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The Seasonal Variations in Physico-Chemical Parameters in Ground Water Quality of Vaijapur Tehsil of Aurangabad District During pre-Monsoon and Post Monsoon

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I. INTRODUCTION

Water is a prime natural resource, a basic human need, and a precious asset, in the absence of which no socio-economic developmental activities can sustain. The water in oceans and seas is highly saline, the estimated 1011 million cubic km of the total water present on earth, and only 33400 cubic meters of water is available for drinking, industrial consumption, and waste disposal¹. The main objective of the water resources development in India was to ensure adequate supplies of water for various uses such as irrigation, urban and rural drinking water, sanitation, industrial water, and others while preserving the ecosystem. Water is an important source of generating energy and electricity, be it hydropower generation, thermal power generation, or nuclear power generation. Thus, the development of water resources plays an important role in the energy sector, particularly for hydropower generation, where there is no conjunctive use of water and no environmental pollution. The other important uses of water relate to navigation, industrial use, and forestry.

India's finite water resources, however, are under pressure with declining per capita water availability and deteriorating water quality due to rapid growth of population, urbanization, and Industrialization. At the time of Independence, the population was less than 40 crore and per capita, water availability was over 5,500 cubic meters per year. Now after 70 years of Independence, India's population has gone up to about 137.8 crores and per capita, water availability in 2021 has fallen to about 1486 cubic meters per year. This per capita water availability will further fall to about 1367 cubic meters per year by the year 2031 due to the increasing population². Thus, growing pressure on water availability is resulting in competing demands for diverse uses of water. Inter-sectoral allocation, planning, and management of increasingly fragile water resources for diverse uses on a sustainable basis are emerging as a major challenge for the nation.

India is rich in surface water resources. The average annual precipitation is nearly 4000 cubic km. and the average flow in the river system is estimated to be 1880 cubic km. Because of the concentration of rains only in the three monsoon months, the utilizable quantum of water is about 690 cubic km. However, conditions vary widely from region to region. Whereas, some are drought-affected, others are frequently flooded. With the

rapid increase in the population, the demand for irrigation, human and industrial consumption of water has increased considerably, thereby causing depletion of water resources. Increased population density, industrialization, agricultural practices, disposal of domestic sewage, and industrial runoffs all contaminate the groundwater and water resources³.

The issue of groundwater availability is critical as one-third world population uses it for drinking purposes⁴. Groundwater that occurs beneath the earth's surface is considered free from contamination, hence usable but anthropogenic as well as natural factors are affecting the quality as well as quantity of this valuable resource⁵. Groundwater is one of the most reliable and vital sources of drinking water because of its widespread availability, occurring in natural conditions, and being less susceptible to water contamination as compared to fresh water⁶⁻⁸.

There is a need for proper planning, development, and management of the greatest assets of the country like water⁹. Water requirements for industrial and domestic use are met partly from reservoirs constructed and managed by the irrigation department. Groundwater is one of the most important natural resources required for human consumption, domestic purposes, irrigation, industrialization, and urbanization¹⁰. The agriculture production technologies have put a lot of stress on groundwater resources in a few areas.

The statistics on water quality derivations into simple ratings in the form of comprehensive conclusions as good, best, poor or excellent for the public assessment that helps to manage their groundwater resources prudently for the near future¹¹.

Physico-chemical characteristics are indeed vital parameters for monitoring and assessing water quality due to their instability¹². The chemical composition of groundwater plays a significant role in determining the water quality for various utility purposes¹³. Suitability of Ground Water for Drinking Purpose is determined keeping in view the effects of various chemical constituents in water on the biological system of the human being. Though many ions are very essential for the growth of human being, when present in excess, have an adverse effect on human body.

India's agricultural and drinking water requirements are partly met by aquifers and groundwater that supply roughly 62% towards irrigation, 85% towards water supply in rural areas, and 45% in urban areas¹⁴. Overexploitation and unabated pollution of this vital resource is threatening our ecosystems and even the life of the future generation¹⁵. The standards proposed by the Bureau of Indian Standards (BIS) for drinking water (IS-10500-91, Revised 2015) were used to decide the suitability of ground water¹⁶. The classification of groundwater samples was carried out based on the desirable and maximum permissible limits for the parameters. Many researchers have reported seasonal Physico-chemical parameters studies in India¹⁷⁻²⁰.

Climate and Rainfall:

The climate of the Vaijapur Tehsil is characterized by a hot summer and a general dryness throughout the year except during the southwest monsoon season, which is from June to September while October and November constitute the post-monsoon season. The winter season commences towards the end of November when temperatures begin to fall rapidly. December is the coldest month with the lowest temperature. From the beginning of March, the daily temperature increases continuously. May is the hottest month with the highest maximum temperature. With the onset of the southwest monsoon by about the second week of June, the temperature falls appreciably. Except during the southwest monsoon season, when the relative humidity is high, the air is generally dry over the Tehsil. The summer months are the driest when the relative humidity is generally between 20 and 25% in the afternoon. Winds are generally light to moderate with the increase in

speed during the latter half of the hot season and in the monsoon season. The winds flow predominantly from directions between west and north during the hot season. They are mostly from directions between southwest and northwest during the southwest monsoon season. They blow mostly from the directions between northeast and southeast during the rest of the year becoming south-westerly to north-westerly in January and February. The average annual rainfall of the Vaijapur Tehsil for the period 2002 to 2011 is 634.23 the average annual rainfall of the district for the period 2002 to 2011 is 705 mm. The average annual rainfall of the Vaijapur Tehsil for the period 2008 to 2017 is 561.13 mm.

II. EXPERIMENTAL- MATERIALS AND METHODS:

The current study is monitoring the pre and post-monsoon groundwater quality of the Vaijapur Tehsil for the last six months through its established monitoring dug wells and borewells. The objectives behind the monitoring are to study the seasonal variation of quality of the Tehsil. The sampling of groundwater from these sites was carried out in May (pre-monsoon period). The water samples after collection were immediately subjected to the analysis of various parameters in the Laboratory of Vinayakrao Patil College, Vaijapur. The parameters analyzed, include pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), Total Hardness (TH), Calcium (Ca^{2+}), and Magnesium (Mg^{2+}).

