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A study on physico-chemical parameters of Lake Pichola of Udaipur (Rajasthan)

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Abstract
The study was carried out to highlights the water quality status of lake Pichola, Udaipur (Rajasthan). The historic lake Pichola has its ethnic and scenic importance for the tourism. However, the lake is facing anthropogenic pressure due to heavy human population and hotels around it. This has created threat to shift its trophic level and alteration in its important physico-chemical parameters. The water samples were collected on monthly interval from four preselected sampling stations. The range of important water quality parameter in the lake were- air temperature (19.88-36.88 ^{0}C), water temperature (18.75-30.90 ^{0}C), transparency (15.91- 72.27 cm), pH (7.20-8.80), dissolved oxygen (4.88-9.43mg/l^{-1}), free carbon dioxide (0.00-11.75mg/l^{-1}) total alkalinity (145.50-177.25 mg/l^{-1}), total hardness (144.00-183.50 mg/l^{-1}), total dissolves solids(187.51-273.51 mg/l^{-1}), nitrate-N (0.36-0.51 mg/l^{-1}) and orthophosphate (0.15-0.27mg/l^{-1}) were observed. Water quality parameters were compared with reported optimum water quality standards prescribed for fish farming or aquaculture are found within limit. The results revealed that aquatic environment of Pichola Lake is conducive for fish growth and water is not only suitable for fish farming but also for irrigation.

Keywords: Anthropogenic, Pichola, water quality, Rajasthan

1. Introduction
Udaipur city is popularly known by the phrase “City of Lakes” as it is adorned with number of lakes. This study is thus aimed to achieve following objectives in one of the historical lakes of Udaipur the “Lake Pichola”. The Lake has a historical background and was created by Pichhu Banjara at the end of 14th Centaury which was later renovated in 1560 A.D. by Maharana Udai Singh [17]. The water is extensively used for fishery since several years and presently, the lake is facing degradation due to anthropogenic activities such as disposal of urban sewage, soil erosion due to destruction of vegetation in the catchment and dumping of waste from nearby habitations and even human defecation. This lake is extensively used by local people for their daily needs of bathing, washing and principally tourism which supports livelihood of many hotel industries located in and around the lake. Moreover, the lake is heavily surrounded by human habitat which lays anthropogenic presser on the lake habitat. The lake is also enriched with a variety of fish fauna and serves as habitat to a variety of aquatic macrophytes. The impact urbanization on the lake is quite high and hence continuous monitoring of this water body is essential to ascertain sustainable productivity, fisheries and conservation.
Life in aquatic environment is largely governed by physico-chemical characteristics and their stability. These characteristics have enabled biota to develop many adaptations that improve sustained productivity and regulate Lake Metabolism. Studies on limnology of Udaipur lakes have been conducted with emphasis on different aspect [19, 20, 25]. The most characteristic criterion to assess the trophic structure of a lake remains to be its primary productivity. Studies on phytoplankton and zooplankton diversity have been made by many authors [3, 8, 12, 13, 16]. Aquatic life depends on the quality of water and a thorough assessment of the water quality is an integral part of wetland evolution. Gupta and Sharma [9] worked on seasonal variations of Limno-chemical parameters of Amarchand reservoir in Rajasthan and found inter relationship among the different parameters.

2. Material and Methods
2.1. Climate of Southern Rajasthan
The experimental zone has a subtropical climate and lies in Agro-climate zone IV A *i.e.* sub-

humid southern plains. The average rainfall of Udaipur is 689 mm and relative humidity of 75-95 per cent during the monsoon period. The summers are relatively hot and winter is a bit cool having an average of maximum temperature during May is 31.6 ^{0}C and minimum in January *i.e.* 16^{0}C respectively [12]. However, the overall range may vary from 1^{0}C to 45 ^{0}C. The elevation of the study zone is 582.17 m above mean sea level.

2.2. Study Area
Lake Pichola is situated in Udaipur city in Udaipur district of Rajasthan at 24°68'N latitude and 73°68'E Longitude with a water spread area of 6.96 km^2. The study area is depicted in the Fig. 1.

2.3. Morphology of Pichola Lake
The details of morphometric features of Pichola are given in Table 1.

Table 1: Morphometric features of Lake Pichola, Udaipur (Raj.)

