CIBTech Journal of Zoology ISSN: 2319–3883
Online, International Journal, Available at http://www.cibtech.org/cjz.htm
2023 Vol.12, pp.115-123/Ashish
***Research Article** (Open Access)*

THE STUDY OF WATER QUALITY PARAMETERS OF SMALL LENTIC WATER BODY FROM GONDIA, MAHARASHTRA (INDIA) WITH RESPECT TO FISH PRODUCTION

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ABSTRACT
The study of physico-chemical parameters of any water body is nothing but a diagnosis of the quality of water with respect to survival and propagation of biotic community which is harbouring in it. The water body understudy is located in Gondia district of Maharashtra state and is used for fishing purpose by the local fishermen. The current study was carried out from January 2022 to December 2022 to examine the physical and chemical characteristics of water body for fisheries management and fish culture. Samples were collected from four different sampling sites. Evaluations were made for variables such as water temperature, pH, Total alkalinity, dissolved oxygen, and free Carbon dioxide by conducting field and laboratory experiments with standard methodologies. Result of study shows that Parameters like Temperature-pH (p=0.00059), Temperature-DO (p=0.02139), pH-DO (p=0.00193) and Total alkalinity-Carbon dioxide (p=0.00181) have significantly different values from each other. All water quality parameter values are determined to be within acceptable range, and the lake's water is found to be suitable for production and propagation of variety of fish species culture.

Keywords: *Deori, Fish production, Keshori Lake, Physico-chemical parameters, Water quality parameters*

INTRODUCTION
The first prerequisite for the existence of life is water. The sum total of physical and chemical characteristics of water determines the quality of the water (Haruna, 2003). Important water resources have drastically decreased as a result of the unrestrained use of water for industrial, drinking, and irrigating purposes (Sharma and Uchchariya, 2019). Degradation of water quality has emerged as a critical global concern for human sustainability. Water supplies are severely threatened by pollution brought on by human activity and improper agricultural drainage from water bodies (Jin *et al.*, 2020). The main causes of surface water pollution and deterioration in water quality are anthropogenic sources such untreated industrial effluents, inadequately deposited household trash, and agricultural runoff (Uddin and Jeong, 2021; Hasan *et al*., 2019). In order to offer the full range of information for the goal of fisheries management, the quality of the water should ideally be analysed based on physico-chemical and biological parameters (Kadam *et al*., 2007b).
Fish need water to survive; it is the only medium that can provide for all of their needs, including breathing, eating, reproducing, and growing (Coche *et al*., 1997). In the water, fish carry out all of their biological functions. Because fish are completely dependent on water for respiration, excretion, salt balance and reproduction, understanding the physical and chemical properties of water is critical to successful aquaculture. The threat to fish production from inland water resources such as rivers, lakes, streams etc includes pollution, habitat degradation and modification, altered river flow, and overfishing (Gupta, 2006).
Gondia district is known for its rice production and ponds. It is one of the important districts of Vidarbha region of Maharashtra. Most of the local fishermen belong to ‘Dhivar’ cast whose main source of income is fishing. Fishermen cooperative societies are established in different parts of Gondia to control the fishing activities of respective water bodies. Deori is one of the tahasils of Gondia where this small lentic water body is situated. The water body is also known by local people as Keshori Lake. This lake is extensively utilized by local fishermen for their livelihood. Recently, Gadwe and Tijare (2023) reported that 28 fish species are

harbouring the lake water. In the present study, the quality of water is assessed by examining physico-chemical characteristics of the lake water with respect to fish production.

MATERIALS AND METHODS

Study Area

The water body understudy is situated at 21° 3' 41.8176" N and 80° 21' 43.974" E. Lake water covers over 40 acres of land during rainy season but due to high atmospheric temperature during summer season it shrinks considerably. The lake is mostly surrounded by farm land but some part of it is in close proximity of the human habitation. People in the vicinity use the water for various purposes that put the lake's ecosystem under severe threat.