Water samples have been collected in 2 litre capacity polythene bottles (soaked overnight in 2% nitric acid and washed well in distilled water) from each location. The collected samples were properly labelled which indicates the source of the sample time and date of collection. Proper care taken in the storage of the sample, in such a way that their composition does not change between the period of collection and analysis. The samples are sealed and stores under cool and dry condition. The samples were brought to the laboratory and analyzed for the parameters within the 48 hours of collection; which has been carried out using the Standard methods of water analysis is employed to analyze the physico- chemical parameters of the water following APHA²¹. The groundwater quality data thus generated was first checked for completeness and then the validation of data was carried out using standard checks. Subsequently, the interpretation of data was carried out to develop the overall picture of groundwater quality in the tehsil in the year 2020-21.

Table 1: Sampling Stations:

S1- Dug Well Vadji
S2- Bore Well Vadji
S3- Dug Well Jarul
S4- Bore Well Jarul
S5- Dug Well Sirasgaon
S6- Bore Well Sirasgaon
S7- Dug Well Khandala
S8- Bore Well Khandala
S9- Dug Well Waghala
S10- Bore Well Waghala
S11- Dug Well Shioor

S12- Bore Well Shioor
S13- Dug Well - Chor waghgaon
S14- Bore Well Chor waghgaon
S15- Dug Well Kavatkhed
S16- Bore Well Kavatkhed
S17- Dug Well Malegaon Kannad
S18- Bore Well Malegaon Kannad

Estimation of following Physico-Chemical parameters was brought about.

1. Temperature
2. Hydrogen Ion Concentration (pH)
3. Dissolved oxygen (DO)
4. Total Dissolved Solids (TDS)
5. Total Hardness
6. Magnesium (Mg)
7. Calcium (Ca)
8. Electrical Conductivity (EC)

1. Temperature:

Temperature-dependent solubility affects the DO levels in streams. Temperature governs many biochemical and physiological processes in aquatic organisms and increases metabolic and reproductive rates throughout the food chain. Temperature also affects abiotic chemical processes, such as re-aeration rate, sorption of organic chemicals to particulate matter, and volatilization rates.

2. pH:

The pH of a solution is a measure of its hydrogen ion activity and is the logarithm of the reciprocal of the hydrogen ion concentration. Thus it is important to remember that a change of one pH unit represents a tenfold change in hydrogen ion concentration. The pH of water is a measure of acidity or alkalinity. The pH is a logarithmic scale based on a measure of the free hydrogen ions in the water. The scale runs from 0 to 14, where 7 is considered neutral, 0 to 7 is acidic and 7 to 14 is alkaline. Because pH can be affected by dissolved minerals and chemicals, it is an important indicator of the change in water chemistry.

The drinking water with a pH between 6.0 and 9.5 generally is considered satisfactory. Water with a pH below 6 or above 9.5 can be corrosive to metal plumbing pipes and fixtures.

The following methods were used for measurement of hydrogen-ion-concentration: pH meter Method: Apparatus: (i) pH meter (ii) Centigrade thermometer (iii) Beakers (iv) Blot paper. Reagents: (i) pH buffer solution in the range of water sample being analyzed. (ii) Distilled water. Procedure: A buffer solution was prepared with a pH near the expected pH of the water sample. 25 ml of buffer solution was poured in a small beaker. The vent of glass reservoir of the fiber junction electrode was opened. The electrodes were rinsed in distilled water, and blotted with soft paper. The electrodes were immersed in the buffer solution.

3. Dissolved Oxygen:

There are two main routes for oxygen input in surface waters: transfer of oxygen directly from the atmosphere (a process called re-aeration), and from plants as a result of photosynthesis. Re-aeration is the primary route for

introducing oxygen into most waters. Oxygen gas (O₂) constitutes about 21% of the atmosphere and readily dissolves in water. The ability of water to hold oxygen is influenced by temperature and salinity. The saturation concentration of DO in water is a measure of the maximum amount of oxygen that water can hold at a given temperature. As the salinity of water increases, the saturation concentration decreases. When oxygen is below the saturation concentration, it tends to diffuse from the atmosphere to water. Apart from these physical processes that influence the DO concentration in surface waters, biological processes like photosynthesis and respiration also influence the DO content. Daytime photosynthesis, influenced by the solar photo cycle, increases the productivity of autotrophs causing the increase of oxygen. In the night time, in the absence of photosynthesis, respiration is active in the streams causing the removal of oxygen. Some fish and aquatic organisms, such as carp and sludge worms, are adapted to low oxygen conditions, but most fish species, such as trout and salmon, suffer if DO concentrations fall below 3 to 4 mg/l.

4. Total Dissolved Solids (TDS):

The high concentrations of TDS may affect taste adversely and deteriorate plumbing and appliances. The EPA recommends that water containing more than 500 mg/l of dissolved solids not be used if other less mineralized supplies are available. However, water containing more than 500 mg/l of TDS is not dangerous to drink.

5. Total Hardness:

The hardness is the property that makes water form an insoluble curd with soap and primarily is due to the presence of calcium and magnesium. Very hard waters have no known adverse health effects and may be more palatable than soft waters. Hard water is primarily of concern because it requires more soap for effective cleaning; forms scum and curd; causes yellowing of fabrics; toughens vegetables cooked in the water; and forms scale in boilers, water heaters, pipes and cooking utensils. The hardness of high-quality water should not exceed 270 mg/l measured as calcium carbonate. Water softer than 30 to 50 mg/l may be corrosive to piping, depending on pH, alkalinity and dissolved oxygen. Water softeners will correct hard water of more than 270 mg/l.

6. Calcium (Ca):

Calcium can be leached from practically all rocks but is much more prevalent in water from regions with deposits of limestone, dolomite and gypsum. Regions where granite or siliceous sand predominates have very low calcium levels in the waters. Waters with a concentration of 10 mg or less per litre are usually oligotrophic, while waters with 25 mg or more per litre are usually distinctly eutrophic.

