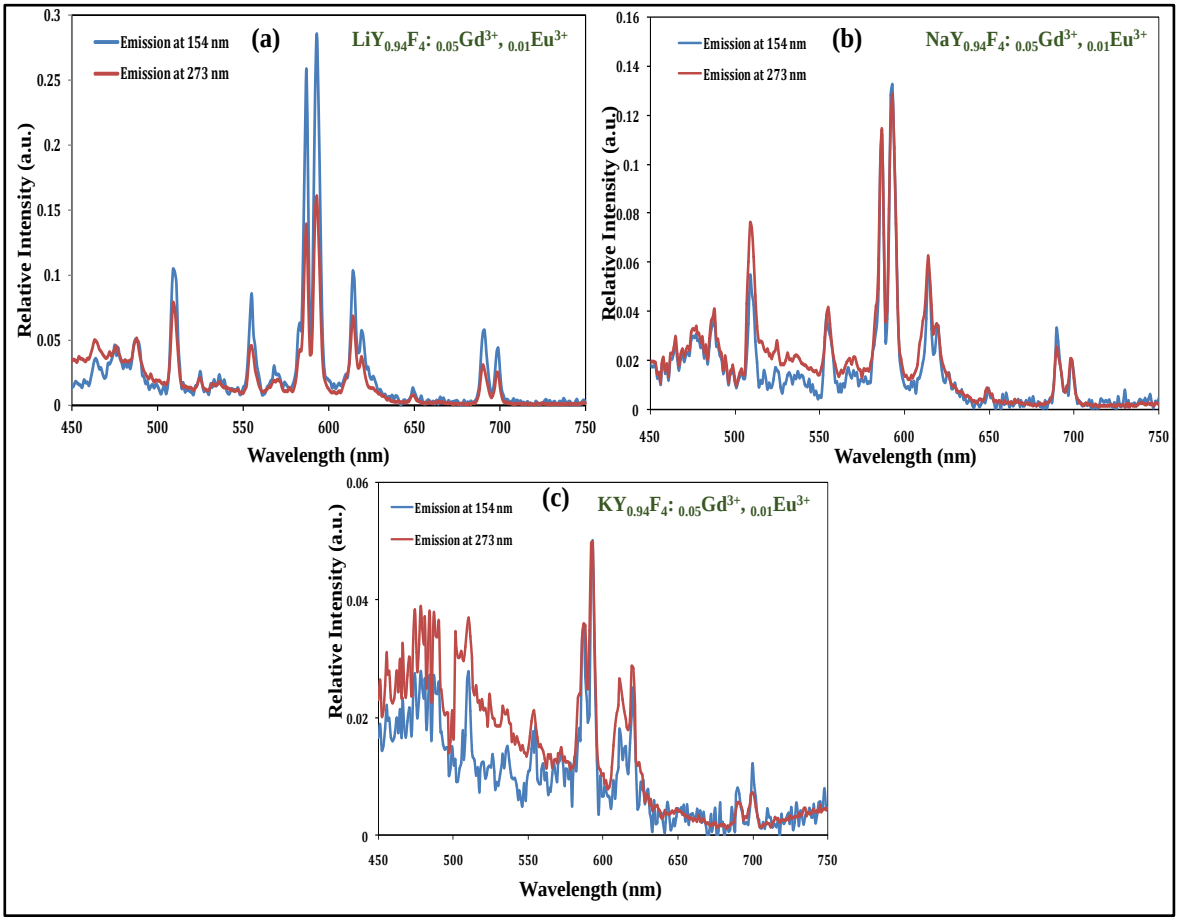


Figure 6 (a), 6 (b), and 6 (c): PL emission spectra of $LiY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$, $NaY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$, and $KY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$ monitored at 154 and 273 nm

From the emission spectra of $LiY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$ shown in fig. 6 (a), the values of intensity ratio of $^5D_0/^5D_{1,2,3}$ of ^6G_J state and the ratio of $^5D_0/^5D_{1,2,3}$ of ^6I_J state are found to be 1.24 and 0.76 respectively. Therefore, the value CRET attained is 0.27. So, the inclusive QE of the phosphor comes out to be **127%.**

From the emission spectra of $NaY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$ and $KY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$ shown in fig. 6 (b) and (c), we can say that the phenomenon of the quantum cutting process has not possible in these synthesized phosphors. The reason behind that is the emission strength at 273 nm excitation wavelength of ^6I_J states is comparable to or greater than the emission strength at excitation wavelength 154 nm of ^6G_J states. Hence QC is unbearable due to excitation at ^6I_J states.

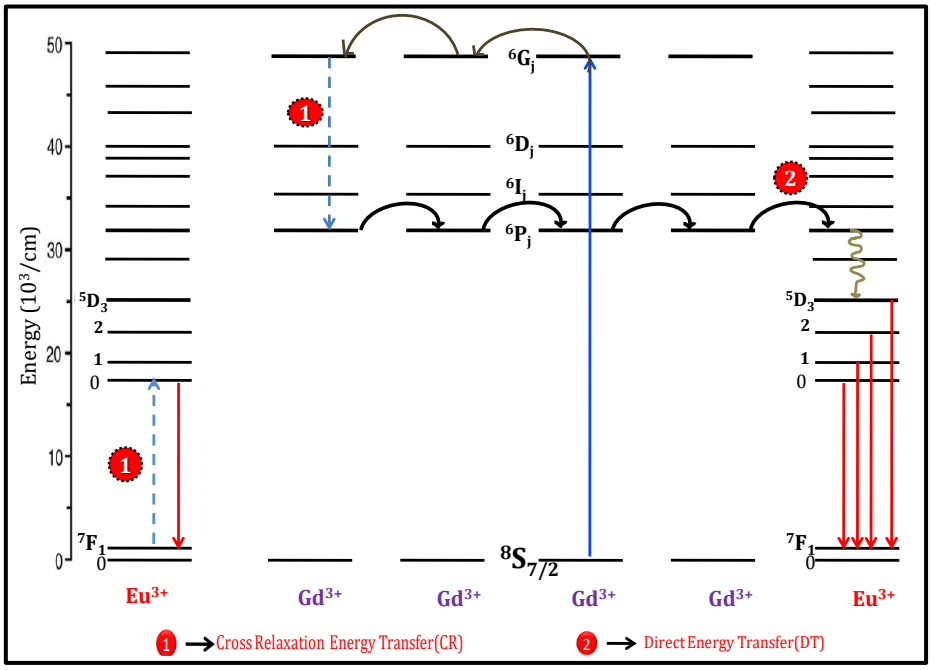


Figure7. Energy states illustrations of Eu^{3+} and Gd^{3+} present the CRET process.

5. The SPD Spectrum and CIE Co-ordinates

The colour excellence of the phosphor will be generally measure by CIE chromaticity synchronize (X, Y). As per the PL emission spectra of $LiY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$, the chromaticity coordinates of the material are found to be (0.434 and 0.4041). The fig. 8 shows Spectral Power Distribution (SPD) input spectra of $LiY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$, tailored to the CIE 1931 chromaticity diagram.

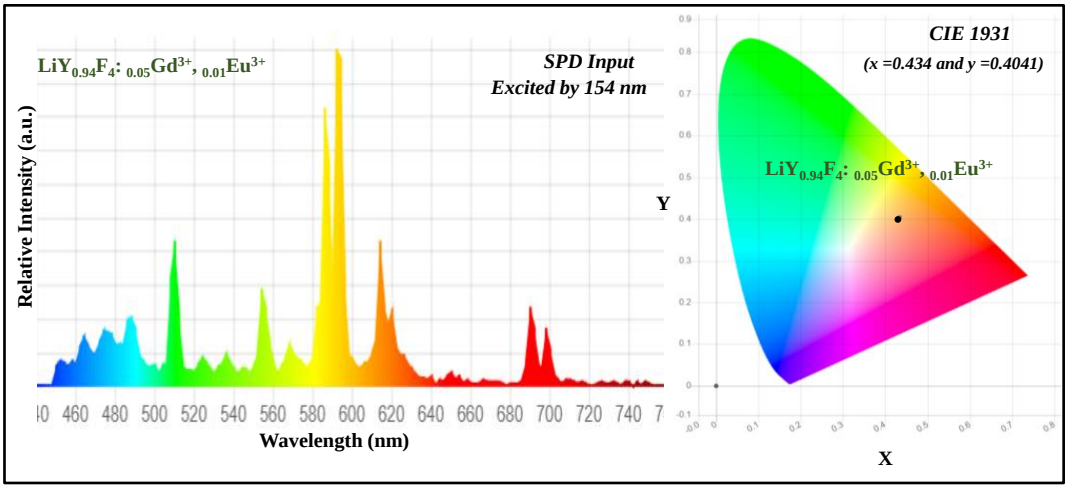


Figure 8. SPD input and CIE chromaticity coordinates of the phosphor $LiY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$

6. Conclusions

The inorganic phosphor materials MYF_4:Gd^{3+}, Eu^{3+} (where M = Li, Na, K) doped with Gd^{3+}-Eu^{3+} ion pairs are successfully synthesized through a soft chemical route (wet chemical) and succeeding heating in reactive atmosphere. The $LiYF_4$ doped and undoped XRD pattern shows a tetragonal structure and matches well with JCPDS file No. 77 -0816. The XRD pattern of $NaYF_4$ doped and undoped shows mixed phases of hexagonal and cubic that resembles with JCPDS file no. 16-0334 (called β-phase) and

JCPDS file no. 01-77-2042 (called α-phase) respectively. From the emission spectra it is clear that, the PL intensity improved when the alkali metal ions are incorporated in the subsequent order $K^+ < Na^+ < Li^+$ in the phosphors. The visible QC and ET through DC is observed only in $LiY_{0.94}F_4$: $_{0.05}Gd^{3+}$, $_{0.01}Eu^{3+}$ and the QE was intended to be around 127% under the excitation of 154 nm wavelength. No quantum cutting is observed in $NaY_{0.94}F_4$: $_{0.05}$ Gd^{3+}, $_{0.01}$ Eu^{3+} and $KY_{0.94}F_4$: $_{0.05}$ Gd^{3+}, $_{0.01}$ Eu^{3+} phosphor under the 154 nm excitation wavelength. Hence $LiY_{0.94}F_4$: $_{0.05}$ Gd^{3+}, $_{0.01}$ Eu^{3+} phosphor may be potential candidate for MFFL.

Acknowledgments

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Review on Comparative Study Of QE Measurement Technique For Phosphor

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Department of Physics,
Shri Shivaji Arts, Commerce and Science College, Akot

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Abstract:- *QE is an important characteristic of luminescence materials and phosphor. There are different theoretical and experiment technique to measurement QE. From the photoluminescence spectrograph QE is calculated theoretical. There are some technique in which experimental find out the QE. It's important to researcher Comparison of cost of measurement of QE by different technique and application of material on the QE characteristic. Initial stage and easy step to find out QE of phosphor then its easy to find out application of phosphor. In some application QE is sacrifices over luminescence and vice versa. On the basis QE application of phosphor is decided to use in Medical, PV solar panel , TV screen display etc.*

Keyword:- *PL an QE*

Introduction:-

Fig. 1 shows how the luminescence process works. Two different forms of returns to the ground state—one radiative and the other non-radiative—are shown in the image. The process of luminescence happens through the former. The other, which is responsible for radiative emission caused by phonons that are transformed into lattice vibrations that carry energy in the form of heat, is unrelated to luminescence. When radiative transitions outweigh non-radiative ones in a luminous material, it is said to be efficient.

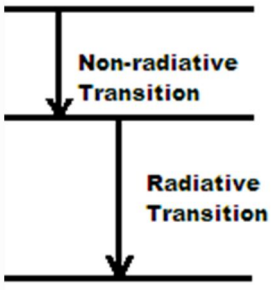


Figure 1: Energy level scheme of the luminescent ion.

The quantum efficiency of the luminescent material (phosphor) is defined as the ratio of the number of photons emitted by the sample to the number of photons absorbed by the irradiated sample. Since the existence of luminescent materials, the quantum efficiency (QE) is one of the most important characteristic of the phosphors.

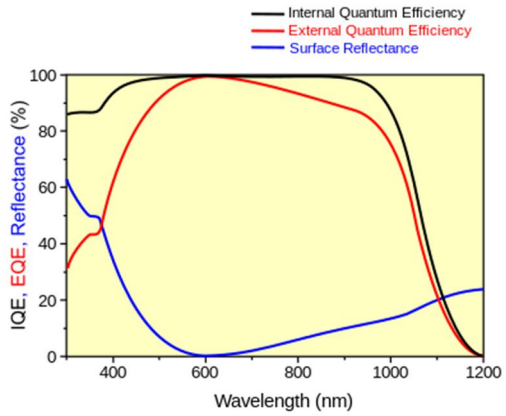
Literature survey:-

QE is a crucial feature of phosphor and luminescence materials. There are several experimental and theoretical methods for measuring QE. Theoretical calculations are made using the photoluminescence spectrograph results. There are a few methods via which experiments determine the QE. Comparing the costs of measuring QE using various techniques and applying different materials to the QE characteristic is an important area of research. Beginning stage and simple procedure to find out QE of phosphor then its easy to

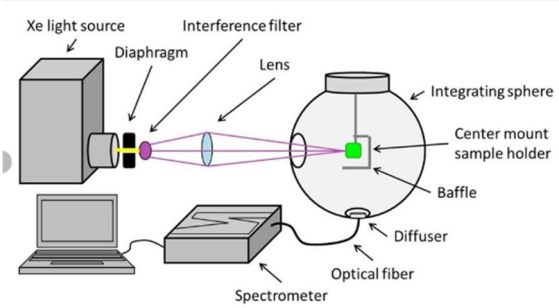
find out application of phosphor. In certain applications, luminescence is sacrificed for QE, and vice versa. Phosphorus application in medical, photovoltaic, TV screen display, and other fields is determined based on QE.