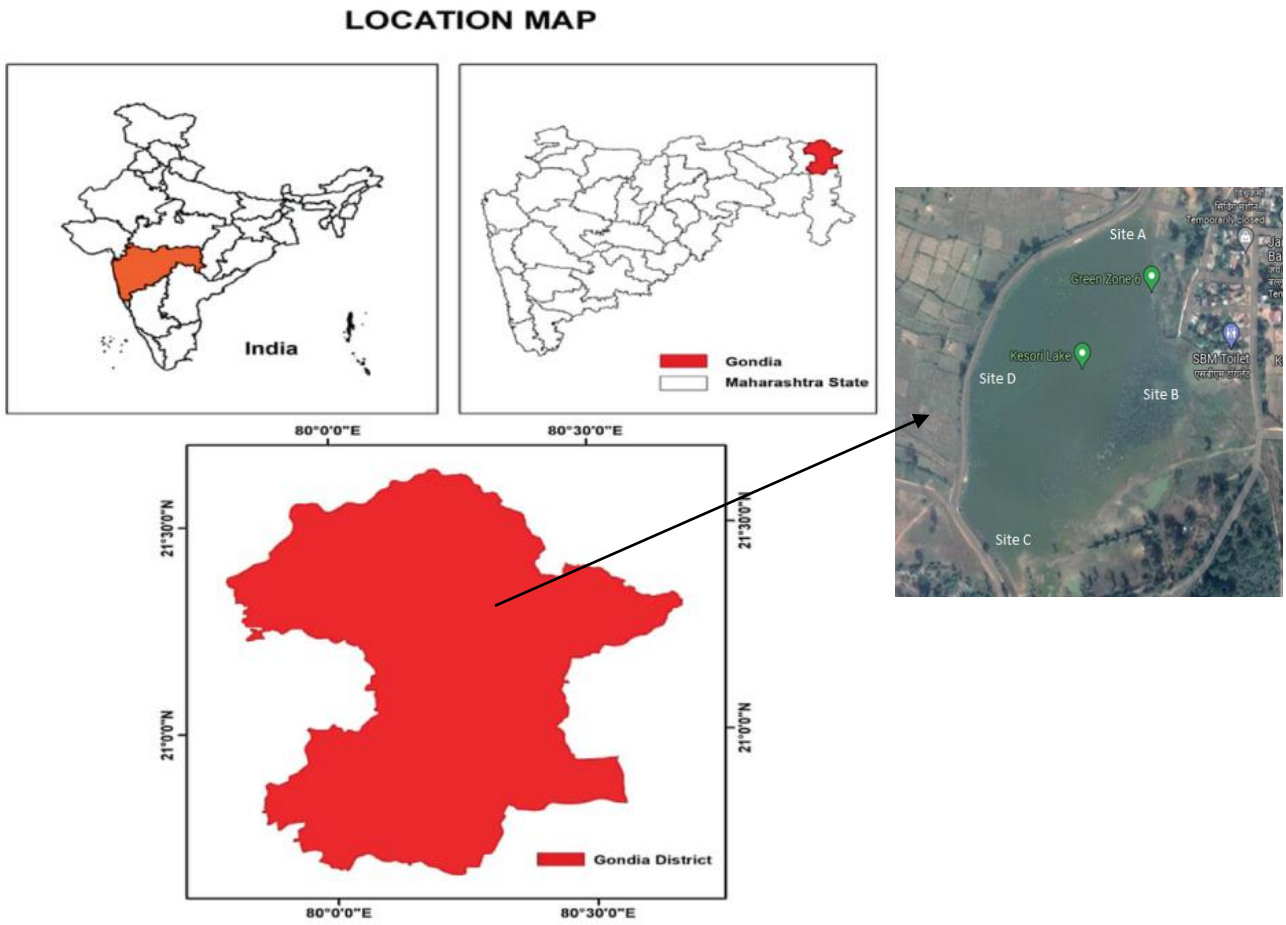


Figure 1: Map of Study Area showing four sampling sites [Image adapted and modified from Kudnar (2022)]

Collection of Samples

The water samples were collected from four sites A (North), B (East), C (South) and D (West) (Fig.1) of the lake, in the first week of every month from January 2022 to December 2022. Sampling was generally carried out in the morning hours. Collected samples were stored in appropriate containers for further study. Water temperature and pH is measured on the spot with the help of digital thermometer and pH meter. And rest of

the parameters i.e. Total Alkalinity, Dissolved Oxygen (DO) and Carbon dioxide were analysed by the methods given in APHA (1985) and Kodarkar (2006).