Calcium is estimated complexometrically by titrating with EDTA using murexide indicator.

7. Magnesium (Mg):

Magnesium in natural water comes mainly from the leaching of igneous and carbonate rocks. In areas where these sources are common, magnesium concentrations in water often range from 5 to 50 mg per litre. Magnesium is related to water hardness in the same manner as calcium and it is also an essential nutrient for plant growth and development.

Magnesium is estimated complexometrically by titrating with EDTA using EBT indicator.

8. Electrical Conductivity (EC):

Conductivity is a measure of the conductance of an electric current in water. This is an easy measurement to make and relates closely to the total dissolved solids (mineral) content of water. The maximum contaminant level is 0.4 to 0.85 micro Siemens per centimetre. Treatment with reverse osmosis is effective for drinking water purposes. Specific Conductance or Conductivity as mentioned above, dissolved ionic substances can be measured by electrical conductance. On laboratory reports this may be shown as specific conductivity. Conductivity is reported as micromhos/cm.

Natural surface waters would be expected to have conductivities that measure from 50 to 1500. Where, well waters from saline ground water strata are used, the conductivity could run higher. The electrical conductivity or EC of a soil or water sample is influenced by the concentration and composition of dissolved salts. Salts increase the ability of a solution to conduct an electrical current, so a high EC value indicates a high salinity level.

Electrical Conductivity (EC) The amount of dissolved ions in the water is best represented by the parameter electrical conductivity. The classification of water for irrigation based on the EC values is as follows. Low Salinity Water (EC: 100-250 $\mu\text{S}/\text{cm}$): This water can be used for irrigation with most crops on most soils with little likelihood that salinity will develop. Medium Salinity Water (EC: 250 – 750 $\mu\text{S}/\text{cm}$): This water can be used if moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most cases without special practices for salinity control. High Salinity Water (EC: 750 – 2250 $\mu\text{S}/\text{cm}$): This water cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected. Very High Salinity Water (EC: >2250 $\mu\text{S}/\text{cm}$): This water is not suitable for irrigation under ordinary condition. The soils must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching and very salt tolerant crops should be selected. The classification of ground water samples collected from monitoring wells for was carried out in Table-3.

III. RESULTS AND DISCUSSIONS:

The physico-chemical parameters of the ground water which are essential for potable purpose like pH, EC, TDS, TH, Calcium, Magnesium, DO, were analysed and presented in Tables. 3. The sampling stations, source of the water from where sampling has been done is given in Table.1 and Indian Standards for drinking water specification: Bureau of Indian Standards¹⁵ New Delhi 2015 is given in Table 2.

Table:2 Standards for quality of drinking water

Sr. No.	Parameter	Acceptable limit	Permissible limit
1.	Calcium (Ca) <i>mg/l</i>	75	200
2.	Dissolved oxygen (DO)	6.0	4.0
3.	Electrical Conductivity (EC)	1500 mmho/cm drinking (WHO)	2250 mhos/cm Irrigation
4.	Hydrogen Ion Concentration (pH)	6.5 to 8.5	No relaxation
5.	Magnesium (Mg) <i>mg/l</i>	30	100
6.	Total Dissolved Solids (TDS) <i>mg/l</i>	500	2000
7.	Total Hardness <i>mg/l</i>	200	600

Table -3: Critical parameter exceeding the permissible limit

Sr. No.	Parameter	BIS Permissible limit	No. of sample exceeding permissible limit		Percentage of sample exceeding permissible limit	
			Pre-Monsoon	Post Monsoon	Pre-Monsoon	Post Monsoon
1.	pH	6.5 to 8.5	00	00	00	00

2.	TDS	2000	02	01	11	05
3.	TH	600	07	04	39	22
4.	Magnesium	100	16	13	89	72
5.	Calcium	200	07	06	33	22
6.	EC	1500	06	06	33	33

Table: 4. Physico-chemical parameters of bore well and dug well in Vaijapur Tehsil of Aurangabad district

Sample sites	Temperature		pH		DO		EC μ Siemens		TDS mg/l		TH mg/l		Ca ²⁺ mg/l		Mg ²⁺ mg/l	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
S1	30.3	25.4	7.35	7.10	6.25	6.50	480	215	353	142	147	98	56	34	98	59
S2	30.1	26.0	8.16	8.07	6.40	6.62	587	246	382	160	179	114	68	43	111	71
S3	29.8	25.6	8.55	8.43	6.17	6.43	580	350	378	127	136	82	51	31	84	51
S4	30.2	25.3	7.87	7.42	6.50	6.70	1244	1090	810	250	350	271	133	103	217	169
S5	29.9	26.0	8.21	7.74	6.30	6.42	2720	2450	1749	1350	1214	857	460	325	754	532
S6	29.7	26.1	7.92	7.35	6.61	6.80	1138	590	741	380	657	393	249	149	408	244
S7	29.8	25.9	8.30	7.76	6.23	6.65	573	950	373	230	229	136	87	51	142	84
S8	29.4	25.6	7.87	7.42	6.80	7.15	1305	750	453	325	405	271	135	110	245	167
S9	30.1	26.2	7.25	7.10	7.13	7.52	525	212	354	254	202	175	75	42	115	101
S10	29.7	25.4	7.90	7.81	6.37	6.58	665	270	433	350	286	207	108	78	177	129
S11	29.8	25.6	7.85	7.52	6.01	6.33	895	593	1117	897	985	879	427	376	457	384
S12	30.2	25.7	7.40	7.25	6.44	6.76	3980	2440	2505	1892	1329	1107	503	419	825	688
S13	30.1	25.5	8.35	8.21	6.72	7.02	1920	1690	1328	1100	250	207	95	78	155	129
S14	29.4	25.8	8.25	8.00	6.15	6.38	2531	1985	1543	987	325	258	123	117	104	98
S15	29.6	25.4	7.75	7.62	6.21	6.60	744	650	485	350	357	279	135	106	222	173