In the context of photoluminescence measurements, the phrase "quantum efficiency" refers to the ratio of photons released to photons absorbed, or external quantum efficiency (EQE). Typically, PL measurements in an integrating sphere are used to get such data. If there is no non-radiative quenching process, the internal quantum efficiency (IQE) is the ratio of the experimentally determined decay time by the radiative decay time of the luminescent centre. The IQE can be obtained through time-dependent measurements, i.e., by determining the decay time. The quantum efficiency rating of a solar cell represents the amount of current it can generate when exposed to photons of a specific wavelength.

The quantum efficiency of the cell may be used to calculate how much current it will generate in the presence of sunlight if it is integrated throughout the complete solar electromagnetic spectrum. The cell's total energy conversion efficiency value is determined by dividing this energy-production value by the maximum energy-production value that could be achieved (i.e., if the QE were 100% over the complete spectrum). Because the incoming photons have more than twice the band gap energy and can produce two or more electron-hole pairs per incident photon, it should be noted that in the event of multiple exciton generation (MEG), quantum efficiencies of higher than 100% may be attained.



A fast and accurate method for determining the internal quantum efficiency of strongly scattering luminous materials is described using an integrating sphere-based setup. Two different but related measuring techniques—a "two measurement" and a "three measurement" approach—are commonly discussed in literature. We assess both approaches using the rigorous integrating sphere theory. It was discovered that the two measuring techniques are reliable. Furthermore, a comparison is made between the two approaches concerning the uncertainty budget of the calculated quantum efficiency values. It was done an inter-laboratory validation with the two different processes. The experimental findings supported the theoretical study's conclusions.



Given 100 photons, a device with a 50% quantum efficiency (QE) will generate 50 electrons of signal. For light-detecting equipment like cameras, solar cells, and photodetectors, QE is essential. The wavelength of the photons and the properties of the device material influence quantum efficiency, or QE. Quantum efficiency (QE) is defined as a function of energy or wavelength and can be either internal or eternal.

Conclusion:-

There are number of theoretical and experiment technique to find out of QE of Phosphor, each with its limitations. But its need to find out low cost technique to find out QE which make a correlation between theoretical and experiment value.

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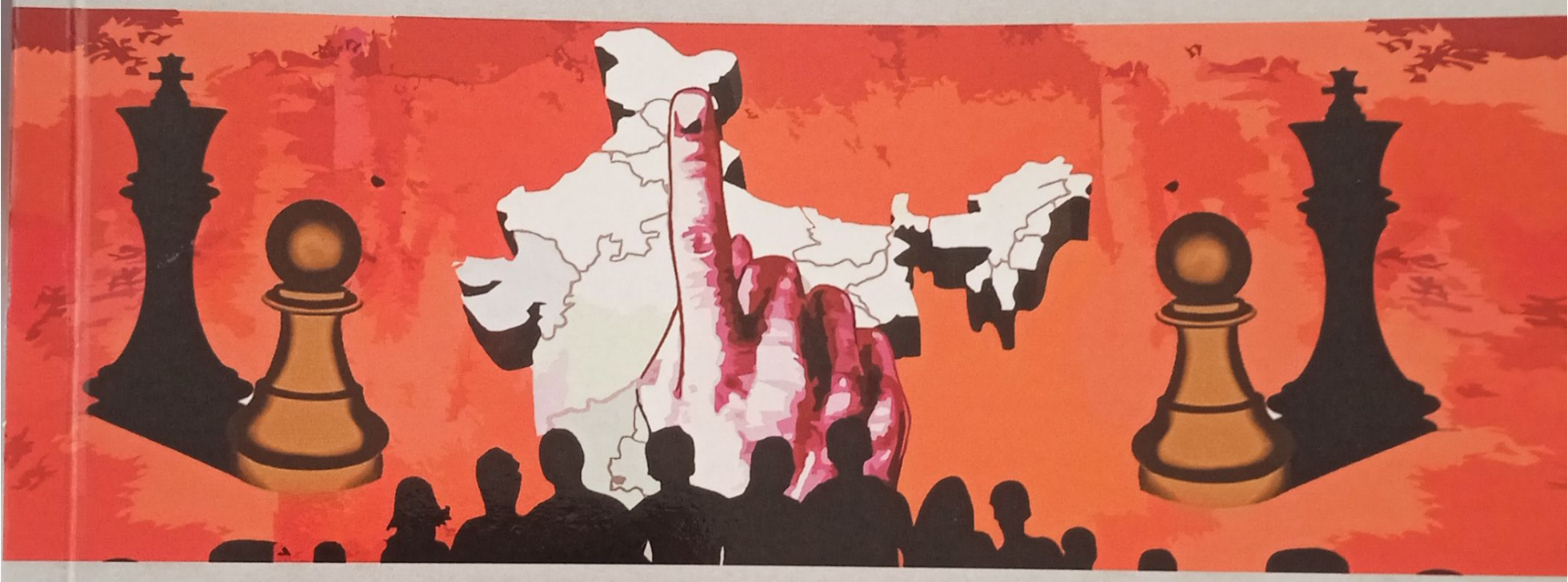

महाराष्ट्र राज्यशास्त्र व लोकप्रशासन परिषदेची संशोधन पत्रिका

विचार मंथन

अथर्व पब्लिकेशन्स

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अध्यक्षीय निवडणूक प्रक्रिया आणि लोकशाही

डॉ. संतोष नारायण कायंदे
प्राध्यापक व राज्यशास्त्र विभाग प्रमुख,
श्री. शिवाजी महाविद्यालय अकोट. जि. अकोला

अमेरिकेचे ४६ वे अध्यक्ष म्हणून जो बायडेन यांनी २० जानेवारी २०२१ रोजी शपथ घेतली. यावेळी झालेली निवडणूक ऐतिहासिक म्हटली पाहिजे. अमेरिकेच्या इतिहासामध्ये पहिल्यांदाच एक महिला उपाध्यक्ष झाली. त्यातही कृष्णवर्णीय महिला उपाध्यक्ष झाली आहे. दुसऱ्या बाजूने या निवडणुकीत घोटाळा झाल्याचा आरोप करून ट्रम्प यांनी आपला झालेला पराभव मान्य केला नव्हता. एवढेच नाही तर नोव्हेंबर महिन्यात झालेल्या अध्यक्षीय मतदाराच्या निवडणुकीत गैरप्रकार झाल्याचे सांगून ट्रम्प समर्थकांनी पहिल्यांदा सांघिक न्यायालयात आणि नंतर सर्वोच्च न्यायालयात सुद्धा धाव घेतली होती. परंतु दोन्ही ठिकाणी त्यांचे म्हणणे अमान्य करण्यात आले. शेवटी त्यांनी मतमोजणीच्या वेळी अमेरिकन काँग्रेसमध्ये घुसून गोंधळ घातला. यावेळी झालेल्या हिंसाचारात चार लोक मृत्युमुखी पडले ज्यायोगे अमेरिकन अध्यक्षीय निवडणूक प्रक्रिया आणि लोकशाही याविषयी साशंकता निर्माण झाली. प्रस्तुत लेखात २०२० ची अध्यक्षीय निवडणूक प्रक्रिया आणि लोकशाही यासह अध्यक्ष जो बायडेन यांच्या पुढील आव्हाने याची चर्चा केली आहे.

प्राथमिक निवडणुका व कॉकसेस : अध्यक्षीय उमेदवाराच्या नामांकन प्रक्रियेमध्ये दोन महत्त्वपूर्ण गोष्टी असतात. एक म्हणजे प्राथमिक निवडणूक व कॉकसेस आणि दुसरी राजकीय पक्षाची राष्ट्रीय अधिवेशने ही होय. वास्तविक संविधानात या संबंधी उल्लेख केलेला नाही. परंतु राज्येव राजकीय पक्ष यांनी याचा विकास केला आहे. अध्यक्षाच्या निवडणुकीच्या वर्षी साधारणपणे जानेवारी व जूनच्या दरम्यान प्राथमिक निवडणुका घेतल्या जातात. या प्राथमिक निवडणुकीत अध्यक्षीय उमेदवाराच्या नामांकनासाठी बोलावल्या जाणाऱ्या पक्षाच्या राष्ट्रीय अधिवेशनासाठी प्रतिनिधींची निवड केली जाते. बहुतांश राज्यात अशा प्रतिनिधींची निवड प्राथमिक निवडणुकीत प्रत्यक्ष मतदानाने होते. प्राथमिक निवडणुकीत प्रतिनिधींची केली जाणारी निवड सर्व राज्यात सारखी नाही. संबंधित निवड राज्यांच्या कायद्याने ठरविली जाते. कॉकसेसचे आयोजन राजकीय पक्ष करतात आणि त्यात आपले प्रतिनिधी निवडतात. असे प्रतिनिधी पक्षाच्या राष्ट्रीय अधिवेशनामध्ये आपल्या पक्षाच्या अध्यक्षीय उमेदवाराची निवड करतात. प्राथमिक निवडणुका व कॉकसेस यामध्ये फरक एवढाच की प्राथमिक निवडणुका राज्याद्वारा व स्थानिक शासनाद्वारा घेतल्या जातात. तर कॉकसेसचे आयोजन सरळ राजकीय पक्षाच्या वतीने केले जाते. यावेळी डेमोक्रॅटिक पक्षाचे राष्ट्रीय अधिवेशन मिल्वाँकी-विस्कॉन्सिन येथे १७ ते २० ऑगस्ट दरम्यान संपन्न झाले. या अधिवेशनात बायडेन यांची पक्षाचे अध्यक्षीय उमेदवार म्हणून निवड करण्यात आली. त्यासाठी झालेल्या मतदानात पक्षाचे एकूण ४७४९ प्रतिनिधी सहभागी होते. अध्यक्षीय उमेदवार म्हणून निवड होण्यासाठी २३७५ मते मिळणे आवश्यक होते. बायडेन यांना ३५५८ मते मिळाली होती. त्यांना मिळालेल्या मतांचे प्रमाण ७४.९२ टक्के होते. बायडेन यांचे प्रतिस्पर्धी सँडर्स यांना ११५१ मते मिळाली होती. त्यांच्या मताचे प्रमाण २४.२४ टक्के होते. याच अधिवेशनात कमला हॅरीस यांची पक्षाची उपाध्यक्षीय उमेदवार म्हणून ऐतिहासिक निवड करण्यात आली. २४ ते २७ ऑगस्ट दरम्यान चालौटे- उत्तर कॅरोलिना येथे झालेल्या रिपब्लिकन पक्षाच्या राष्ट्रीय अधिवेशनात डोनाल्ड ट्रम्प यांची अध्यक्षीय उमेदवार म्हणून आणि माईक पेन्स यांची उपाध्यक्षीय उमेदवार म्हणून निवड करण्यात आली. यावेळी पक्षाचे २५५० प्रतिनिधी सहभागी झाले होते. ट्रम्प आणि पेन्स या दोहोंनाही पक्षांच्या प्रतिनिधींची सर्व २५५० मते मिळाली होती. अध्यक्षीय उमेदवारांच्या निवडीपासून ते अध्यक्षाच्या निवडणुकीपर्यंत प्रचारासाठी जवळजवळ तीन महिन्यांचा अवधी असतो. या दरम्यान दोन्ही प्रमुख राजकीय पक्ष प्रचार कार्यासाठी मोठी यंत्रणा उभारतात. त्यावर प्रचंड खर्च केला जातो. यावेळी सार्वजनिक आरोग्य, आर्थिक परिणाम आणि पोलीस अधिकारी डेरेक चॉविन यांनी काळ्या वर्णाच्या जॉर्ज फ्लॉईड यांचा

घेतलेला जीव हे निवडणूक प्रचारातील प्रमुख मुद्दे होते. याशिवाय दोन्ही प्रमुख राजकीय पक्ष आपल्या पारंपारिक मुद्यांना नेहमीच प्रचारात लावून धरतात. कमीतकमी कर, बंदूक बाळगण्याचा अधिकार आणि स्थलांतरितांवर कठोर निर्बंध हे तीन मुद्दे रिपब्लिकन पक्षाच्या प्रचारात असतात. आपला ग्रामीण भागातील पक्षाचा जनाधार टिकून ठेवण्यासाठी रिपब्लिकन पक्ष नेहमीच याचा प्रचारात उपयोग करतो. तर डेमोक्रॅटिक पक्ष आपला शहरी भागातील जनाधार टिकून ठेवण्यासाठी लोकांचे आरोग्य आणि लोकांचे अधिकार व स्वातंत्र्याच्या मुद्याला आपल्या प्रचारात अधिक महत्त्व देतो. यावेळी करोना संकटामुळे निवडणुकीचा खर्च कमी होईल असे वाटत होते परंतु प्रत्यक्षात झाले उलटेच. आतापर्यंतच्या तुलनेत या निवडणुकीत सर्वात जास्त खर्च झाल्याचे आढळते. यासंबंधी सेंटर फॉर रिस्पॉन्सी व पॉलिटिक्स या संस्थेने केलेल्या सर्वेक्षण अभ्यासाचा निष्कर्ष हे सांगतो की यावेळी निवडणुकीत १४ अब्ज डॉलर खर्च झाले.