Statistical Analysis

All the obtained values of parameters are subjected to statistical mean and standard deviation calculation. To find out the correlation among different water parameters Correlation coefficient (r value) is calculated and Pearson correlation matrix is formed with different colour gradation depicting positive or negative correlation. The *p* value with 95% confidence level ($p<0.05$) is calculated by using regression and ANOVA tests between two parameters at a time for detecting whether they are significantly correlated with each other or not. For all these statistical tests Excel's Data Analysis Toll pack 2007 is used. With the help of statistical software Past4.12b, principal component analysis (Biplot) is obtained showing spatial relationship of all the water parameters with each other. Cluster analysis various parameters is also performed using same software.

RESULTS AND DISCUSSION

Table I is showing the values of five physico-chemical parameters like water Temperature, pH, Total Alkalinity, Dissolved Oxygen and Carbon dioxide of four sampling sites A, B, C and D obtained during study period of January 2022 to December 2022 (12 Months). All these parameters have profound influence on fish culture.

Temperature

Temperature plays an important role in thermal stratification which has some effect on chemical and biological activities of aquatic media. The degree to which fish can tolerate different temperatures varies greatly. Indian large carps are known as eurythermal because they often survive a wide variety of temperatures. In the present investigation, the water temperature recorded in the range of 17.30 to 38.30ºC at all four stations. The Fig.2(a) is depicting a graph, showing the temporal variation of water temperature throughout the year. As expected, that water temperature is highest in the months of May and June and lowest recorded in the months of November and December. As apparent from table II, Temperature showing strong negative correlation (r = -0.84205) with pH of the water. It does not show linear correlation with Total Alkalinity (r = -0.02448) and Carbon dioxide (r = 0.02526) but it shows moderate negative correlation with Dissolved Oxygen (r = -0.65273). Obtained *p* value between temperature and pH of water is 0.00059 ($p<0.05$) which is indicating that both the parameters are significantly different from each other. Whereas, *p* values of temperature with Total alkalinity and Carbon dioxide are 0.93978 ($p>0.05$) and 0.93788 ($p>0.05$), respectively, showing no significance. The *p* value between Temperature and Dissolved oxygen is 0.02139 ($p<0.05$), showing that both the temperature and dissolved oxygen are significantly different from each other.

pH

pH is the scale of intensity of acidity and alkalinity of water and measures the concentration of H^+ ions. According to Swingle (1967), pH range of 6.5 to 9.0 is suitable for pond culture. Even a pH tolerant fishes dies at pH 11. In contrast, acidic water reduces the appetite of the fish, their growth and tolerance to toxic substances. The fishes get prone to attack of parasites and diseases in acidic waters. Hence, pH is considered as an indicator of overall productivity that causes habitat diversity (Minns, 1989). In the present investigation, pH of lake water is ranged from 7.30 to 7.88. The pH is less alkaline in nature at all the selected four stations. The Pearson's Correlation matrix (Table 2) shows that pH has strong positive correlation with Dissolved Oxygen (r = 0.79639) and strong negative correlation with Temperature as already discussed earlier, but has slightly negative correlation with Carbon dioxide (r = -0.11676) and negligible negative correlation with Total alkalinity (r = -0.02852). '*p*' value between pH and DO is 0.00193 ($p<0.05$), showing that both the parameters are significantly different from each other whereas, *p* values of pH with total alkalinity and Carbon dioxide are 0.92987($p>0.05$) and 0.71781 ($p>0.05$) respectively, showing no significance.

Table 1: Monthly variations of Physico-chemical parameters of Lake with mean values and standard deviations.