S16	29.7	25.9	8.2 1	7.5 1	6.4 6	6.7 7	191 8	1780	589	138 7	786	579	29 8	219	48 8	359
S17	30.3	26.2	7.9 5	7.7 6	6.5 4	6.8 9	419	328	272	214	929	571	35 2	216	57 7	444
S18	29.7	25.7	7.3 5	7.2 3	6.3 2	6.6 7	412 0	3190	269 0	235 0	152 1	986	57 6	350	94 5	532

Table-5: Classification of water samples on the basis of conductivity values

Sr. No.	Conductivity range $\mu\text{S}/\text{cm}$	Classification	No. of sample	Percentage of samples
1.	100-250	Low Salinity	00	00
2.	250-750	Medium Salinity	08	44
3.	750 – 2250	High Salinity	06	33
4.	>2250	Very High Salinity	04	22

3.1. Physical Parameters

3.1.1. Temperature:

The values of temperatures during pre-monsoon season vary in range 29.4 °C to 30.3 °C and in past monsoon season it is found to be in the range 25.3 °C to 26.1°C. The minimum and maximum values recorded in the same field stations, as shown in Table 4. From the Table 4 it is observed that the temperature values are higher during pre-monsoon season than post monsoon season due seasonal temperature variation.

3.1.2. Electrical Conductivity:

The Electrical Conductivity of the sampling waters for pre-monsoon seasons is ranging from 480 to 4140 $\mu\text{S}/\text{cm}$ and for post-monsoon seasons it is in the range of 215 to 3190 $\mu\text{S}/\text{cm}$. The values of minimum and maximum have recorded in the same field stations, given in Table. 4. The EC values from all the sampling stations recoded at higher in pre monsoon season than post monsoon season. The electrical conductance values of sampling sites S13, S14 and S16 are above acceptable limits (1500 $\mu\text{S}/\text{cm}$) and at sites S5, S12, S13, S14, S16 and S18 the values are are higher than permissible limit in both pre and post monsoon seasons¹⁴. The electrical conductance values (Table 5) suggest that in pre-monsoon season 33% water samples are in the category of medium water and only 17% samples shows very high water salinity.

3.2. Chemical Parameters

3.2.1. pH:

The pH values of study area are ranged from 7.35 to 8.55 during pre-monsoon and 7.10 to 8.35 during post monsoon. The minimum and maximum values have recorded during post and pre monsoon seasons at the same field stations. The pH values of all the stations indicating alkaline condition and within permissible limits (6.5 to 8.5 pH) as per the Indian Standards, given in Table. 2. The pH values of the sampling stations show that higher values are recorded during pre-monsoon season than post monsoon due to dilution effect. (Table 4).

3.2.2. Dissolved Oxygen:

In pre-monsoon season the Dissolved Oxygen of the sampling sites is ranging from 6.42 mg/l to 7.52 mg/l and this was 6.01 mg/l to 7.13 mg/l during summer. The minimum and maximum values recorded in the same field

stations, is shown in Table.4. The Dissolved Oxygen concentration from all the stations is recorded at more or equal during pre-monsoon season than post monsoon.

3.2.3. Total Dissolved Solids:

The Total Dissolved Solids of the samples in pre-monsoon season is ranging from 272 mg/l to 2690 mg/l and 450 mg/l to 1600 mg/l in post monsoon season. The minimum and maximum values have recorded in the same field stations and data given in Table. 4

During the pre-monsoon season it is observed that the half of the sampling stations are found to be in acceptable limit while remaining sampling sites records the TDS value above acceptable limit except the sites S12, and S18 whose TDS value is above permissible limit. However the values are within the maximum permissible limits (2000 mg/l). It is observed that the TDS values are recorded at higher during pre-monsoon than post monsoon season.

3.2.4. Total Hardness:

During pre-monsoon season the Total Hardness expressed as CaCO_3 of water samples under study is recorded in the range 147 mg/l to 1521 mg/l and its value in post monsoon season is found to be 98 mg/l to 1107 mg/l. The minimum and maximum hardness has recorded from the same sampling stations, are given in Table. 3. It is noticed that the concentration of Total Hardness recorded in pre monsoon season is more than the post monsoon season. The Total Hardness of only three water samples (S1, S2, S3 and S9) in pre-monsoon is found in acceptable limit and all other sampling sites recorded the TH above acceptable limit except S5, S11, S12, S16, S17 and S18 whose TH is recorded above the permissible limit. Near about same trend is followed by post monsoon season. It is observed that the Total Hardness recorded in pre monsoon season is more than the post monsoon season.

3.2.5. Magnesium:

The values of Magnesium have been recorded from the study area is ranging from 84 mg/l to 945 mg/l in Pre-Monsoon season and 51 mg/l to 688 mg/l during summer expressed as Mg. The minimum and maximum values recorded from the same field stations, were discussed in Table. 4. From Table 4 it is observed that the concentrations of Magnesium are recorded at higher during pre-monsoon than post monsoon season. All the water samples show the Magnesium concentrations more than acceptable and permissible limits.

3.2.6. Calcium:

In Pre-Monsoon season the Calcium values from the sampling stations were ranging from 56 mg/l to 576 mg/l and this was 34 mg/l to 376 mg/l during Post Monsoon season. The minimum and maximum values recorded from the same field stations, were discussed in Table 4. The sampling station of S1, S2, S9 and S3 recorded Calcium values within acceptable limit while sampling station S4, S8, S10, S14, S15 shows the values above acceptable limit and Calcium values of sampling station S5, S6, S11, S12, S15 and S16 are found to be above permissible limit as shown in Table.4. The Calcium values are recorded at higher concentration during pre-monsoon than post monsoon season.

3.3. Correlation Matrix of Various Physicochemical Parameters During Pre - as well as Post-Monsoon

The systematic studies of correlation and regression coefficients were found to be useful to measure the overall groundwater. Pearson's correlation coefficient (indicated 'r') is normally useful to find the relationship between the two variables. The parameters having $r > 0.5$ or < -0.5 are considered important. The correlation

coefficients of the physicochemical parameters data of pre-monsoon as well as post-monsoon have been given in Table-5 and Table-6, respectively.