अध्यक्षीय मतदारांची निवड : अध्यक्ष व उपाध्यक्षाच्या निवडणुकीमध्ये अध्यक्षीय मतदाराची निवड हा महत्त्वाचा टप्पा आहे. अध्यक्ष व उपाध्यक्षाच्या निवडणुकीमध्ये मतदान करणारा एक विशिष्ट मतदारवर्ग असतो. त्यालाच निर्वाचक गण म्हटले जाते. मतदारवर्ग किंवा निर्वाचक गण म्हणजे लोकांचा असा गट आहे जो अध्यक्ष व उपाध्यक्षाची निवड करतो. याचाच अर्थसामान्य मतदार अध्यक्ष व उपाध्यक्षाच्या निवडणुकीमध्ये अध्यक्षीय व उपाध्यक्षीय उमेदवाराला सरळ मतदान करीत नाही. सामान्य मतदार अध्यक्ष व उपाध्यक्षाची नाही तर वस्तुतः अध्यक्षीय मतदारांची निवड करतो. अध्यक्षीय मतदारांची संख्या राज्यनिहाय निराळी आहे. प्रत्येक राज्याची अध्यक्षीय मतदारांची संख्या ही त्या राज्याच्या लोकसंख्येवर आधारीत असते. प्रत्येक राज्याची अध्यक्षीय मतदारांची संख्या ही त्या राज्यातील काँग्रेसमधील प्रतिनिधींच्या संख्ये इतकी असते. काँग्रेसची एकूण सभासद संख्या (सिनेट १०० व प्रतिनिधीसभा ४३५) ५३५ आहे. अमेरिकेतील एकूण ५० राज्यातील अध्यक्षीय मतदारांची संख्या सुद्धा ५३५ आहे. परंतु अध्यक्षीय मतदारांची एकूण संख्या ५३८ आहे. त्यासाठी २३ वी घटनादुरुस्ती महत्त्वाची राहिली आहे.[१] सध्याची अध्यक्षीय मतदारांची संख्या २०१० च्या जनगणने वर आधारित आहे. त्याला अनुसरून ५० पैकी ७ राज्यातील अध्यक्षीय मतदारांची संख्या ३ आहे.[२] अमेरिकेच्या सांघिक संविधानानुसार अध्यक्षीय मतदारांची निवड करण्याची पद्धत सरळ संघशासनाद्वारे नाही तर प्रत्येक राज्याच्या विधिमंडळाद्वारा ठरविली जाते. बहुतांश राज्यांमध्ये अशी पद्धत आहे की, संबंधित राज्यात येथून झालेल्या मतदानापैकी बहुमत प्राप्त करणाऱ्या पक्षाचे सर्वच्यासर्व उमेदवार अध्यक्षीय मतदार म्हणून निवडून आल्याचे घोषित केले जाते. या पद्धतीचा परिणाम म्हणून कधीकधी सर्व राज्यातील मिळून जनतेची मते सर्वाधिक मिळूनही संबंधित अध्यक्षीय मतदारांच्या जागा कमी मिळतात आणि संबंधित पक्षाच्या अध्यक्षीय उमेदवाराला पराभवाचा सामना करावा लागतो. आतापर्यंत असे पाच वेळा घडले आहे.[३] परंतु बहुतांश राज्यात असलेल्या वरील पद्धतीला मेन व नेब्रास्का या दोन राज्यांचाअपवादआहे.[४]

निवडणूक निकालाचे विश्लेषण : २०२० च्या अध्यक्षीय निवडणुकीच्या वेळी बायडेन आणि ट्रम्प यांना प्रत्येकी पंचवीस राज्यांमध्ये बहुमत मिळाले असले तरी त्यांना मतदारवर्गाच्या मिळालेल्या जागा सारख्या नव्हत्या. कारण प्रत्येक राज्याची मतदारवर्गाची सदस्यसंख्या सारखी नाही. बायडेन यांना ३०६ आणि ट्रम्प यांना २३२ जागा मिळाल्या होत्या. बायडेन यांना २५ राज्यात ३०२ जागा मिळाल्या होत्या. सोबतच बायडेन यांना डिस्ट्रिक्ट ऑफ कोलंबियाच्या ३ आणि नेब्रास्का राज्यातील १ जागा (एका काँग्रेसीय जिल्ह्यात बहुमत प्राप्त केल्याने) मिळाली होती. ट्रम्प यांना २५ राज्यांमध्ये २३१ जागा आणि मेन राज्यात १ जागा (एका काँग्रेसीय जिल्ह्यात बहुमत प्राप्त केल्याने) मिळाली होती. बायडेन यांना पेंनसिल्वानिया राज्यात बहुमत मिळेपर्यंत अध्यक्षीय मतदाराच्या आवश्यक २७० जागांचा आकडा पार करता आला नव्हता. अध्यक्षीय मतदारासाठी ३ नोव्हेंबर रोजी मतदान झाले असले तरी पेंनसिल्वानिया राज्याचा निकाल ७ नोव्हेंबर रोजी जाहीर झाला होता. पेंनसिल्वानिया राज्यात बहुमत मिळाल्याने बायडेन यांना अध्यक्षीय मतदाराच्या तेथील २० जागा मिळाल्या होत्या. हा निकाल येण्याआधी बायडेन यांना अध्यक्षीय मतदाराच्या २५३ जागा मिळाल्या होत्या. याचाच अर्थ वरील निकालाने बायडेन यांना अध्यक्षीय मतदाराच्या आवश्यक २७० जागांचा आकडा पार करून वर ३ जागा मिळाल्या होत्या. एबीसी न्यूज, एनबीसी न्यूज, सीबीएस न्यूज, द असोसिएटेड प्रेस, सीएनएन आणि

फॉक्स न्यूज या सर्वांनी बायडेन यांचा निवडणुकीतील विजय त्यांना पेनसिल्वानीया राज्यात मिळणाऱ्या बहुमतावर आधारित असल्याचे मत व्यक्त केले होते.[५] बायडेन यांना जॉर्जिया, विसकॉन्सिन आणि ऍरिझोना या तीन राज्यात ट्रम्प यांच्या तुलनेत मतांची आघाडी मिळाली असली तरी ही आघाडी जास्त मतांची नव्हती. वरील तीन राज्यात बायडेन आणि ट्रम्प यांना मिळालेल्या मतांमध्ये सर्वात कमी अंतर होते. दोहोमध्ये फक्त ४२९१८ मतांचे अंतर होते. बायडेन आणि ट्रम्प यांना जॉर्जियात अनुक्रमे २४७३६३३ (४९.४७ टक्के) आणि २४६१८५४ (४९.२४ टक्के), विस्कॉन्सिन राज्यात १६३०८६६ (४९.४५ टक्के) आणि १६१०१८४ (४८.८२ टक्के) आणि एरिझोनात १६७२१४३ (४९.३६ टक्के) आणि १६६१६८६ (४९.०६ टक्के) मते मिळाली होती. परंतु या तीन राज्यात जरी बायडेन यांच्याऐवजी ट्रम्प यांना बहुमत मिळाले असते तरी अध्यक्षीय निवडणुकीचा निकाल बायडेन यांच्या बाजूनेच लागला असता. कारण वरील तीन राज्यातील अध्यक्षीय मतदारांची एकूण संख्या ३७ आहे.[६] वरील तीन राज्यातील ३७ जागा ट्रम्पयांना मिळाल्या असत्या तर ट्रम्प आणि बायडेन यांना अध्यक्षीय मतदाराची सारखी २६९ मते मिळाली असती. अशा स्थितीत कोणालाही स्पष्ट बहुमत (अध्यक्षीय मतदाराची २७० मते) न मिळाल्याने आणि दोन्ही प्रमुख उमेदवारांना सारखी (अध्यक्षीय मतदाराची २६९) मते मिळाल्यामुळे अध्यक्षाची निवड प्रतिनिधीसभेने केली असती. असे झाले असते तर प्रतिनिधीसभेत डेमोक्रॅटिक पक्षाला असलेल्या बहुमताचा फायदा बायडेन यांना मिळाला असता आणि तेच अध्यक्ष म्हणून निवडले गेले असते. २०२० च्या प्रतिनिधीसभेच्या निवडणुकीमध्ये डेमोक्रॅटिक पक्षाला २२२आणि रिपब्लिकन पक्षाला २१३ जागा मिळाल्या होत्या. त्याआधी २०१८ च्या निवडणुकीमध्ये सुद्धा डेमोक्रॅटिक पक्षाला २३५ आणि रिपब्लिकन पक्षाला १९९ जागा मिळाल्या होत्या. २०१८ च्या तुलनेत २०२० मध्ये रिपब्लिकन पक्षाच्या १४ जागा वाढल्या असल्या आणि डेमोक्रॅटिक पक्षाच्या १३ जागा कमी झाल्या असल्या तरी दोन्ही वेळी प्रतिनिधीसभेत डेमोक्रॅटिक पक्षाचेच बहुमत होते. परंतु पुन्हा असे की, वरील तीन राज्यातील ३७ जागांसह नेब्रास्कातील एका काँग्रेसीय जिल्ह्यातील (कमी मताने गमावलेली) १ जागा[७] ट्रम्पयांना मिळाली असती तर निवडणुकीचा निकाल निराळा राहिला असता. असे झाले असते तर अध्यक्षपदी निवडून येण्यासाठी आवश्यक असलेली अध्यक्षीय मतदाराची बरोबर २७० मते ट्रम्प यांना मिळून ते पुन्हा एकदा अध्यक्ष झाले असते. अध्यक्षीय मतदारांची संख्या जास्त असलेल्या चार राज्यांपैकी बायडेनव ट्रम्प यांना प्रत्येकी दोन राज्यांमध्ये बहुमत मिळाले असले तरी त्यांना अध्यक्षीय मतदाराच्या मिळालेल्या जागा सारख्या नव्हत्या. अध्यक्षीय मतदाराच्या सर्वात जास्त ५५ जागा असलेल्या कॅलिफोर्निया राज्यात बायडेन यांना आणि त्याखाली ३८ अध्यक्षीय मतदार असलेल्या टेक्सास राज्यात ट्रम्प यांना बहुमत मिळाले होते. न्यूयॉर्क आणि फ्लोरिडा राज्यात अध्यक्षीय मतदाराच्या प्रत्येकी २९ जागा आहेत. न्युयॉर्कमध्ये बायडेन आणि फ्लोरिडामध्ये ट्रम्प यांना बहुमत मिळाले. बायडेन यांना बहुमत मिळालेल्या वरील दोन राज्यांमध्ये अध्यक्षीय मतदाराच्या ८४ आणि ट्रम्प यांना बहुमत मिळालेल्या वरील दोन राज्यांमध्ये अध्यक्षीय मतदाराच्या ६७ जागा मिळाल्या. त्यातही बायडेन यांना बहुमत मिळालेल्या वरील दोन राज्यात बायडेन आणिट्रम्प यांना मिळालेल्या मतांमध्ये अधिक अंतर होते. दुसऱ्या बाजूने ट्रम्प यांना बहुमत मिळालेल्या वरील दोन राज्यांमध्ये ट्रम्प आणि बायडेन यांना मिळालेल्या मतांमध्ये कमी अंतर होते. बायडेन यांना कॅलिफोर्निया राज्यात १११११०२५० (६३.४८ टक्के) व न्यूयॉर्कमध्ये ५२३०९८५ (६०.८६ टक्के) मते मिळाली आणि ट्रम्प यांना या दोन्ही राज्यात अनुक्रमे ६००६४२९ (३४.३२ टक्के) व ३२४४७९८ (३७.७५ टक्के) मते मिळाली. वरील दोन्ही राज्यात बायडेन व ट्रम्प यांना मिळालेल्या मतांमध्ये अनुक्रमे २९.१६ टक्के आणि २३.११ टक्के अंतर होते. उलट ट्रम्प यांना टेक्सासमध्ये ५८९०३४७ (५२.०६ टक्के) व फ्लोरीडात ५६६८७३१ (५१.२२ टक्के) मते मिळाली आणि बायडेन यांना या दोन्ही राज्यात अनुक्रमे ५२५९१२६ (४६.४८ टक्के) व ५२९७०४५ (४७.८६ टक्के) मते मिळाली. वरील दोन्ही राज्यात ट्रम्प व बायडेन यांना मिळालेल्या मतांमध्ये अनुक्रमे ५.५८ टक्के आणि ३.३६ टक्के मतांचे अंतर होते. अध्यक्षीय निवडणुकीचा निकाल आधीच्या २०१६ च्या निवडणूक निकालाच्या बरोबर उलट निकाल म्हटला पाहिजे. २०१६ च्या वेळी सुद्धा विजयी उमेदवाराला ३०६ आणि पराभूत उमेदवाराला २३२ जागा मिळाल्या होत्या. परंतु त्यावेळी ३०६ जागा

मिळून विजय प्राप्त करणारे रिपब्लिकन डोनाल्ड ट्रम्प यावेळी २३२ जागांवर थांबून पराभूत झाले. दुसऱ्या बाजूने त्यावेळी डेमोक्रॅटिक हिलरी क्लिंटन यांना ट्रम्प यांच्या तुलनेत जनतेची लोकप्रिय मते (Popular votes) अधिक मिळूनही अध्यक्षीय मतदाराच्या कमी २३२ जागा मिळाल्या आणि पराभव पत्करावा लागला. यावेळी डेमोक्रॅटिक जो बायडेन यांना जनतेची लोकप्रिय मते आणि अध्यक्षीय मतदाराच्या जागाअधिक मिळून विजय मिळाला. वरील आधारावर अमेरिकन जनतेने अध्यक्षीय निवडणुकीत रिपब्लिकन ट्रम्पयांच्या तुलनेत डेमोक्रॅटिक बायडेन यांना अधिक पसंत केल्याचे आढळते. याचा अन्वयार्थ हा की, अमेरिकन जनतेने अध्यक्षीय निवडणुकीत ट्रम्प यांच्या एकाधिकारशाही प्रवृत्तीच्या तुलनेत बायडेन यांच्या रूपात लोकशाहीवादी प्रवृत्तीला अधिक पसंती दिली.