Parameters	Sites	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Mean +/-	SD
Water Temperature (^{o}c)	A	20.70	25.10	25.00	30.00	38.00	37.50	31.00	27.00	21.00	19.40	18.00	17.40	25.84	± 7.09
	B	20.80	26.00	26.20	29.10	37.50	38.00	30.00	27.50	21.50	19.20	18.80	17.50	26.00	± 6.88
	C	21.00	25.00	27.00	30.60	38.20	37.00	31.50	27.00	21.00	20.00	18.20	17.80	26.19	± 6.99
	D	21.50	26.50	26.50	30.50	38.30	38.10	30.00	28.00	21.50	19.00	18.30	17.60	26.31	± 7.11
pH of Water	A	7.64	7.56	7.30	7.35	7.32	7.34	7.40	7.50	7.56	7.58	7.71	7.85	7.50	± 0.17
	B	7.63	7.55	7.32	7.35	7.32	7.35	7.40	7.52	7.58	7.58	7.70	7.86	7.51	± 0.17
	C	7.63	7.56	7.32	7.36	7.30	7.34	7.42	7.52	7.57	7.57	7.72	7.88	7.51	± 0.17
	D	7.64	7.55	7.30	7.38	7.30	7.34	7.42	7.50	7.55	7.57	7.70	7.87	7.51	± 0.17
Total Alkalinity (mg/l)	A	133.00	129.80	128.90	130.00	131.20	131.80	135.20	138.90	137.10	136.90	127.00	130.40	132.51	± 3.72
	B	133.20	129.80	128.80	130.60	131.10	131.90	135.40	138.80	137.00	136.90	127.10	130.20	132.56	± 3.68
	C	133.00	129.70	128.80	130.50	131.10	131.70	135.20	139.00	137.10	136.80	127.00	130.50	132.53	± 3.71
	D	133.40	129.60	128.90	130.30	131.10	131.60	135.40	139.00	137.00	136.90	127.10	130.30	132.55	± 3.74
Dissolved Oxygen (mg/l)	A	9.50	9.10	6.00	6.50	6.10	7.20	8.50	9.80	8.90	8.86	8.90	9.33	8.22	± 1.38
	B	9.50	9.00	5.80	6.60	6.30	7.20	8.57	9.86	8.85	8.87	8.91	9.30	8.23	± 1.37
	C	9.41	9.10	6.10	6.40	6.60	7.00	8.54	9.80	8.89	8.88	8.89	9.25	8.23	± 1.31
	D	9.61	9.10	6.10	6.80	6.20	7.30	8.50	8.87	9.01	8.87	8.90	9.22	8.20	± 1.24
Carbon dioxide (mg/l)	A	4.20	3.98	4.15	3.92	3.87	4.25	6.79	6.19	5.81	4.88	3.99	3.81	4.65	± 1.03
	B	4.02	3.95	4.22	3.99	3.86	4.22	6.80	6.10	5.79	4.89	3.98	3.82	4.63	± 1.02
	C	4.15	3.97	4.12	4.09	3.99	4.20	6.80	6.12	5.81	4.91	3.97	3.85	4.66	± 1.01
	D	4.28	3.98	4.05	4.03	3.89	4.12	6.81	6.01	5.79	4.90	3.99	3.83	4.64	± 1.00

Table 2: Pearson's Correlation Matrix showing relationship among all the water quality parameters under study.

Parameters	*Water Temperature*	*pH of Water*	*Total Alkalinity*	*Dissolved Oxygen*	*Carbon dioxide*
Water Temperature	1				
pH of Water	-0.84205	1			
Total Alkalinity	-0.02448	-0.02852	1		
Dissolved Oxygen	-0.65273	0.79639	0.42475	1	
Carbon dioxide	0.02526	-0.11676	0.79914	0.35	1

Table 3: Analysis of Different water quality parameters by Regression and ANOVA tests at 95% confidence level.

Parameters	***Water Temperature***		***pH of Water***		***Total Alkalinity***		***Dissolved Oxygen***		***Carbon dioxide***	
	P value	*Significant*	*P value*	*Significant*	*P value*	*Significant*	*P value*	*Significant*	*P value*	*Significant*
Water Temperature			0.00059	**Yes**	0.93978	No	0.02139	**Yes**	0.93788	No
pH of Water					0.92987	No	0.00193	**Yes**	0.71781	No
Total Alkalinity							0.16870	No	0.00181	**Yes**
Dissolved Oxygen									0.26472	No
Carbon dioxide										

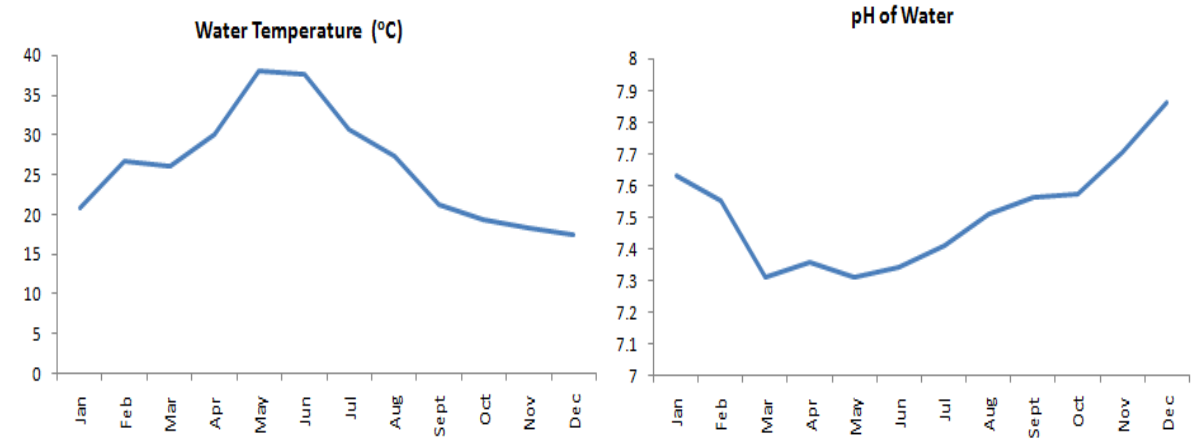
Note: "Yes" denotes that the water quality parameters are significantly different from each other, and "No" denotes that the water quality parameters are not significantly different from each other.