Table-5: Correlation Matrix between Water Quality Parameters: Pre-Monsoon

	pH	DO	EC	TDS	TH	Ca ²⁺	Mg ²⁺
pH	1						
DO	-0.2880	1					
EC	-0.2007	-0.0803	1				
TDS	-0.2465	-0.1798	0.9552	1			
TH	-0.3016	-0.1554	0.7343	0.7532	1		
Ca ²⁺	-0.2964	-0.1902	0.7099	0.7453	0.9973	1	
Mg ²⁺	-0.3143	-0.0936	0.7364	0.7343	0.9884	0.9764	1

Table-6: Correlation Matrix between Water Quality Parameters: Post-Monsoon

	pH	DO	EC	TDS	TH	Ca ²⁺	Mg ²⁺
pH	1						
DO	-0.2882	1					
EC	-0.2008	-0.0801	1				
TDS	-0.2465	-0.1799	0.9550	1			
TH	-0.3016	-0.1556	0.7341	0.7536	1		
Ca ²⁺	-0.2965	-0.1903	0.7098	0.7455	0.9971	1	
Mg ²⁺	-0.3142	-0.0937	0.7367	0.7341	0.9885	0.9765	1

In both the pre as well as postmonsoon periods, strong positive correlations exist between TDS with EC (0.9552), Ca²⁺ with TH (0.9884) and Mg²⁺ with Ca²⁺(0.9764) which represents that these ions contribute considerably to TDS, TH in the groundwater of this study region. The parameters that moderately correlated with each other were, TH with EC (0.7343) and TDS (0.7532), Ca²⁺ with EC (0.7099) and TDS (0.7453), and Mg²⁺ with EC (0.7364) and TDS. The pH and DO is negatively correlated with all the other physico-chemical parameters namely, EC, TDS, TH Ca²⁺ and Mg²⁺.

IV. CONCLUSION

The physico-chemical parameters of the ground water have been assessed in order to study the pre-monsoon and post monsoon effect on the quality of water in Vaijapur Tehsil of Aurangabad district in the current study area of eighteensampling stations. Based on the study some results showed that the water quality is poor and majority of the waters doesn't meeting the standards as per Indian Standards for drinking water (BIS: 10500, 2015). It is observed that the water quality parameters recorded at higher concentration during pre-monsoon season than post monsoon season may be due to the influence of monsoon rains. The pH of all the study stations is at alkaline condition but within the range of 6.5 to 8.5. It is observed that the TDS from the majority sampling stations is recorded within acceptable limit with some exceptions during both post and pre monsoon seasons.

The TH is recorded in majority the study stations is more than the permissible limit and some sites recorded more than the maximum permissible limit for both pre and post monsoon seasons. It is noticed that the Calcium concentration in majority sample stations are less than the permissible limit for both pre and post monsoon seasons. The Magnesium values nearly all the samples records concentration more than the permissible limit during pre and post monsoon seasons. From Table 4 it is observed that electrical conductance values suggest that 33% water samples were in the medium water salinity category. Table 5 and 6 shows the strong positive correlation TDS with EC, Ca^{2+} with TH and Mg^{2+} with Ca^{2+} . The pH and DO is negatively correlated with all the other physico-chemical parameters namely, EC, TDS, TH Ca^{2+} and Mg^{2+} .

Declarations

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Synthesis, Characterization and Antimicrobial study of Manganese (II) Complex of (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl) prop-2-en-1-one

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ABSTRACT

The synthesis of Manganese (II) metal complex **1** has been synthesized by using novel (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl)prop-2-en-1-one ligand. The ligand was prepared by the Claisen-Schmidt condensation method of 2,6-dihydroxy acetophenone and 2-furaldehyde. The structure of the complex has been characterized by the analytical data, conductivity measurement, magnetic moment, UV-Vis spectra, and thermal studies. Analytical data shows 1:2 stoichiometry and the magnetic moment, TG-DTA suggests that Mn(II) complex has octahedral geometry. The presence of coordinated water molecules in Mn (II) complex **1** is confirmed by thermal studies. The conductivity data reveals that the complex is non electrolyte. Antimicrobial study of complex with selected bacterial strain and fungal strain carried out and the results have been compared with commercial standards. The Mn (II) complex **1** shows moderate to good Antibacterial and Antifungal activity.

Keywords: Antimicrobial activities, TG-DTA study, Physico-chemical property, Magnetic Susceptibility and Conductivity.

I. INTRODUCTION

Chalcones and their metal complexes play an important role in modern coordination chemistry. These compounds possessing novel structural features, interesting spectral and magnetic properties, have been observed of intensive research due to their importance in medical, agriculture, analytical, biological and industrial fields. In recent years a number of β -dicarbonyl compounds in which the carbonyl function bonded to olefinic linkage have gained considerable importance mainly because of the fact that such compounds are structurally related to the active chemical constituents of several traditional medicinal plants[1-3].

Chalcones constitute an important group of natural products, which has two aromatic rings joined by α , β unsaturated carbonyl system. The name chalcone is given by Kostanecki and Tambar [4]. The metal complexes

possess interesting biochemical properties, such as antitumor, antioxidant, and antimicrobial, anti-fungal and antimicrobial activities [5]. The magnetic moment, TG-DTA supports the octahedral geometry of the metal complex of chalcone.

II. MATERIALS AND METHODS

2.1. Synthesis of (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl) prop-2-en-1-one ligand:

The reagents used for preparation of (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl) prop-2-en-1-one are of A.R. grade. A mixture of 2,6-dihydroxy acetophenone (0.01 mol) and 2-furaldehyde (0.01 mol) are dissolved in ethanol (20 mL) and then solution of potassium hydroxide 10 mL (15%) were added to it. The mixture was stirred for overnight. The progress of the reaction was monitored by TLC. It was then poured on ice cold water and acidified with dilute HCl. The coffee brown solid was precipitates, filtered and washed with water and recrystallized from ethanol to give the chalcone [6].