निवडणूक निकालाची वैशिष्टये : या निवडणुकीच्या निकालाची काही महत्त्वपूर्ण वैशिष्टये आहेत. पहिले हे की, १९३२ पासून पहिल्यांदा प्रस्थापित अध्यक्षा विरुद्ध निवडणूक जिंकून बायडेन यांनी सर्वात जास्त लोकप्रिय मते प्राप्त केली होती. बायडेन यांना ८१२६८९२४ मते मिळाली होती. त्यांच्या मतांचे प्रमाण ५१.३ टक्के होते. ट्रम्प यांना ७४२१६१५४ मते मिळाली होती. त्यांच्या मतांचे प्रमाण ४६.८६ टक्के होते. बायडेन यांना ट्रम्प यांच्या तुलनेत ७०५२७७० लोकप्रिय मते जास्त मिळाली होती. विशेष म्हणजे बायडेन व ट्रम्प या दोन्ही प्रमुख उमेदवारांना ७४ मिलीयन पेक्षा जास्त लोकप्रिय मते मिळाली होती. या दोघांनीही २००८ च्या निवडणुकीमध्ये बराक ओबामा यांना मिळालेल्या ६९.५ मिलियन विक्रमी लोकप्रिय मतांपेक्षा जास्त मते प्राप्त केली होती. दुसरे असे की या निवडणुकीत झालेले मतदानाचे प्रमाण सर्वात जास्त होते. या निवडणुकीत झालेल्या मतदानाचे प्रमाण ६६.७ टक्के होते. १९०० पासून झालेल्या मतदानाच्या तुलनेत हे प्रमाण सर्वात जास्त म्हटले पाहिजे. तिसरे वैशिष्ट्य हे की ट्रम्प हे १९९२ पासून (जॉर्ज एच. डब्ल्यू. बुश यांच्यानंतर) पहिले आणि अमेरिकन इतिहासात अकरावे असे अध्यक्ष ठरले ज्यांचा दुसऱ्या कार्यकाळासाठी झालेल्या निवडणुकीत पराभव झाला. चौथे हे की बायडेन रिचर्ड निक्सन यांच्यानंतर दुसरे असे माजी उपाध्यक्ष ठरले ज्यांनी पहिल्या कार्यकाळासाठीच्या अध्यक्षीय निवडणुकीत विजय प्राप्त केला. १९६८ मध्ये रिपब्लिकन पक्षाचे रिचर्ड निक्सन असे पहिले अध्यक्ष झाले होते. राजकीय पक्षाचा विचार करता बायडेन हे असे पहिले डेमॉक्रॅटिक अध्यक्ष ठरले आहेत. आणखी असे की बायडेन यांच्या रूपाने डेमॉक्रॅटिक पक्षाला १९९२ पासून जॉर्जियात आणि १९९६ पासून एरिझोनात पहिल्यांदा बहुमत मिळाले. दुसऱ्या बाजूने डेमोक्रॅटिक पक्षाला १९६० पासून ओहिओत आणि १९९२ पासून फ्लोरिडात पहिल्यांदा बहुमत मिळाले नाही. या निवडणुकीचे एक वैशिष्ट्य हे सांगता येईल की, यावेळी अध्यक्षीय निवडणुकीत दहा कोटी मतदारांनी मतदान दिवसाच्या आधीच मतदान केल्याने टपाली मतदानात मोठी वाढ झाली होती. अनेक राज्यात ही मते निर्णायक व महत्त्वाची ठरली होती. या मतांच्या मोजणी बाबत वाद निर्माण होऊन तो न्यायालयात गेला होता. रिपब्लिकन ट्रम्प यांनी टपाली मतदानास विरोध केला होता. टपाली मते आपल्या विरोधात जाण्याची भीती त्यांना वाटत होती. न्यायालयाच्या आदेशाने टपाली मतांची मोजणी करण्यात आली. टपाली मतदानचा फायदा ट्रम्प यांच्या तुलनेत बायडेन यांनाच अधिक झाला. तसेच आताच्या निवडणुकीत अमेरिकी भारतीय मतदारांनी ट्रम्प यांच्या तुलनेत बायडेन यांना अधिक पसंती दर्शवली होती. यासंबंधी युगव्ह या संस्थेने केलेला सर्वेक्षण अभ्यास हे सांगतो की ७२% अमेरिकी भारतीयांनी बायडेन यांना आणि २२% अमेरिकी भारती यांनी ट्रम्प यांना आपली पसंती दाखवली होती. आणखी एक महत्त्वाची गोष्ट ही की या वेळी लिबर्टे रियनजो जॉंर्जसेन आणि ग्रीन पक्षाचे हावर्ड हॉकिन्स यांच्यासह आणखी सहा उमेदवार निवडणूक स्पर्धेत होते. जॉंर्जसेन यांना १८६५७२४ आणि हॉकिन्स यांना ४०५०३५ लोकप्रिय मते मिळाली परंतु त्यांना अध्यक्षीय मतदाराची एकही जागा मिळू शकली नाही.

जो बायडेन यांच्यापुढील आव्हाने : अध्यक्ष जो बायडेन आणि उपाध्यक्ष कमला हॅरीस यांच्या रूपाने अमेरिकेत नवीन पर्व सुरू झाले असले तरी त्यांच्या पुढील आव्हाने कमी नाहीत हे नक्की. अध्यक्षीय निवडणुकीत बायडेन यांच्या बाजूने कल दिसू लागल्याने ट्रम्प समर्थकांनी निवडणुकीमध्ये गैरप्रकार झाल्याचा कांगावा करून न्यायालयात धाव घेतली होती. न्यायालयाने प्रतिसाद न दिल्याने खवळलेल्या समर्थकांनी शेवटी मतमोजणीच्या दिवशी अमेरिकन काँग्रेसमध्ये धुडगूस घालून हिंसाचार घडवून आणला. यामध्ये एक पोलिस कर्मचाऱ्यासह

पाच व्यक्तींचा मृत्यू झाला आणि इतर अनेक जखमी झाले. यामुळे जगात अमेरिकेची प्रतिमा मलिन होऊन तिच्या लोकशाहीवर प्रश्नचिन्ह निर्माण झाले. अमेरिकन लोकशाहीला लागलेला हा काळा डाग पुसण्याचे पहिले महत्त्वाचे आव्हान बायडेन यांच्यापुढे आहे. स्वातंत्र्य, समता आणि सर्वंकष लोकशाही ही अमेरिकेची सर्वोच्च मूल्ये आहेत. ही मूल्ये अमेरिकेने फ्रेंच राज्यक्रांतीच्या १३ वर्ष आधी जगाला दिली आहेत. दुसरे महत्त्वाचे आव्हान करोना संकटाचे आहे. अमेरिकेत करोनामुळे आजपर्यंत चार लाखाहून अधिक लोकांचा मृत्यू झाला आहे. आधीच्या प्रशासनाने हा प्रश्न नीटपणे हाताळला नाही. त्यामुळे आणि प्रशासनाच्या ढिसाळपणामुळे करोना संकट अधिकच गडद झाले. करोना संकटाची तीव्रता कमी करून व्यवस्था पूर्ववत करणे अगत्याचे आहे. यासंबंधी अध्यक्ष बायडेन यांनी काही महत्त्वपूर्ण निर्णय घेतले असले तरी करोना संकट काही कमी झाले नाही. त्यासाठी व्यवस्थापकीय यंत्रणेतील सुधारणांसह काही कठोर उपाय करावे लागतील. तिसरे आव्हान अर्थातच अर्थव्यवस्थेचे आहे. जगातील सर्वात मोठी अर्थव्यवस्था म्हणून अमेरिकेकडे पाहिले जात असले तरी तिच्या सकल राष्ट्रीय उत्पादनात –जीडीपीत पाहिजे तेवढी वाढ झालेली दिसत नाही. २०२० मध्ये ही वाढ ४.५ टक्के होती तर २०२१ मध्ये ती ३.१ टक्के आहे. यासाठी दोन कारणे महत्त्वाची ठरली आहेत. पहिले २००७ चे आर्थिक संकट आणि दुसरे आताचे करोना संकट. आधीच्या संकटातून पूर्णपणे बाहेर पडण्याआधीच आताचे दुसरे संकट उभे ठाकले आहे. संघशासनालाच नाही तर तेथील राज्ये व स्थानिक शासन यांनाही मोठा आर्थिक फटका बसला आहे. त्यांच्या करसंकलनात मोठी घट झाली आहे. दुसऱ्या बाजूने त्यांचा सार्वजनिक आरोग्यावरील खर्च मोठा वाढला आहे. सध्या अमेरिकेत वित्तीय तूट आणि सरकारी खर्च वाढला आहे. एवढेच नाहीतर सरकारी कर्जात मोठी वाढ झाली आहे. सध्या अमेरिकेचे कर्ज तिच्या सकल राष्ट्रीय उत्पन्नाच्या १०६ टक्के आहे. चौथे आव्हान नागरिकत्व कायद्यात सुधारणा करण्याचे आहे. स्थलांतरित व्यक्तींना केवळ कागदपत्र अभावी नागरिकत्व न देणे योग्य नाही. त्यासाठी नवीन प्रशासनाला योग्य ते पाऊल उचलावे लागेल. अनेक वर्षापासून प्रलंबित असलेला हा प्रश्न मार्गी लावणे अगत्याचे झाले आहे. सोबतच वर्णभेदाचा जुनाच प्रश्न अजूनही सुटलेला नाही. अलिकडेच यासंबंधी तिथे हिडीस स्वरूप पाहायला मिळाले होते. मेनीयापोलिस शहरात २५ मे २०२० रोजी तेथील पोलीस अधिकारी डेरेक चाँविन यांनी पोलिस बळाचा अतिरेकी वापर करत जॉर्ज फ्लॉईड नामक काळया वर्णाच्या व्यक्तीला अमानुष मारहाण करून तिचा जीव घेतला होता. संपूर्ण देशात वर्ण समतेच्या दृष्टीने बायडेन यांनी काही पाऊल उचलले असले तरी यासंबंधी ठोस कृती करण्याची गरज आहे. आधीच्या ट्रम्प प्रशासनाने 'ब्लॅक लाईव्ज मॅटर' आंदोलन करणाऱ्यांचे दमन केले. याच प्रशासनाने श्वेतवर्णीयांची मते मिळावी म्हणून शिक्षण धोरणात बदल करण्यास सुरुवात केली होती. पुढील आव्हान परराष्ट्र धोरणासंबंधीचे आहे. यासंबंधी ट्रम्प प्रशासनाने जे चुकीचे पाऊल उचलले होते त्याला आवश्यकती मुरड घालून आताचे अध्यक्ष बायडेन यांना पुढे जावे लागेल. शेजारील राष्ट्रे मेक्सिको व कॅनडा यांच्याशी चांगले संबंध प्रस्थापित करावे लागतील. ट्रम्प यांच्या काळात या दोन्ही देशांशी असलेल्या संबंधात दुरावा निर्माण झाला होता. त्याला कारण असे की, अमेरिकेने मेक्सिकोशी असलेल्या सीमेवर भिंत बांधण्याचे काम सुरू केले होते. ते काम बंद करण्याची मागणी करूनही ट्रम्प प्रशासनाने त्याकडे सोयीस्कर दुर्लक्ष केले. असाच प्रकार युरोपियन राष्ट्रांबाबत सांगता येईल. त्यांच्याशी संबंधित असलेल्या नाटो (नॉर्थ अटलांटिक ट्रिटी ऑर्गनायझेशन) या लष्करी संघटनेशी असलेल्या संबंधात वितुष्ट निर्माण झाले. या संघटनेमध्ये तीस युरोपीय देशांचा आणि उत्तर अमेरिकन राष्ट्रांचा समावेश आहे. नवीन अध्यक्ष बायडेन यांनी मेक्सिको सीमेवरील भिंतीचे बांधकाम थांबवण्याचा निर्णय त्वरित घेतला असला तरी वरील दोन्ही राष्ट्रांसह युरोपियन राष्ट्रांबाबत पूर्ववत चांगले संबंध प्रस्थापित करण्यासाठी सहकार्याच्या धोरणाचा अवलंब करावा लागेल. करोना संकटाच्या पार्श्वभूमीवर जागतिक आरोग्य संघटनेवर कडवट टीका करुन ट्रम्प यांनी तिच्यातून एक प्रकारे माघार घेतली होती. नवीन अध्यक्ष बायडेन यांनी ही माघार थांबवण्याचा निर्णय घेतला असला तरी सध्याच्या करोना संकटाच्या काळात जागतिक आरोग्य संघटनेला अमेरिकेच्या सक्रीय सहभागाची आणि भरीव सहकार्याची खरी गरज आहे. अमेरिका फर्स्ट धोरण आणि पॅरिस हवामान करार या बाबतही हेच म्हटले पाहिजे. थोडक्यात अंतर्गत व परराष्ट्रीय अशा दोन्ही पातळीवर असलेल्या आव्हानांशी बायडेन

यांना तोंड द्यावे लागेल. त्यासाठी शांतता आणि एकता महत्त्वाची असून त्याचीच कास धरण्याचा मनोदय अध्यक्ष बायडेन यांनी अध्यक्षपदाची शपथ घेतल्यानंतर केलेल्या आपल्या भाषणात व्यक्त केला होता. त्यावर ते किती खरे उतरतात आणि अमेरिकन लोकशाहीला कसे बळकट करतात हे पाहणे महत्त्वाचे ठरणार आहे.