Total Alkalinity

The primary components of pond water are bicarbonate and carbonate, and their quantities are measured as total alkalinity**.** Fish growth is dangerously hampered by acidic water; therefore, alkalinity in the reservoir or ponds is necessary for the acids to be neutralised and the growth of fish to be possible. Alikunhi (1957) noted that highly productive water has an alkalinity of above 100 ppm, and Schaperclaus (1933) noted that the most productive water had a CaCO3 titer of 200 to 500 ppm. In the present investigation, Total alkalinity values are found to be in the range of 127 mg/l to 139 mg/l. As per the correlation matrix (Table 2) it shows moderate positive correlation with DO (r = 0.42475) and Carbon dioxide (r = 0.79914) but no significant correlation with Temperature (r = -0.02448) and pH(r = -0.02852). '*p*' value between total alkalinity and Carbon dioxide is 0.00181(p<0.05) showing that both the parameters are significantly different from each other whereas it is not showing significance with parameters like temperature, pH and DO.

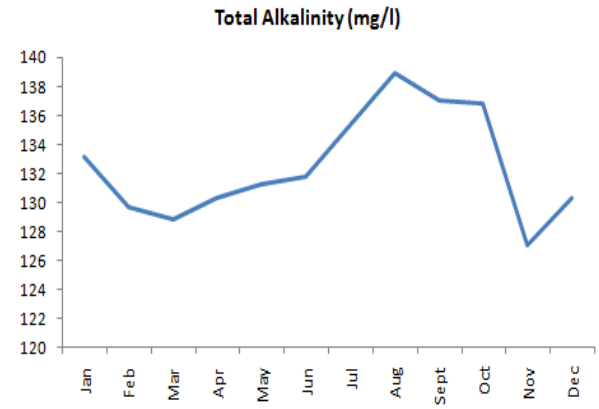
Dissolved Oxygen (DO)

The formation of oxygen involves both photosynthesis by organisms living in the water body and atmospheric absorption at the pond's surface. Thus, oxygen acts as a marker of planktonic development,

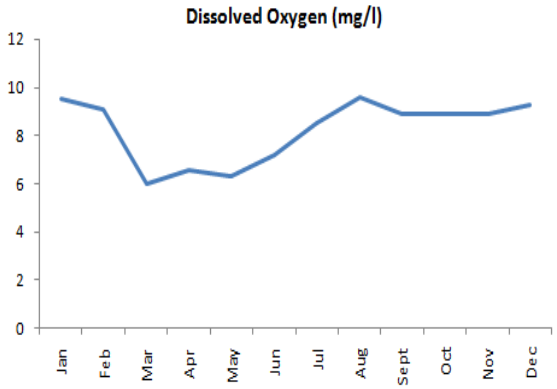


(a) Temperature

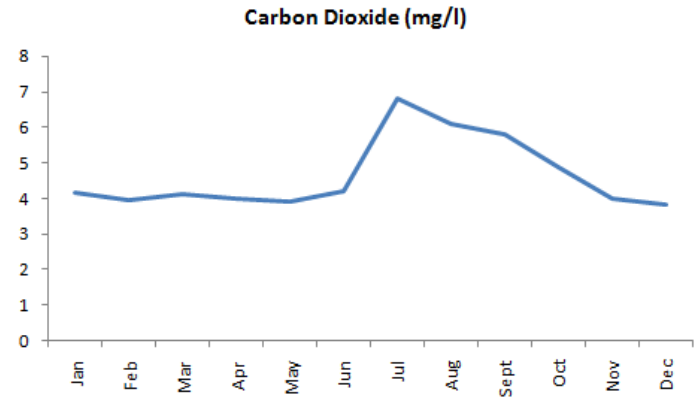
(b) pH



(c) Total Alkalinity



(d) Dissolved Oxygen



(e) Carbon dioxide

Figure 2: Temporal variation of physicochemical properties of water of the Lake from January 2022 (month 1) to December 2022 (month 12).