2.2. Synthesis of Metal Complex:

The solution of 0.02 mole of (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl)prop-2-en-1-one was taken in round bottom flask containing 30 ml of anhydrous methanolic solution and boiled for 10 minutes. A hot solution of 0.01 mole, of Manganese Acetate in 20 ml of methanol was added drop wise to the solution of the chalcone of 5-methylfurfural to this reaction mixture, 10% alcoholic ammonia was added up to slightly alkaline pH. The complex was precipitated at 8 pH range. The pH 8-10 range was definite for these complexes [7]. The content was stirred on magnetic stirrer for one hour. The solid metal complex separated out and washed with methanol three to four times. The melting point of the complex was determined by Thiele's melting apparatus. The reactions of formation of Mn (II) complex 1 is shown in Figure-1.

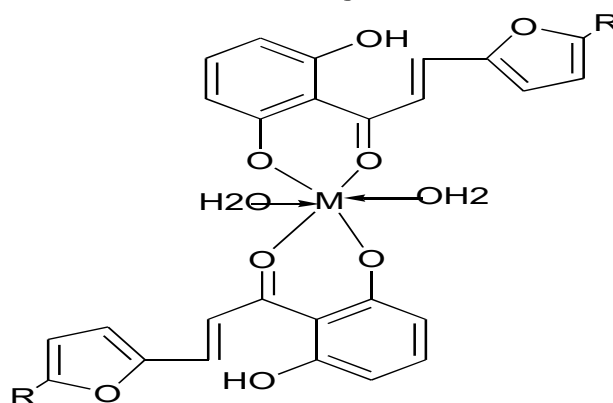


Figure-1: Metal complex 1 of Manganese (II) with (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl)prop-2-en-1-one
R= -H, M= Mn(II)

III. RESULTS AND DISCUSSION

3.1. Physical parameters:

Metal complex 1 of Manganese (II) with (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl)prop-2-en-1-one was brown in color. The complex was precipitated at 8 pH range, having Melting point 320°C. The complex is insoluble in water and soluble in DMSO, DMF [8].

3.2. CHO analysis:

The carbon, hydrogen, oxygen, Manganese metal percentage in Mn (II) complex **1** of chalcone measured at SAIF Cochin, Kerala. The calculated and measured values of CHO analysis are matching and are given in the Table-1.

Table-1: Study CHO analysis of synthesized Mn (II) complex **1**

Metal complex	Chemical formula	Mol. Wt.	Elemental analysis : % found (calculated)						
			C	H	N	O	S	X(Br)	M
Mn (II) Complex	[C ₂₆ H ₂₂ O ₁₀ Mn]	549	56.84 (64.33)	4.03 (4.57)	-	29.12 (19.78)	-	-	9.99 (11.32)

3.3. Magnetic susceptibility, solution conductivity and electronic absorption spectral data Magnetic susceptibility:

The magnetic moment of Mn (II) complex **1** in the present investigation are in the range which is almost close to the spin only value of 5.92 B.M. These values are in good agreement with the moment reported for mononuclear high spin octahedral Mn (II) complex **1** by earlier workers [9].

Table-2: Study magnetic susceptibility, solution conductivity and electronic absorption of synthesized Mn (II) complex **1** of (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl)prop-2-en-1-one

Mn(II) Complex	Molar Conductance Ohm ⁻¹ cm ² mol ⁻¹	μ_{eff} (B.M.)	Absorption Maxima cm ⁻¹ (nm)		
			⁶ A _{1g} → ⁴ T _{2g} (G)	⁶ A _{1g} → ⁴ A _{1g} (G), ⁴ E _g	Charge Transfer
1	2.12	5.86	24937(401)	28571(350)	32154(311)

Solution conductivity and electronic absorption spectral data:

The solution conductivities of 10⁻³ M solution of metal complex in DMSO were measured on EQUIPTRONICS digital conductivity meter EQ - 660 with 20 μΩ to 200 μΩ at 298K temperature. They are insoluble in water and soluble in DMSO, DMF. The low solution conductivity of 10⁻³ M solutions of Mn (II) complex **1** in DMSO indicates their non-electrolytic nature.

Figure-2.



Figure-2: Electronic absorption spectrum of Mn (II) complex **1** of (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl)prop-2-en-1-one

The electronic absorption spectra of Mn(II) complex **1** were showed three bands at 19,120 to 25000 cm^{-1} , 25125 to 27700 cm^{-1} , and 28993 to 30581 cm^{-1} assignable to ${}^6A_{1g} \rightarrow {}^4T_{2g}(G)$, ${}^6A_{1g} \rightarrow {}^4E_{1g}$ or ${}^6A_{1g} \rightarrow {}^4T_{1g}(G)$ and charge transfer indicating octahedral geometry around the metal ion [10-11].

3.4. Infra-red spectrum:

The IR spectrum of α, β -unsaturated carbonyl group has characteristic bands of chalcone at prominent bands between 1625 to 1650 cm^{-1} . The characteristic peaks in infra red spectrum give the presence of particular functional group. The region at which other absorption bands appear depends on the type of aromatic / hetero-aromatic rings as well as the substituent present on these rings. The infrared spectrum of Mn (II) complex **1** of (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl)prop-2-en-1-one was recorded on a Perkin- Elmer Spectrum RX-IFTIR Spectrophotometer in the range 4000-400 cm^{-1} (Table-2) using potassium bromide pellet at CIL, Chandigarh, Punjab. The stretching frequency of (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl)prop-2-en-1-one is represented in table number (2) and the IR spectrum in Figure-3.