संदर्भ व टीपा

१) २३ व्या घटना दुरुस्तीला अनुसरून राष्ट्रीय राजधानी असलेल्या वाशिंग्टन, डि. सी. (डिस्ट्रिक्ट ऑफ कोलंबिया) ला तीन अध्यक्षीय मतदार देण्यात आले आहेत. ही संख्या लहान राज्याच्या अध्यक्षीय मतदाराइतकी आहे. लहान राज्याची लोकसंख्या कितीही असली तरी त्याची अध्यक्षीय मतदारांची संख्या किमान तीन असते.

२) अलास्का, डेलावरे, मोन्टाना, उत्तर डाकोटा, दक्षिण डाकोटा, वरमोंट आणि व्योमिंग राज्यांमध्ये अध्यक्षीय मतदाराची संख्या तीन आहे.

३) २०१६ च्या निवडणुकीमध्ये हिलरी क्लिंटन यांना डोनाल्ड ट्रम्प यांच्यापेक्षा जनतेची मते (६५८५३५१४) जास्त मिळूनही अध्यक्षीय मते (२३२) कमी मिळाली आणि त्यांना पराभव पत्करावा लागला. याउलट ट्रम्प यांना क्लिंटन यांच्या तुलनेत जनतेची मते (६२९८४८२८) कमी मिळूनही अध्यक्षीय मते (३०६) जास्त मिळाली आणि विजयही मिळाला. त्याआधी २००० च्या निवडणुकीत डेमोक्रॅटिक पक्षाचे अल्गोर यांना जनतेची सर्वाधिक (५०९९९८९७) मते मिळूनही जनतेची कमी (५०४५६००२) मते मिळवणाऱ्या जॉर्ज डब्ल्यू. बुश यांच्याकडून पराभव पत्करावा लागला. अर्थात या निवडणुकीचा निकाल सर्वोच्च न्यायालयाच्या निर्णयाला अनुसरून देण्यात आला होता. त्याआधी १८८८, १८७६ व १८२४ मध्ये असेच घडले होते. १८८८ मध्ये ग्रोवर क्लिवलँड यांना बेंजामिन हॅरिसन यांच्याकडून, १८७६ मध्ये सॅम्युयल टिल्डेन यांना रुदरफोर्ड यांच्याकडून तर १८२४ मध्ये अँड्रयू जॅक्सन यांना जॉन क्विन्सी अँडम्स यांच्याकडून असाच पराभव पत्करावा लागला होता.- कायंदे, स. ना., ब्रिटन व संयुक्त राज्य अमेरिकेचे शासन आणि सार्क, पृष्ठ ९७.

४) मेन व नेब्रास्का या दोन्ही राज्यातून अनुक्रमे चार व पाच अध्यक्षीय मतदार निवडून दिले जातात. या दोन्ही राज्यात राज्य काँग्रेसीय जिल्ह्यांची संख्या अनुक्रमे २ व ३ आहे. या दोन्ही राज्यात अध्यक्षीय मतदार निवडतांना वेगळी पद्धत अवलंबली जाते. वरील दोन्ही ठिकाणी राज्यात बहुमत मिळवणाऱ्या पक्षाला प्रत्येकी दोन अध्यक्षीय मतदार दिले जातात आणि राहिलेल्या जागा दोन्ही राज्यातील प्रत्येक काँग्रेसीय जिल्ह्यामध्ये बहुमत मिळवणाऱ्या पक्षाला दिल्या जातात. - कित्ता, पृष्ठ ९६.

५) **Wagner, meg; etal. (November 7,** 2020). Joe Biden elected President, CNN. Archived from the original on November 7, 2020. Retrieved November 7, 2020.

६) जॉर्जिया राज्यात १६, एरिझोना राज्यात ११ आणि विस्कॉन्सिन राज्यात १० अध्यक्षीय मतदार आहेत.

७) नेब्रास्का राज्यात अध्यक्षीय मतदार निवडण्याची वेगळी पद्धत आहे. या राज्यात एकूण पाच अध्यक्षीय मतदार आहेत. या राज्यात काँग्रेसीय जिल्ह्याची संख्या ३ आहे. राज्यात बहुमत मिळवणाऱ्या पक्षाला दोन अध्यक्षीय मतदार दिले जातात आणि राहिलेल्या काँग्रेसीय जिल्ह्यातील तीन जागा प्रत्येक काँग्रेसीय जिल्ह्यामध्ये बहुमत मिळवणाऱ्या पक्षाला दिल्या जातात. २०२० च्या निवडणुकीमध्ये नेब्रास्का राज्यात रिपब्लिकन पक्षाला ५५६८४६ (५८.२२ टक्के) आणि डेमोक्रॅटिक पक्षाला ३७४५८३ (३९.१७ टक्के) मते मिळाली होती. त्यामुळे रिपब्लिकन पक्षाला राज्यात मिळालेल्या बहुमतासाठी दोन आणि तीन काँग्रेसीय जिल्ह्यांपैकी दोन काँग्रेसीय जिल्ह्यांमध्ये मिळालेल्या बहुमतासाठी दोन अशा अध्यक्षीय मतदाराच्या एकूण चार जागा मिळाल्या होत्या. एका काँग्रेसीय जिल्ह्यामध्ये बहुमत न मिळाल्याने रिपब्लिकन पक्षाला एक जागा गमवावी लागली होती. या काँग्रेसीय जिल्ह्यामध्ये रिपब्लिकन पक्षाला १५४३७७ (४५.४५ टक्के) आणि डेमोक्रॅटिक पक्षाला १७६७६८ (५१.९५ टक्के) मते मिळाली होती. दोन्हीमध्ये २२०९१ मतांचे अंतर होते. या जागेवर डेमोक्रॅटिक पक्षाला बहुमत मिळाल्याने ही एक जागा डेमोक्रॅटिकला मिळाली होती.

IMPACT OF LEMONGRASS SUPPLEMENTATION ON SOME BIOCHEMICAL PARAMETERS OF FRESHWATER FISH *CHANNA PUNCTATUS* (BLOCH, 1793)

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Abstract
The present study was aimed to assess the effects of lemongrass supplementation on biochemical profile of freshwater fish Channa punctatus (Bloch, 1793). The Channa punctata is one of the commonly cultivated fish in India known for its deliciousness and nutrient contents. Cymbopogon citratus is commonly known as lemon grass is pharmacological properties in traditional medicine of India. Control and experimental feed were formulated with using easily available ingredients and lemongrass powder. The improved serum biochemical profile of fish fed on lemongrass based formulated feed was observed. In the present study, total protein, albumin, globulin and albumin/globulin ratio increased. The serum triglycerides, Total cholesterol and LDL-cholesterol decreased while HDL-Cholesterol increase. The increased level digestive enzymes (amylase and lipase) while decreased level of metabolic enzymes (SGOT and SGPT) were observed. The control and test feed groups were significantly different ($P<0.05$). In considering the overall observations, lemongrass supplementation in diet is recommended for successful aquaculture of this important fish species.

Keywords: *Biochemistry, Channa punctatus, feed, herb, lemongrass, supplementation.*

Introduction

The *Channa punctata*, the spotted snakehead, is a species of snakehead fish. It is a highly nutritive and rich source of animal proteins. During culture, provided an artificial feed, by which fish grow rapidly and attain maximum weight in shortest possible time. One approach is to include new substances into fish diets to improve feed conversion efficiency or elevate general conditions for fish growth and maintenance (Bhosale *et al.*, 2010). The hormones, antibiotics and several other chemicals have been tested as growth promoters, antibacterial and for other purposes in aquatic animals, but their use in aquatic animal production cannot be recommended due to the residual effects in the muscle of fish (Shrivastava *et al.*, 2012)

Plants are natural sources of safer and cheaper chemicals. The beneficial effects of bioactive plant substances in animal nutrition may include the stimulation of appetite and feed intake, growth promotion, the improvement of endogenous enzyme secretion, and activation of immuno-stimulation and antioxidant actions in aquaculture practices (Joshi, 2017). A lemongrass (*Cymbopogon citratus*) is well known for its cytoprotective, antioxidant, and anti-inflammatory properties. In traditional medicine of India, the leaves of the plant are used as stimulant, sudorific, antiperiodic, and anticatarrhal, while the essential oil is used as carminative, depressant, analgesic, antipyretic, antibacterial, and antifungal agent (Shah *et al.*, 2011, Joshi *et al.* 2022).

In this concern, present study aims to study the effect of lemongrass supplementation on some biochemical parameters of freshwater fish *Channa Punctatus* (Bloch, 1793)

Materials And Methods

Experimental diets: For the experiment, Lemongrass from conventional organic farm was used. A mature lemongrass trimmed to 1/2-inch above the soil. Then the fresh meat was thin sliced. The harvested grass blades and meat slices were laid on a clean baking sheet separately and placed into food dehydrator. The temperature was set to 150^{O} F for eight hour or until dry; then grinded in food processor. The ingredients were weighed, mixed and pelleted. After pelleting, the feeds were air dried and put in an air-tight container. The composition of experimental diet is given in Table 1.

Table 1: Ingredient composition of the experimental feeds (on % basis)

Ingredients (%)	LG 0	LG 1	LG 2	LG 3	LG 4	LG 5
Wheat flour	45	44	43	42	41	40
Soybean flour	24	24	24	24	24	24
Corn flour	10	10	10	10	10	10
Meat powder	15	15	15	15	15	15
Soybean oil	05	05	05	05	05	05
Watrmin® Forte*	01	01	01	01	01	01
Lemongrass Powder	00	01	02	03	04	05
* Vitamins, Minerals and Amino Acids supplements for Aquatic feed. Manufactured by Virbac Animal Health India Pvt. Ltd.						

Experimental fish and feeding: *Channa punctatus* is commonly known as the spotted snakehead murrel. For experiment, the specimens were collected from the local sources. They were disinfected with 0.1% $KMNO_4$ solution to avoid fungal infection. These collected fishes were acclimatized for 2 weeks and maintained in specially designed closed re-circulating system tanks in groups (control and test feeds). During acclimation, fish were fed the control diet to satiation twice a day at 09:00 and 15:00 hours. After acclimation, fish were fasted for one day; batch weighted and randomly distributed. During the experiment, fish were fed on experimental diet to satiation third a day at 08:00, 12:00 and 16:00 hours.

Experimental system: The closed recirculation aquaculture system was used for the experimental trailer. The culture system composed of different tanks with specific volumes. System primarily composed of rearing tanks of 200L volume of each. The fish were maintained in these tanks. The rearing tank also aerated by air pump for supply of oxygen to individuals. The drain settled in tanks is collected by drainage pipe is transferred to filtration unit. The filtration unit composed four different chamber settling tank, gravel filter, sand filter and bio-filter of 250 each.

Water quality standards: Water quality was maintained during the feeding trial with light: dark cycle of 12:12 h during study. The water analysis is performed according to APHA (2000). The water composition and characteristics were maintained within the effective range (Bhatnagar and Devi, 2013). During the experimental period, water temperature was 28.5±2.5^{O}C; pH 8.1±0.5; total dissolved solids 240.5±19.5 mg/L; dissolved oxygen 4.42±0.24 mg/L; biological oxygen demand 1.70±0.20 mg/L; free CO_2 13.4±1.3 mg/L; alkalinity 65.3±5.0 mg/L; hardness 123.20±16.76 mg/L; ammonia 0.55±0.01 mg/L; nitrate 0.136±0.28 mg/L; nitrite 11.39±0.37 mg/L; salinity 0.3±0.1 ppt in the experimental tanks (Joshi e*t al.*, 2022).

Biochemical analysis

The serum biochemical analysis of experimental fishes were carried out at the end of 60 days. The blood samples of fish were collected directly from heart with the help of syringe for Biochemical analysis (Hassaan and Soltan, 2016; Joshi *et al*, 2021). Blood samples were collected 18 h after the final feeding for the biochemical assay. The samples were collected in non-heparinized tubes and stored in freezer at 4-8°C up to 24 hrs. The blood samples were allowed to clot and then centrifuged at 4000 rpm for 10 minutes to separate the serum (Hassan and Sotan, 2016; Pradhan *et al.*, 2021). The parameters were estimated with help of Automated Analyzer (Mispa Ace Clinical Chemistry Analyser, Agappe Diagnostic Ltd. India).