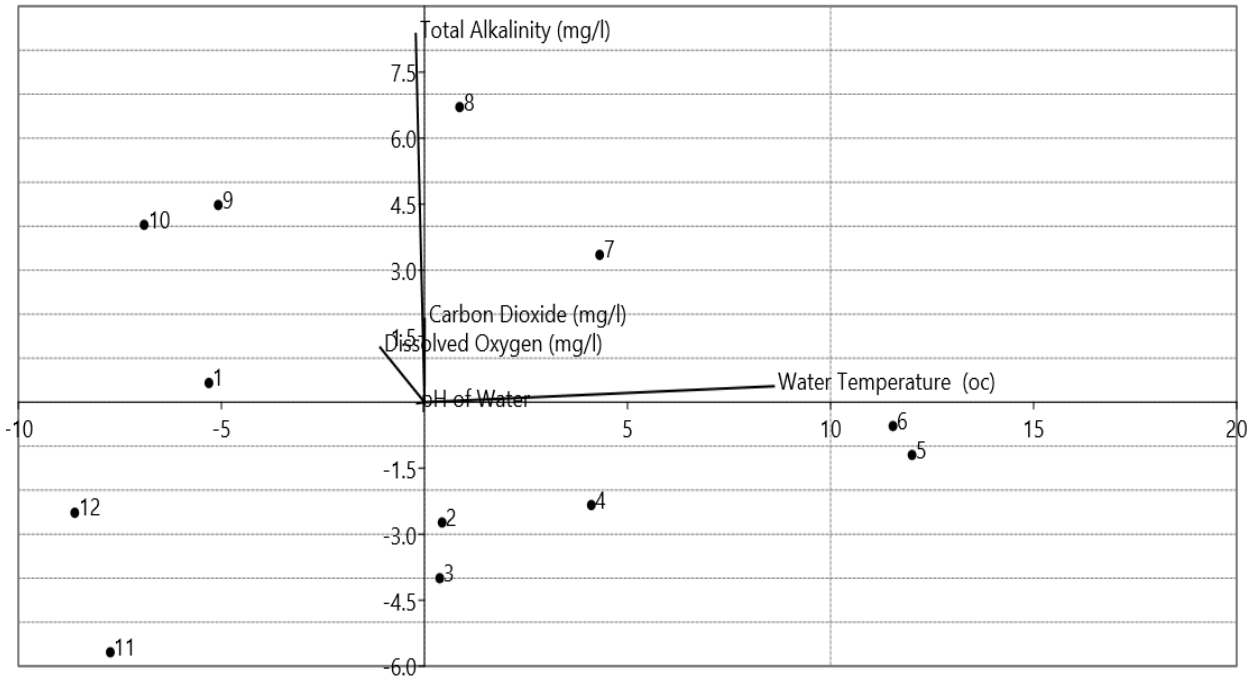


Figure 3: Principal Component Analysis Showing the Biplot of various water quality parameters of the lake

which is important for fish growth (Jayaraju *et al.*1994). The high temperature and low DO during summer create favourable condition for the development of blue green algae.In the present study, the DO range falls between 5.80 to 9.86 mg/l. Lower DO values recorded mostly in summer months and higher values observed in monsoon and post monsoon months. Similar observations were also noted by Sakhare and Joshi (2003), Kadam *et al*., (2007a, 2007b) and Lokhande *et al*., (2010). As apparent from Table II DO has negative correlation with water temperature (r = -0.65273) and positive correlation with pH, Total alkalinity and Carbon dioxide. As discussed earlier DO values are significantly different from Temperature and pH but no real significance found with Total alkalinity and Carbon dioxide.