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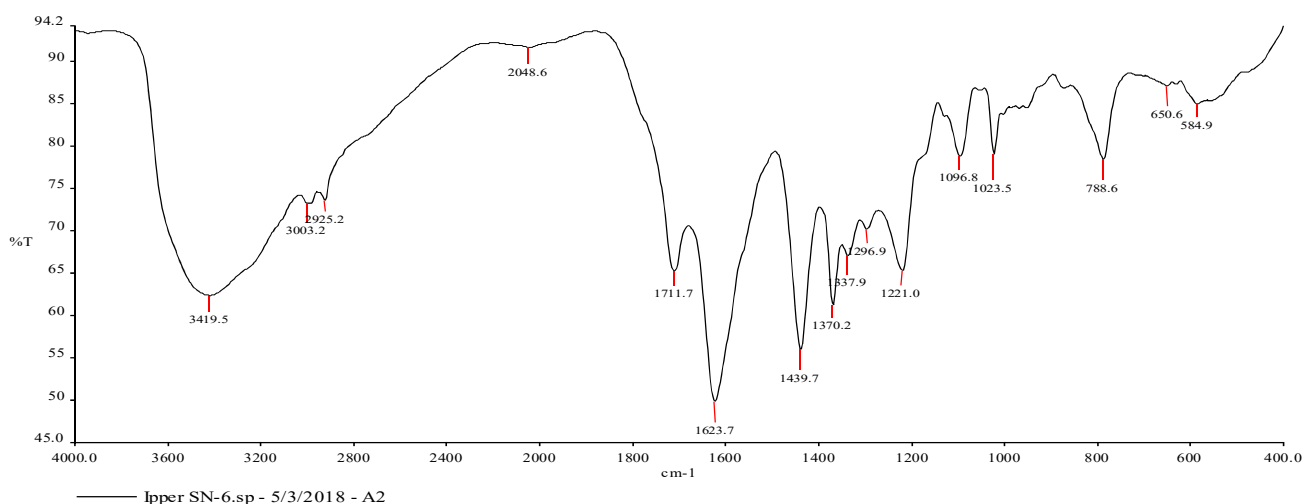


Figure-3: IR spectrum of Mn (II) complex **1** of (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl)prop-2-en-1-one

Table-3: IR spectral data of Mn (II) complex **1** of (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl)prop-2-en-1-one

Molecule	$\nu(\text{OH})$) Enolic	(-CO-CH=CH-) α, β -unsaturated carbonyl group	Carbon yl group (-C=O in pyron ring)	(C-O-C) Stretching Frequency	(C=C) Stretching Frequency	Aromatic Ring (C=C) Stretching Frequency	Ar-H Stretching Frequency	-NO ₂ stretching frequency
Ligand	3420	1652	-	1096	1575	1457	2920	-

3.5. Thermal analysis Mn (II) complex 1 of (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl)prop-2-en-1-one

The simultaneous thermo gravimetric, differential thermal analysis of Mn (II) complex **1** of (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl)prop-2-en-1-one was performed in an inert nitrogen atmosphere on Perkin Elmer STA

6000 at SAIF, Cochin, Kerala. The heating rate was 10°/min and flow rate of nitrogen 50 ml/min. The reference substance used was α Al₂O₃ in platinum crucible and sample weighted in the range of 4-12 mg. The thermogram of Mn (II) complex (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl)prop-2-en-1-one is presented in figure-2. This curve reveals that there is presence of lattice as well as coordinated water in the complex.

The thermogram of Mn (II) complex **1** of (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl)prop-2-en-1-one shows first weight loss at 60°C indicating presence of lattice water. The second loss due to the coordinated water molecule liberated, from the complex. The anhydrous compound undergoes four step decomposition. In the first two steps, decomposition occurs due to loss of non-coordinated part of ligand. The first step shows decomposition within a temperature of range from 240-330°C with mass loss of 39.29%, which is supported by a sharp endothermic peak at 259°C in DTA curve. It may be due to half decomposition of non-coordinated part of ligand. In the second step, decomposition observed at about 350-400°C with the weight loss of 33.78% in TG curve. This is supported by an endothermic peak at 380°C. This may be due to decomposition of remaining coordinated part of ligand. Beyond 600°C there is a formation of MnO as indicated by constant weight loss of in TG-DTA curve.

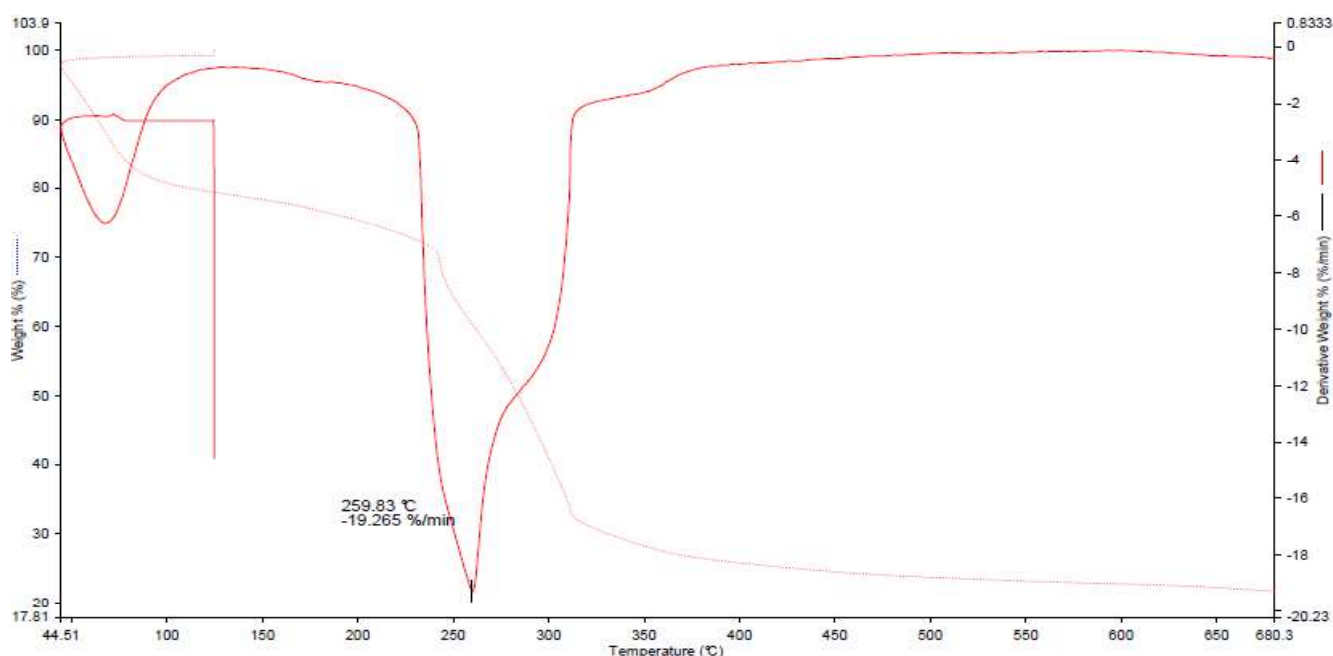


Figure-4: TG-DTA curve of Mn (II) complex **1** of (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl)prop-2-en-1-one