Statistical analysis

Results were recorded as Mean ± Standard Deviation of triplicate. One way ANOVA followed by Tuckey's post-hoc test analysis used for comparison of means. Differences between means were considered as significant at $P < 0.05$ (Joshi *et al.*, 2015).

Results snd Discussion

The present study was aimed to assess the effects of lemongrass supplementation on enzyme activity in freshwater fish *Channa punctatus* (Bloch, 1793). In the present study, total protein, albumin, globulin and albumin/globulin ratio increased. The serum triglycerides, Total cholesterol and LDL-cholesterol decreased while HDL-Cholesterol increase. The increased level digestive enzymes (amylase and lipase) while decreased level of metabolic enzymes (SGOT and SGPT) were observed. The control and test feed groups were significantly different ($P<0.05$).

Table 1: Effects of lemongrass supplementation on some biochemical parameters of freshwater fish *Channa punctatus*

Parameter		**LG 0**	**LG 1**	**LG 2**	**LG 3**	**LG 4**	**LG 5**
Total Protein (g/dl)	Mean	7.095	7.265	8.016	8.334	9.051	9.881
	±SD	0.421	0.512	0.569	0.603	0.671	0.750
Albumin (g/dl)	Mean	3.911	4.014	4.468	4.673	5.071	5.571
	±SD	0.512	0.352	0.296	0.114	0.523	0.478
Globulin (g/dl)	Mean	3.195	3.252	3.547	3.661	3.980	4.309
	±SD	0.011	0.011	0.023	0.011	0.045	0.011
Albumin/Globulin Ratio	Mean	1.387	1.399	1.433	1.455	1.444	1.467
	±SD	0.034	0.011	0.034	0.023	0.034	0.102
Triglycerides (mg/dl)	Mean	232.4	224.1	215.5	199.5	187.0	182.4
	±SD	6.697	6.799	7.879	8.800	7.811	7.129
Total Cholesterol (mg/dl)	Mean	239.5	232.9	219.7	221.6	212.2	201.9
	±SD	9.255	8.425	9.551	9.710	7.766	6.140
HDL- Cholesterol (mg/dl)	Mean	36.18	43.42	46.89	50.99	55.24	59.19
	±SD	1.023	1.228	1.319	1.319	1.433	1.444
LDL- Cholesterol (mg/dl)	Mean	172.8	161.0	145.5	143.6	131.5	125.2
	±SD	4.286	4.525	4.639	4.559	4.662	4.150
Amylase (U/mg protein)	Mean	0.375	0.307	1.194	2.081	1.615	2.308
	±SD	0.114	0.034	0.409	0.330	0.239	0.466
Lipase (U/mg protein)	Mean	0.387	0.284	0.637	0.955	0.785	1.194
	±SD	0.057	0.114	0.102	0.296	0.273	0.398
SGOT (U/L)	Mean	11.36	11.57	11.05	10.56	10.64	10.40
	±SD	0.580	0.659	0.296	0.637	0.432	0.443
SGPT (U/L)	Mean	7.788	8.311	7.220	6.947	7.038	6.072
	±SD	1.455	0.637	1.217	0.978	1.069	1.148

Biochemical parameters are useful tool for assessing fish health and nutritional status as well as other physiological disturbances in intensively farmed fish (Satheeshkumar *et al.*, 2011; Rodge *et al.*, 2018). As biochemical changes help to detect different types of stress conditions like exposure to pollutants, diseases, and hypoxia. Hence, it could be suggested that any unhealthy condition caused by poor nutrition could affect the biochemical characteristics of fish (Hassaan *et al.*, 2014; Lee *et al.*, 2016).

Proteins present in blood that serve many different functions, including transport of lipids, hormones, vitamins, and minerals in the circulatory system and the regulation of acellular activity and functioning of the immune system. Albumin functions primarily as a carrier protein for steroids, fatty acids, and thyroid hormones in the blood and plays a major role in stabilizing extracellular fluid volume by contributing to oncotic pressure of plasma. Globulins are a group of proteins in your blood. They are made in your liver by your immune system. Globulins play an important role in liver function, blood clotting, and fighting infection. Low ratios may also increase the risk of death for those with cancer or heart disease. In present investigation, biochemical parameters analyzed were within normal range. In fishes, albumen account for more than 50% of total serum protein and normal A/G ration is between 1.1 and 2.5.

Elevated triglycerides may contribute to pancreatitis or hardening of the arteries. This increases the risk of stroke, heart attack and heart disease. Healthy Cholesterol (HDL) plays a vital in many of the body's processes, including building cellular membranes, making hormones. HDL (high-density lipoprotein), or good cholesterol, absorbs cholesterol and carries it back to the liver. The liver then flushes it from the body. LDL stands for low-density lipoproteins. It is sometimes called the bad cholesterol because a high LDL level leads to a build-up of cholesterol in arteries. High levels of VLDL cholesterol have been associated with the development of plaque deposits on artery walls, which narrow the passage and restrict blood flow.

The SGOT and SGPT are liver enzymes and they have the function of transferring the amino group from alpha-amino acids to alpha-keto acids. A large amount of GOT and GPT is released in the blood mostly during liver cell damage. Thus, detection of the serum level of GOT and GPT allows monitoring liver cell damage. Application of phytochemically potent herbs in diet may cause stabilization cell membrane and protect the liver against deleterious agents and free radical-mediated toxic. This is reflected in the reduction of liver

enzymes. Hence supplementation do not affect metabolic enzyme status in freshwater fish *Channa punctatuts.* The quality food helped to maintain serum biochemical characteristics of fish.

The quality food helped to maintain serum biochemical characteristics of fish. These views are in well agreement with the findings of earlier researchers (Thongprajukaew *et al.,* 2011; Hassaan and Soltan, 2016; Baldissera *et al*., 2019; Amanda *et al.* 2020; Pradhan *et al.*, 2021).

Conclusion

An experimental study was carried out successively to evaluate the effects of lemongrass supplementation on biochemical profile of freshwater fish *Channa punctatus* (Bloch, 1793). The improved serum biochemical profile of fish fed on lemongrass based formulated feed was observed. The control and test feed groups were significantly different ($P<0.05$). In considering the overall performance, lemongrass supplementation in diet is recommended for successful aquaculture of this important fish species.

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STUDY ON MORPHOMETRIC RELATIONSHIP AND INTERMUSCULAR BONES OF *CATLA CATLA* (HAMILTON, 1822)

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Abstract
The present study is the assessment of morphometric relationship and intermuscular bones of Catla catla (Hamilton, 1822). Samples of farmed fish were collected from local fish market. They were cultivated intensively on isonitrogenous and isocaloric formulated pelleted feed. Fish specimens of one year culture with average length of specimens was 43.17±0.76 cm while average weight was 1209.33±64.51 g. The Calculated weight [$W = a\ L^b$] was significantly similar to observed weight with a= 0.015 & b= 3.0005. The average Relative Condition Factor (KR) was observed to be 1.00 while Fulton condition factor equation (KF) was observed to be 1.5. indicating the robustness or well-being of experimental fish. The number of S pin and Y pin intermuscular bones were 38 & 54 respectively in fish specimen with length 42.5 cm and weight 1150 g.

Keywords: *Catla catla, condition factor, fish, intermuscular bones morphometry.*

Introduction

The *Catla catla* commonly cultivated fish also known as the major South Asian carp, is an economically important South Asian freshwater fish in the carp family Cyprinidae. It is native to rivers and lakes in northern India, Bangladesh, Myanmar, Nepal, and Pakistan, but has also been introduced elsewhere in South Asia and is commonly farmed (Day 1986, Jayaram 2010)

Catla is a fish with large and broad head, a large protruding lower jaw, and upturned mouth. It has large, greyish scales on its dorsal side and whitish on its belly. It reaches up to 182 cm (6.0 ft) in length and 38.6 kg (85 lb) in weight. Catla is a surface and midwater feeder. Adults feed on zooplankton using large gill rakers, but young ones on both zooplankton and phytoplankton. Catla attains sexual maturity at an average age of two years and an average weight of 2 kg (Menon 1987, 1992).

It is one of the most important aquacultured freshwater species in South Asia. It is grown in polyculture ponds with other carp-like fish, particularly with the Labeo rohita and mrigal carp. The reported production numbers have increased sharply during the 2000s, and were in 2012 about 2.8 million tonnes per year. Catla is sold and consumed fresh, locally and regionally. It is transported on ice. Fish of 1–2 kg weight are preferred by consumers (Talwar and Jhingran 1991).

It is rich in Omega 3 fatty acids, Vitamin A, Vitamin B and Vitamin C. It is also rich in Vitamin D, a Vitamin which is present only in a few foods and consumption of the fish will prevent Osteoporosis, a Vitamin D deficiency disease (Eschmeyer and Fricke 2011).

According to Elliot *et al.,* (2023) reviewed that along with length-weigh relationship and condition factor, Intermuscular bones (IBs) are a common characteristic of Asian carp. Ingested IBs and other fishbone fragments are associated with health complications and have remained a significant concern among consumers. Asian carp are bony, and their safety concerning IBs is a hot topic, prompting extensive research on possible ways of eliminating IBs from fish products.

In this concern, present investigation aims to study the length -weight relationship, condition factor and the intermuscular bones of *Catla catla.*

Materials and Methods

Sample Collection: Samples of farmed fish were collected from fish market of Akot, Dist. Akola, Maharashtra (India). They were cultivated intensively on isonitrogenous and isocaloric formulated pelleted feed. Fish specimens of one year culture and each of 1100-1200 g weight range were collected for concern species. Specimens were brought to laboratory and identified using available literature (Day 1986, Jayaram 2010; Menon 1987, 1992; Talwar and Jhingran 1991, Eschmeyer and Fricke 2011).

Morphometric Study: Length-weight relationships (LWRs) and relative condition factor are of great importance in fishery assessment studies since it provide information about the growth of the fish, its general wellbeing, and fitness in culture system.

Length-Weight Relationship: The log transformation formula of was used to establish

LWRs (Le Cren, 1951). The length-weight equation $W = a\ L^b$ was used to estimate the relationship between the weight (g) of the fish and its total length (cm). Using the linear regression of the log-transformed equation: log (W) = log (*a*) + *b* log (L), the parameters *a* and *b* were calculated with '*a*' representing the intercept and '*b*' the slope of the relationship. In order to establish LWRs with respect to periodic variations that can affect *b* (Zargar *et al.*, 2012). When applying this formula on sampled fish, *b* may deviate from the "ideal value" of 3 that represents an isometric growth (Ricker and Carter, 1958) because of certain environmental circumstances or the condition of the fish themselves. When *b* is less than 3, fish become slimmer with increasing length, and growth will be negatively allometric. When *b* is greater than 3.0, fish become heavier showing a positive allometric growth and reflecting optimum conditions for growth. Simple linear regression was calculated with using PAST Ver. 4.03. The formula for simple linear regression is Y=mX+b, where Y is the response (dependent) variable, x is predictor (independent) variable, m is the estimated slope and bis the estimated intercept.

Condition Factor: The condition factor or ponderal index (K) was determined using length and weight data of fish samples. The condition factor was calculated as per the standard method of Le Cren (1951). The Relative Condition Factor (KR)= W_0/W_c Where W_0 is observed weight while W_c is Calculated weight. The Fulton condition factor equation (KF) =(WX100) / L^3. These formulae were used to estimate the relationship between the weight (g) of the fish and its total length (cm). When 'K' value for fish is greater than 1.0, indicate the robustness or well-being of experimental fish.

Inter-Muscular Bones: The fishes were taken to post-harvest laboratory, sacrificed and bled. The whole fish was cooked for few minutes for both the sides. The whole fish after cooking were chilled and placed on a dissecting tray, the skeleton and pin bones were dissected out using needle and artery forceps (Sahu *et al.,* 2012).

Statistical Analysis: The statistical analyses were performed following Zar (1999) using the SPSS version 10 (SPSS Inc., Chicago, IL, USA; Kinnear and Gray 2000).

Results and Discussion

Length-Weight Relationship: The average length of specimens was 43.17±0.76 cm while average weight was 1209.33±64.51 g (Table 4.1). The calculated weight was significantly like observed weight. The obtained *b* value for the experimental fishes was observed to be greater than 3 showing a positive allometric growth and reflecting optimum conditions for growth. Length weight relationship is significant at $p<0.05$.