Carbon dioxide

Carbon dioxide is produced by the respiration of aquatic plants and animals as well as the decomposition of organic materials. This gas is extremely soluble in natural waters. Although necessary for plants to engage in photosynthetic activity, Carbon dioxide is a waste product for fish. High concentration of free Carbon dioxide more than 20 mg/l is toxic to fish Kadam *et al.*, (2007b). In the present investigation Carbon dioxide values are found to be in the range of 3.81 to 6.81 mg/l. Low values are observed in winter months and higher values observed in Monsoon months. Similar observation was also reported by Dwivedi and Pandey (2002). According to correlation matrix, Carbon dioxide has positive correlation with Total Alkalinity (r = 0.79914) and DO (r = 0.35), but shows negative correlation with pH (r = -0.11676). No linear correlation found with water temperature. Carbon dioxide and Total alkalinity are found to be significantly different from each other and rest of the parameters did not show any significance with Carbon dioxide (See Table 3).

Cluster Analysis

Ward's approach was used to perform a cluster analysis on the normalised data, using squared Euclidean distances as a measure of similarity. According to Ward's technique, the rise in squared error indicates how close two clusters are to one another. To find similarities among various sampling months, hierarchical cluster analysis was utilised. The dendrogram (fig.4) of the 12 months (from January 2022 to December 2022) using Ward's linkage method and squared Euclidean distances showed two statistically significant

clusters. First cluster is of months, September, October, November, December and January and second cluster include months, February, March, April, May, June, July and August. The first cluster is of post monsoon and winter months and second cluster is of Dry season and pre-monsoon. These clusters show that water quality parameters show some kind of relationship among months.

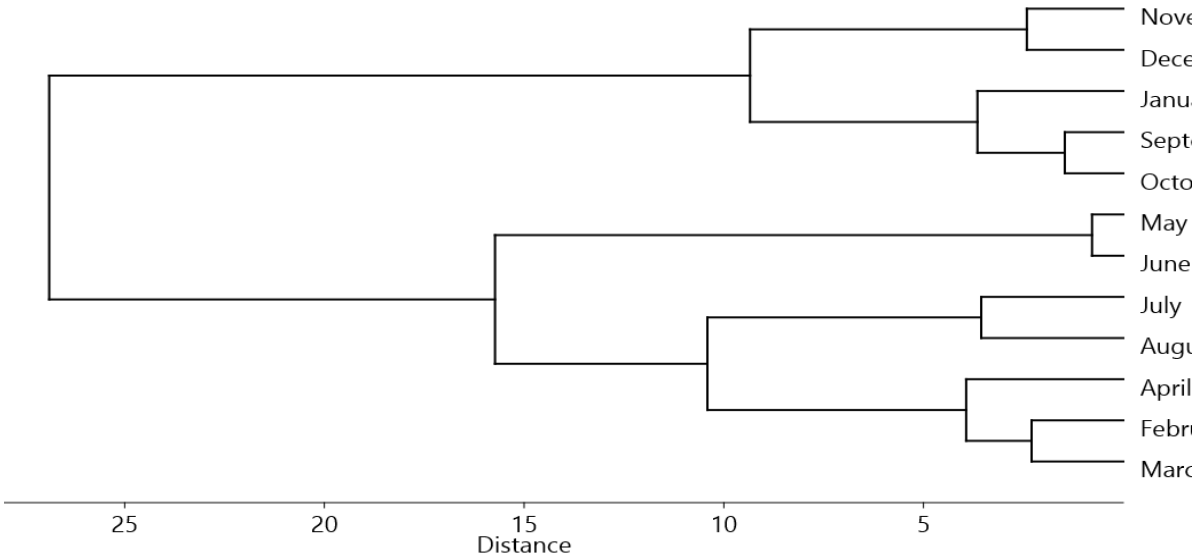


Figure 4: Dendrogram using hierarchical clustering of sampling months of water collection

CONCLUSION

All the parameters are within the permissible limits with respect to fish production. The water of the lake is alkaline which is good. Temperature shows strong negative correlation with pH and DO. Furthermore, DO has positive correlation with pH and Total Alkalinity. Carbon dioxide has positive correlation with Total alkalinity and DO. Parameters like Temperature-pH, Temperature-DO, pH-DO and Total alkalinity-Carbon dioxide have significantly different values from each other. The water is productive having maximum alkalinity 139 mg/l, pH is less than 8 also DO and Carbon dioxide of the water is measured within the range of 5 to 10 mg/l which are suitable conditions for the fish growth. Hence, the catchment area of this lentic water body can be utilized for the production of fish on a large scale and variety of fish species can be cultured.

ACKNOWLEDGEMENT

Author is thankful to the Principal, M.B Patel College of Arts, Commerce and Science, Deori and Director, Institute of Science, Nagpur to provide necessary laboratory facility for this work.

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