3.6. Thermodynamic and Kinetic Parameters

Akahira [12], first introduced that decomposition and kinetic studies of thermal reactions are useful in determining thermodynamic and kinetic parameters like free energy, entropy change, activation energy, pre-exponential factor. Thermal decomposition studies of materials are useful in predicting thermal stability (**Table-3**).

The negative values of the entropy of activation (ΔS) indicate that the metal complex is thermally stable. ΔG is positive for the complexes revealing that the free energy of the final residue is higher than that of the initial complex, and all decomposition steps are non-spontaneous processes. Also, the value of free energy of activation, ΔG increases significantly for the subsequent decomposition stages of a given complex [13]

Table-3: Thermodynamic and Kinetic Parameters of Mn (II) complex 1 of (E)-3-(furan-2-yl)-1-(2,6-dihydroxyphenyl)prop-2-en-1-one

Metal complex	Method	Step	Decomp. Temp.	Order of Reaction	Ea(KJ mol ⁻¹)	ΔS(KJ mol ⁻¹)	ΔG(KJ mol ⁻¹)	Z (S ⁻¹)	Correlation Coefficient (r)
Mn (II) complex	H-M C-R	I	300	0.5	26.84 21.75	- 153.91 -97.64	37.80 28.70	112973.9 98100737	0.907 0.989
	H-M C-R	II	450	0.5	6.73 4.09	- 172.89 -83.66	19.06 9.96	11545.4 527754555.2	0.999 0.997

3.7. Antimicrobial activity:

Antimicrobial activity was assayed by cup plate agar diffusion method by measuring inhibition zones in mm. In vitro antimicrobial activity of all synthesized compounds and standard have been evaluated against strains of The fungal toxicity of Mn (II) complex 1 was studied *in vitro* against *Aspergillus niger* ATCC 16404, *Saccharomyces cerevisiae* ATCC 9763, *Candida albicans* ATCC10231 fungal pathogens at fixed 1% concentration.

The antibacterial activity of Mn (II) complex 1 was studied, for evaluating antibacterial activity Gram positive and Gram negative bacterial pathogens were used. *Staphylococcus aureus* ATCC 6538, *Bacillus megaterium* ATCC 2326, *Bacillus subtilis* ATCC 6633 were Gram positive pathogens used in this study. *Escherichia coli* ATCC8739, *Salmonella typhi* ATCC9207, *Shigella boydii* ATCC 12034, *Enterobacter aerogenes* ATCC13048, *Pseudomonas aerogenosa* ATCC9027, *Salmonella abony* NCTC6017 were the Gram-negative pathogens used in this study.

From the results of antimicrobial activity of ligands and complex it is clear that the complex shows enhanced activity than ligand. The increase in antimicrobial activity is due to faster diffusion of metal complexes as a whole through the cell membrane or due to the combined activity of the metal and ligands [14].

IV. CONCLUSION

The Mn (II) complex 1 was colored, soluble in most of the organic solvent. The stoichiometry ratios of the metal complexes are obtained has been found to be 1:2. Solution conductivity of this metal complex reveals non-electrolytic nature. The electronic spectral data, magnetic moment, TG-DTA suggests that Mn (II) has Octahedral geometry. The CHO analysis gives C, H, and O percentage in the metal complex. From the antimicrobial activity of ligand and complex it is clear that the complex shows enhanced antimicrobial activity than ligand.

V. ACKNOWLEDGEMENT

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Chalcone Biological Significance and Synthesis A Review

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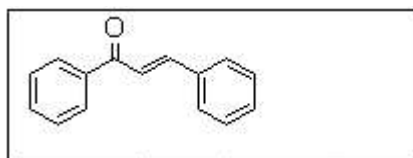
ABSTRACT

Chalcone is an aromatic ketone that forms the central core of many important biological compounds. The biogenetic building blocks of flavonoids and isoflavonoids, which are abundant in plants, are called chalcones. Chalcones are active lead molecules in the search for new drugs in medicinal chemistry. Here, we review the biological significance and synthesis of natural and synthetic chalcones.

Keywords: Chalcones, Antibacterial activity, Antidiabetic activity, Claisen–Schmidt condensation, Wittig reaction

I. INTRODUCTION

Chalcones are the building blocks of several natural compounds.¹⁻² The word “chalcone” is derived from the Greek word “chalcos”, meaning “bronze”, which results from the colors of most natural chalcones.³ Chalcones are 1, 3-diaryl-2-propen-1-ones with various substitution patterns that exist in cis and trans isomeric forms, with the trans form being thermodynamically advantageous. They are represented as



On their aryl rings, they have different substituents. Some of these substituents affect the biological properties that chalcones have. However, the key pharmacophore is believed to be the, α,β -unsaturated ketone moiety.⁴ Naturally occurring chalcones and their synthetic analogues have been documented to comprise a wide range of biological activity. They are therefore high in demand as the starting components in the synthesis of a number of different heterocyclic compounds. Chalcones have been utilized as medicine for thousands of years to treat a variety of pharmacological conditions through the use of plants and herbs. There are many chalcone-containing drugs that have received clinical use approval. Metochalcone was previously employed as a choleric medication, whereas sofalcone was used as an antiulcer and mucoprotective medicine (Figure 1)^{5,6}