Table 1: Length weight relationship in *Catla catla* (Hamilton, 1822)

Sr. No.	Total Length^X	Observed Weight^Y	Length-Weight Relationship		
			a	b	Calculated W
1	42.5	1150	0.015	3.0005	1153.428
2	43.0	1200			1194.624
3	44.0	1278			1279.936
Length-Weight Relationship equation					$Y=0.015X^{3.0005}$
Linear regression equation					Y=84.28X-2429
r= 0.9979		r^2= 0.9958			*p=0.0410*

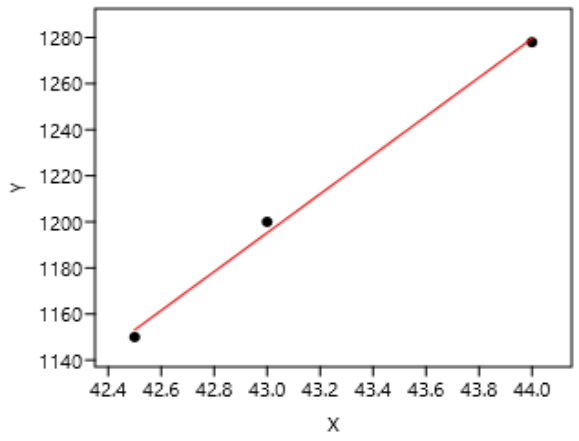

Figure 1: Length weight relationship in *Catla catla* (Hamilton, 1822)

The present findings are in well agreement with the findings of previous studies of Sarder *et al.,* (2011), Kumaresan (2011), Saima *et al.,* (2013), Ujjania *et al.,* (2013), Roshni *et al.,* (2014), Javaid *et al.,* (2015), Bhatt *et al.,* (2016), Soni and Ujjania (2017), Balai *et al.,* (2017), Rathore and Sharma (2017), Taymaa *et al.,* (2018), Chandrvanshi *et al.* (2019), Soni and Ujjania (2019), Nimat *et al.*(2020), Andrabi *et al.* (2021), Beata *et al.* (2022) and Elliot *et al.,* (2023).

Condition Factor: The average length of specimens was 43.17±0.76 cm while average weight was 1209.33±64.51 g. The average Relative Condition Factor (KR) was observed to be 1.00 while Fulton condition factor equation (KF) was observed to be 1.5. indicating the robustness or

well-being of experimental fish (Table 4.2). The present findings are in well agreement with the findings of previous studies of Ujjania *et al.,* (2013), Roshni *et al.,* (2014), Bhatt *et al.,* (2016), Soni and Ujjania (2017), Balai *et al.,* (2017), Rathore and Sharma (2017), Chandrvanshi *et al.* (2019), Nimat *et al.*(2020), Andrabi *et al.* (2021).

Table 2: Condition factor of *Catla catla* (Hamilton, 1822)

Sr. No.	Total Length	Observed Weight	KR	KF
1	42.5	1150	0.9970	1.4981
2	43.0	1200	1.0045	1.5093
3	44.0	1278	0.9985	1.5003

Inter-Muscular Bones: The fish with length 42.5 cm and weight 1150 g was taken to laboratory, sacrificed and bled. The whole fish was cooked for few minutes for both the sides. The whole fish after cooking were chilled and placed on a dissecting tray, the skeleton and pin bones were dissected out using needle and artery forceps. In studied fish 38 Spins and 54 Y Pins intermuscular bones were observed (Table 4.3). The number of intermuscular bones (IBs) are related with length and weight of specimens and have a significant concern among consumers. These views are in well agreement with the findings of previous studies of Sahu *et al.,* (2012), Roshni *et al.,* (2014), Sahu *et al.,* (2014), Beata *et al.* (2022) and Elliot *et al.,* (2023).

Table 3: Intermuscular bones of *Catla catla* (Hamilton, 1822)

Sr. No.	Total Length	Observed Weight	S Pins	Y Pins
1	42.5	1150	38	54

Figure 2: *Catla catla* (Hamilton, 1822)

Figure 3: Inter-Muscular Bones of *Catla catla* (Hamilton, 1822)

Conclusion

From the above observations and discussed results, it is concluded that the obtained values of length-weigh relationship, condition factor and Intermuscular bones (IBs) represented its healthy status and have a significant concern among consumers.

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Study on Aquatic Macrophytes Diversity of Popatkhed Dam Near Akot Tahsil, District Akola (MS), India

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Abstract: *The Popatkhed Dam is principal fresh water body located in Popatkhed village of Akot Tahsil in Akola District of Maharashtra State. Akot is a tahsil place and it is 45 km north side away from Akola. In present investigation Popatkhed Dam is 15 km north side away from Akot tahsil and it is about 778Mabove form sealevel and is at 77o 5'3.89" E longitude and 21o 12' 15.17" N latitude and depth of water is 42.6 M (140 feet). The gross storage capacity of water is 10,709 km3 (2,569 cu. mi), the water of this dam is primary used for washing, bathing, fishing activities, agricultural and other domestic purpose but now it is at a traditional state with respect to degradation. The Macrophytes were studied from Jan 2023 to Dec 2023 during this period total 21 species of Macrophytes were found in sample of water three sites A, B and C. In the present study total 21 Macrophytes species of 5 different types were recorded in Popatkhed Dam..*

Keywords: Macrophytes diversity, Popatkhed Dam, Akot, Maharashtra

I. INTRODUCTION

Aquatic macrophytes play a vital role in healthy ecosystems. Macrophytes are the conspicuous plants that dominate wetlands, shallow lakes and streams. They serve as primary producers of oxygen through photosynthesis provide a substrate for algae and shelter for many invertebrates. There are three types of macrophytes, floating macrophytes. Submerged plants with small leaves and growing in dense stands, provide structure, where as floating-leaves plants and pleustophytes provide little submerged surface, but support animals such as amphibians and water birds. As a conscquence, aquatic macrophytes are one of the essential ecological components wherever they occur. In the present study total 21 Macrophytes species of 5 different types were recorded in Popatkhed Dam.

II. MATERIAL AND METHODS

Macrophytes is shallow water were collected directly while those from deeper water with the help of long handled hook. On collection the specimen were thoroughly washed, excess water soaked with filter paper, kept in polythene bags lined with filter paper and brought to the laboratory. The specimen was identified up to species level as per the guidelines of Kodarkar (1994).

III. RESULT AND DISCUSSION

Macrophytes are most of the aquatic weeds referred such as the macrophytes that grows in or near Water. On the basis of habit and habitats aquatic weeds are classified into floating weeds, submerged weeds, emergent weeds, marginal weeds, filamentous weeds and algal blooms.

Narayana, et. al. (2006) reported about the aquatic macrophytes of Husain sagar in Karanataka. Kiran, et al., (2006) observed about the macrophytes in the fish culture pond in Bhadra fish farm, Karnataka. Game and Salaskar (2007) recorded about the macrophytcs on Malchmali lakes of Thane, Maharashtra. Sanjay Mishra and Satya Narain (2010) they observed and reported of wetlands macrophytes. Uzma Ahmad (2012) observed thc aquatic macrophytes in Chautal pond at Aligarh. NV. Harney, et. al.,(2013) founded 19 species of macrophytes belonging to 5 groups in three lakes in Bhadrawati, District Chandrapur, Maharashtra.

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K. Harish Kumar (2015) observed the 13 species belonging to 11 families were recorded in Jannapura tank Bhadravati Taluka of Karnataka. Santosh Kumar and Narendra V. Harney (2015) reported 16 species representing 15 families from Moharli lake near Chandrapur. (M.S.).Venkatraman et al. (2000), Yadav Sardesai (2002), Pejawar (2005), Kumar (2011), Sitre (2013), Sitre et al. (2014), Datta (2014), Parveen et al. (2014), Parikhet et al. (2015), Pradeep & Dwivedi (2016), Murkute & Chavan (2016), Kaisar et al. (2016), Islam et al. (2017), Sanyal (2017), Prasad & Das (2018), Pimpalshende et a1. (2021), Yadav (2021), Patil (2022), Rathod (2022), Paul (2022), Bhanja et al. (2023), there are no reported research work on aquatic macrophytes diversity in Popatkhed dam near Akot tahsil, district Akola, India. Therefore the work was carried out to Study on Aquatic Macrophytes Diversity of Popatkhed Dam Near Akot Tahsil, District Ako1a (M.S.), India.

The total 21 species of macrophytes belonging to 5 groups are observed during the present study. Among different macrophytes, *Salvenia sp. Vallisneria sp. Ipomoea sp* and *Nymbhaea sp.* Were founded in abundance in site A as compare to site B and site C While *Utricularia sp.* was not recorded from site A.

Table No. 1.1: Macrophytes forms of site A, Site B and Site C

Sr. No.	Types/Life Forms	Name of the Macrophytes
1	Submerged floating weeds	*Ceratophyllum echinatum*
2	Submerged floating weeds	*Ceratophyllum demersum*
3	Submerged floating weeds	*Nymphaea odorata*
4	Submerged floating weeds	*Myriophyllum exalbescens*
5	Submerged floating weeds	*Utricularia sp.*
6	Submerged floating weeds	*Eutricularia sp.*
7	Submerged floating weeds	*Vallisneria americana*
8	Rooted floating leaves weeds	*Marsilea quadrifolia*
9	Rooted floating leaves weeds	*Nymphaea tuberosa*
10	Rooted floating leaves Weeds	*Trapa natans*
11	Rooted emergent with heterophile weeds	*Sagittaria sp*
12	Free floating suspended submerged	*Lemna minor*
13	Free floating suspended submerged	*Azolla carolimana*
14	Free floating suspended submerged	*Salvinia rotundifolia*
15	Free floating suspended submerged	*Pistia stratiates*
16	Free floating suspended submerged	*Najas indica*
17	Free floating suspended submerged	*Wolfia*
18	Free floating suspended submerged	*Nymphidis*
19	Rooted submerged hydrophytes	*Hydrilla*
20	Rooted submerged hydrophytes	*Ipomoea aquatica*
21	Rooted submerged hydropbytes	*Ipomoea indica*

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DIVERSITY OF ZOOPLANKTON IN WAN RIVER FLOWING LOWER STREAM TO HANUMAN SAGAR DAM, WARI, DIST. AKOLA, MAHARASHTRA

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Abstract

The study was conducted during February 2021 to January 2023 to assess the biodiversity of zooplankton in Wan River Flowing Lower Stram to Hanuman Sagar Dam of Wari, Dist. Akola, Maharashtra, India. The effective protocol was adopted. The study revealed the rich zooplankton diversity. During the period of investigation, 51 species belonging to four groups namely Rotifera, Cladocera, Ostracoda and Copepoda were identified. The maximum number of individuals was observed during winter and lower by summer and monsoon. The Rotifers were obtained in maximum quantity while Cladocera, Copepoda and Ostracoda showed the moderate population.

Keywords: *Diversity, Zooplankton, Wan River, Hanuman Sagar Dam, Wari.*

Introduction

Among entire aquatic biota, the zooplanktons are one of the important biological indicators that represent the health of water body. Zooplanktons are tiny animals suspended in the water column. Like phytoplankton, these species have developed mechanisms that keep them from sinking to deeper waters, including drag-inducing body forms and the active flicking of appendages such as antennae or spines (Singh *et al.*, 2021). Plankton are organisms drifting in oceans, seas, and bodies of fresh water. Individual zooplanktons are usually microscopic, but some are larger and visible to the naked eye. Zooplankton is a categorization spanning a range of organism sizes including small protozoans and large metazoans (Barskar and Kumar, 2022). It includes holoplanktonic organisms whose complete life cycle lies within the plankton, as well as meroplanktonic organisms that spend part of their lives in the plankton before graduating to either the nekton or a sessile, benthic existence. Although zooplankton are primarily transported by ambient water currents, many have locomotion, used to avoid predators or to increase prey encounter rate (Surachita, and Palita, 2023).

The study was conducted during February 2021 to January 2023 to assess the biodiversity of zooplankton of Wan River Flowing Lower Stram to Hanuman Sagar Dam of Wari, Dist. Akola, Maharashtra, India.

Materials and Methods

Wan reservoir is also known as Hanuman Sagar. It is located between 21.183611°N and 76.804047°E on wan river at the site of Wari village in Telhara Taluka of Akola District in Maharashtra, India. This is one of the largest irrigation projects in the Indian state of Maharashtra. The water is mainly used to irrigate agricultural land in the western Vidarbha. It also provides water for drinking to nearby towns, villages and Cities like Akola, Telhara and Shegaon. The surrounding area of the dam has a garden old Hanumana temple. The height of the dam above its lowest foundation is 67.65 m (221.9 ft) while the length is 500 m (1,600 ft). The volume content is 599 km3 (144 cu mi) and gross storage capacity is 0.081 km3 (0.019 cu mi). During monsoon reservoir gets enough water but in post monsoon period particularly March and April water level is very much reduced. The reservoir is surrounded by red laterite soil and black cotton soil. The inland reservoir is fed by seasonal drainage to its periphery and nearby local streams and springs (Gazetteer of Maharashtra, 2022).

After detailed survey of the lake, convenient stations were fixed for study. Water samples were collected from the flowing lower stream of dam from three different spots at early in the morning between 07.00 a.m. to 08.30 a.m. Water samples were collected separately for the study of all the zooplankton. Zooplankton were collected by filtering net known quantity (1000 liter) of water filtered from sampling site through zooplankton net which is made up of fine mesh and zooplankton collected in to 100 ml bottle which is attached at the bottom of net. The samples were preserved in 4% formaldehyde solution and studied for diversity by using standard key literature (Trivedy and Goel, 1986; IAAB, 1992).

Figure 1: Map of Hanuman Sagar Dam flowing lower stream

Result and Discussion

During the period of investigation, species belonging to four groups were identified. The maximum number of individuals was observed during winter and lower by summer and monsoon. The Rotifers were obtained in maximum quantity while Cladocera and Copepoda showed the moderate population. The observed Zooplankton groups with their respective genera composition is shown in Table 1. The observed species composition was found to be in well agreement with many of previous studies that mainly deals with zooplankton diversity of similar ecosystem. These recent studies mainly included Patra *et al* (2011), Bhoopendra *et al* (2012), Shukla and. Hassan (2013), Dutta (2014), Nair *et al.* (2015), Anand *et al* (2016), Kadam (2016), Sivalingam *et al.* (2016), Krishna and Kumar (2017), Narasimman *et al*. (2018), Sivalingam (2018) and name a few.

Figure 2: Quantitative zooplankton composition at Wan River Flowing Lower Stram to Hanuman Sagar Dam

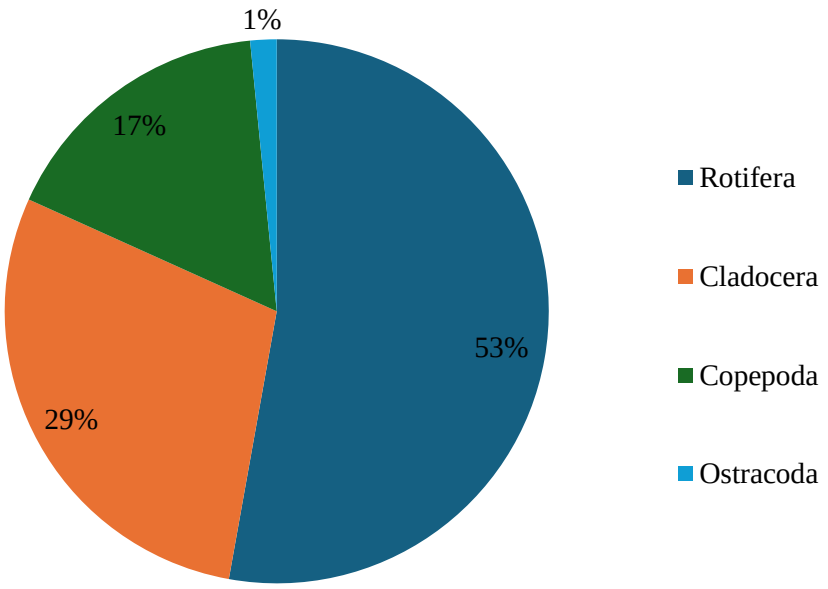

Figure 3: Quantitative analysis of zooplankton (org/L) at Wan River Flowing Lower Stram to Hanuman Sagar Dam

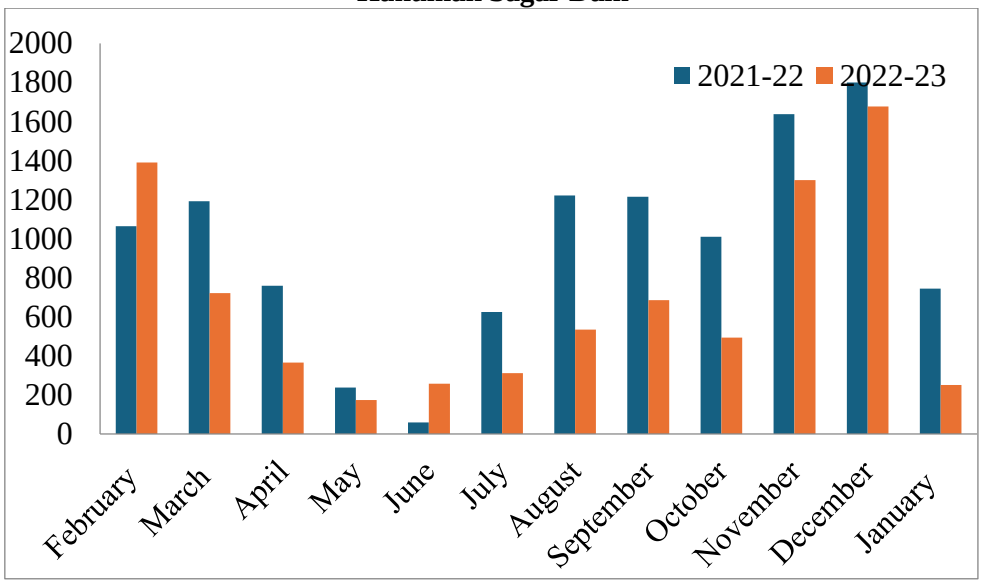

Table 1: Zooplankton groups with their respective genera composition

A] Rotifera	***B] Cladocera***
1. Ascomoypha saltans	*1. Bosmina longirostris*
2. Asplanchna prodota	*2. Ceriodaphnia laticaudata*
3. Brachionus bidentata	*3. Chydorus spharicus*
4. Brachionus calyciflorus	*4. Dadaya sp.*
5. Brachionus caudate	*5. Daphnia laevis*
6. Brachionus plicatilis	*6. Leydigia acanthocercoides*
7. Cephallodella forficulla	*7. Macrothrix sp.*
8. Colurella obtuse	*8. Moina brachiata*
9. Conochilus unifornis	*9. Moinodaphnia macleayli*
10. Epiphanes senata	
11. *Euchlanis sp.*	***C] Ostracoda***
12. Filinia longiseta	*1. Condona ohioensis*
13. Gastropus minor	*2. Cyclocypris sp.*
14. Gastropus stylifer	*3. Cyprinotus glaucus*
15. Harringia rousseleti	*4. Cypris subglobosa*
16. Hexarthra mira	5. *Stenocypris sp.*
17. Horella brahmi	
18. Keratella coachlearis	***D] Copepoda***
19. Keratella hiemalis	*1. Cyclops sp.*
20. Keratella quadrata	*2. Diaptomus edax*
21. Keratella tropica	*3. Diaptomus marshianus*
22. Keratella vulga	*4. Eucyclops agilis*
23. Lacane luna	*5. Nauplii sp.*
24. Lepadella ovalis	6. *Senecel calanoides*
25. Limnias melicerata	
26. Monommata grandia	
27. Monostyla lunais	
28. Monostyla mucronata	
29. Notholca acuminate	
30. Philodina roseola	
31. Trichocerca sp.	

Conclusion

During the period of investigation, 51 species belonging to four groups namely Rotifera, Cladocera, Ostracoda and Copepoda were identified. The maximum number of individuals was observed during winter and lower by summer and monsoon. The Rotifers were obtained in maximum quantity while Cladocera, Copepoda and Ostracoda showed the moderate population. The study revealed the rich zooplankton diversity. The observed status of zooplankton diversity was mostly related to the studied physicochemical parameters.

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STUDY OF DIETARY GARLIC INDUCED EFFECTS ON HEMATOLOGICAL PROFILE OF *Clarias batrachus* (LINNAEUS, 1758)

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Abstract

The present work was carried out to study the effect of dietary garlic on hematological profile of *Clarias batrachus.* The fish were fed on control and experimental diet for 30 days. The collected samples were analyzed for hematology profile by using automated analyzers. The results proved that dietary garlic improved the Hematological composition in fish. The obtained results cleared that dietary garlic (*Allium sativum*) improved the hematological profile of *Clarias batrachus* so garlic should be added to the diets of fish.

Keywords: *Clarias batrachus, formulated diet, feeding, garlic, hematology*

Introduction

The species *Clarias batrachus* is locally known as Magur. It has an elongated body shaped and reaches almost 0.5 m in length and 1.2 kg in weight. It is mainly grey or grayish brown in colour; often covered laterally in small white spots. It has long based dorsal and anal fins, several pairs of sensory barbells. The skin is without scales but covered with mucous which protect the fish when it is out of water. This fish is normally lives in slow moving and stagnant water of ponds, swamps, streams and rivers, paddy fields or temporary pools (Joshi and Gulhane, 2015). The garlic supplementation to the diet of *Clarias batrachus* help to improve the growth performance. It is probably one of the earliest known medicinal plants. Garlic contains Alliin, Allicin and volatile oils. Allicin gives garlic its characteristic pungent smell. Also, it contains vitamins and minerals and trace elements like selenium and germanium (Hassaan*et al.,* 2014; Joshi *et al.,* 2015; Hassaan and Soltan, 2016; Joshi and Gulhane, 2017, Petropoulos *et al.,* 2018).

The present work was carried out to study the effect of dietary garlic on hematological profile of *Clarias batrachus.*

Material and methods

Materials and Methods

The present investigation aimed to analyze the effects of dietary garlic on hematological profile of *Clarias batrachus*. For the presented experiment, the following protocol suggested by Joshi (2017) was adopted

Experimental fish: The fishes measuring about 20±0.5 cm length and weighing ranges from 50±05g in weight were selected for the experimental study. Fishes were transferred to the place of experiment and acclimated for a week. During the acclimation, fish were fed the experimental diet to satiation twice a day at 09:00 and 15:00 hours. After acclimation, fish were fasted for one day; batch weighted and randomly distributed among density of 10 fish per tank. During experiment, the water quality, aeration and light: dark cycle of 12:12 h was maintained (Joshi *et al.,* 2015).

Experimental diet and feeding regime: The basal experimental diets were formulated with the commonly available ingredients. The formula and analyzed proximate composition of the basal diet are shown in Table 1. The ingredients were dried, grinded, milled, weighed, mixed and pelleted. After pelleting, the feeds were air dried and put in an air-tight container. During the experiment, fish were fed the experimental diet to satiation third a day at 08:00, 12:00 and 16:00 hours.

Table 1: Formulation of experimental fish diets with different concentration of garlic powder and oil (g/100g diet).

Sr. No.	Ingredients (g dry wt.)	Control	Garlic Powder		Garlic Oil	
		G1	G2	G3	G4	G5
1.	Wheat flour	45	42.5	40	43.75	42.5
2.	Soybean flour	25	25	25	25	25
3.	Corn flour	10	10	10	10	10
4.	Meat powder	15	15	15	15	15
5.	Soybean oil	05	05	05	05	05
6.	Garlic Powder	-	2.5	5	1.25	2.5

Table 2: Haematology of freshwater fish *Clarias batarchus* fed on control and garlic formulated diet for 30 days.

Sr. No.	Parameter	Control		Garlic Powder				Garlic Oil			
		G0		G1 (2.5 %)		G2 (5%)		G3 (1.25 %)		G4 (2.5 %)	
		Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD
1.	Total Leucocytes Count (Count/ cumm)	12,200	69.5	15,860	90.35	20740	118.15	18300	104.25	23180	132.05
2.	Red Blood Corpuscles Count (Mill./cumm)	4.2	0.35	5	0.455	7.14	0.595	6.3	0.525	7.98	0.665
3.	Hemoglobin (g/dl)	13.3	0.25	17	0.325	22.61	0.425	19.95	0.375	25.27	0.475
4.	Pack Cell Volume (%)	41.2	0.45	54	0.585	70.04	0.765	61.8	0.675	78.28	0.855
5.	Mean Corpuscular Volume (fl)	190.38	4.37	170.34	3.91	130	2.99	150.3	3.45	100.2	2.3
6.	Mean Corpuscular Hemoglobin (pg)	31.2	1.3	41	1.69	53.04	2.x`	46.8	1.95	59.28	2.47
7.	Mean Corpuscular Hb Conce. (g/dl)	68.4	3.23	61.2	2.89	47	2.21	54	2.55	36	1.7
8.	Platelets (Count/ cumm)	4,70,000	683	6,11,000	887.9	799000	1161.1	705000	1024.5	893000	1297.7

Hematological Analysis: After 30 days of feeding, the blood samples of fish were collected directly from heart with the help of syringe. The blood samples were preserved into the vials. The hematological estimations were performed by using the automated analyzer (Kharat and Kothavade, 2012).

Statistical Analysis: Data were collected, organized and analyzed by using Microsoft Excel program. Results were recorded as mean ± standard deviation (SD) of survived individuals.

Results and Discussion

It is cleared that garlic is one of the main vegetable that extensively cultivated in many countries. It is used as food for humans as well as some animals and as remedy for several diseases, as reported in folk medicine. The effects of dietary garlic on hematological profile of *Clarias batrachus* after 30 days were studied. The results related to hematology of *Clarias batrachus* fed on control and experimental diets for 30 days were as given below (Table 2). The results proved that dietary garlic improved the Hematological composition in fish.

Hematological variables are good predictors for explaining the health status of fish (Hrubec *et al.,* 2000) and the improvement in hematological and biochemical profile of fish is mostly influenced by environmental factor and diet supplementation (Acharya and Mohanty, 2014; Rao *et al.,* 2017). Blood cell content in fish gives a guide to the health status of fish and can be helpful to determine any abnormalities arising from the use of feed additives. Accordingly, the elevate number of RBCs multiplies the concentration of hemoglobin ultimately resulting in a high capacity for oxygen carrying which improved the health of fish and consequently enhancing growth (Hassaan *et al.,* 2014). The present study is consistent with previous studies of Sahu*et al.,* (2007); Soltan and El-Laithy (2008); Fazllolahzadeh *et al.*(2011); Talpur and Ikhwanuddin (2012); Yilmazand Ergün (2012); Hassaan and Soltan (2016), Adineh, *et al.* (2020); Akter and Hossain (2021); Edeh *et al.* (2022) and name a few. Hence these findings suggested that the present improvement in hematological profile is influenced by dietary garlic.

Conclusion

The obtained results cleared that dietary garlic (*Allium sativum*) improved hematological profile of *Clarias batrachus* so garlic should be added to the diets of fish.

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