S. No.	Morphometric features	Lake Pichola
1.	Location	Udaipur Rajasthan
2.	Longitude	73 °68'E
3.	Latitude	24 °58'N
4.	Altitude	598m (MSL)
5.	Average rainfall	640mm
6.	Surface area of lake	6.96 km^2
7.	Catchment area	12700 ha
8.	Maximum depth	8.5 m
9.	Average depth	4.5 m
10.	Maximum length	4 km
11.	Maximum width	3 km
12.	Average width	3 km
13.	Type of Dam	Masonry
14.	Water volume	13.08 million m^3
15.	Catchment area	55 km^2
16.	Type of lake	Fresh water
17.	Tehsil	(Girwa) Udaipur
18.	Accesses	Udaipur city
19	Year of construction	1362 A.D.

2.4. Sampling stations
For the proposed study, four sampling stations were selected as shown in Figure 1, in Lake Pichola for collection of water samples. Station A was located on the South Eastern shore, this station in relatively shallow isolated site. Whereas, station B was located near the North Eastern shore and is surrounded by maximum human habitation. Sampling station C was at the Northern end, this station site was also surrounded by human habitation and posing threat of entrophication due to solid and liquid waste disposal. And station D was selected near the Western end of lake, this station is on the tail and of lake with major water inlet through Sisorma river while brings silt and agricultural runoff along with rain water. This station is also affected by cattle grazing (Fig 1).

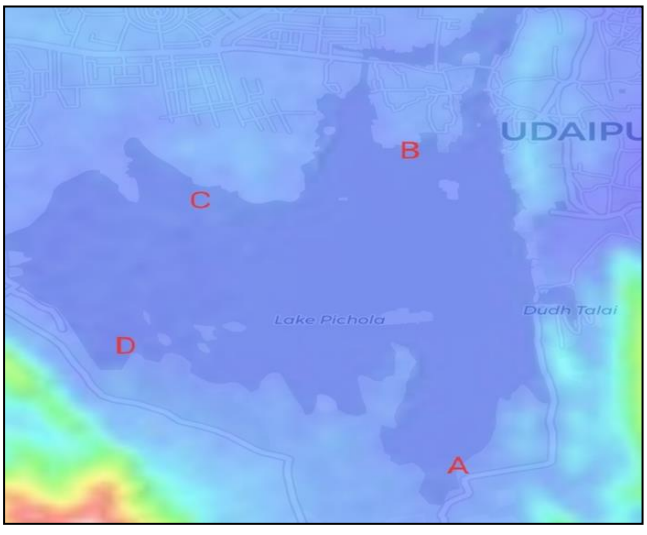

Fig 1: map of study area and sampling stations (A, B, C and D)

2.5. Duration of study
The study was carried out during August 2015 to July 2016 with a view to investigation the water quality of Lake Pichola, Udaipur (Rajasthan).

2.6. Collection of water sample
During the study period, surface water samples from four selected sampling stations of pichola were collected using a plastic bucket. The water samples thus collected were stored in one liter pre cleaned laboratory grade plastic bottles with air tight cap for analyses of certain parameters in the laboratory; whereas some of the parameters were assessed at the sampling site itself.

2.7. Water quality analysis
Water quality parameters such as temperature of air and water, depth of visibility, turbidity, electrical conductivity-EC, total dissolved solids, pH, carbonates and bicarbonates alkalinity, dissolved oxygen, free carbon dioxide were determined in the field itself, while for the analysis of nitrate-nitrogen and orthophosphate the samples were brought to the laboratory and analyzed as soon as possible using standard methods of Trivedi [24] and APHA [2]. The physical parameters such as temperature of air and water, pH and total dissolved solids were recorded by using digital meter. The transparency of water was measured by using Secchi disc.

3. Results and Discussion
The temperature is an important factor which effects rate of chemical reactions of water and biological processes of aquatic organisms and thus has profound influence on the biotic communities. During the present investigation the average air temperature was 19.88-36.88 °C and water

temperature was 18.75-30.90 °C. Similar results were recorded by many workers [4, 14, 16].

Transparency is directly proportional to the amount of suspended organic and inorganic particulate matters. The other factors which affect the transparency of water body are plankton density, wind velocity, rainfall, nature of water body and prevailing weather conditions. In the present work range of transparency were from 15.91 to 72.27 cm. The findings of present study are in agreement with many researchers [5, 14, 15, 21].

During the present investigation average value of pH was observed 8.00. The pH of water appears to be dependent upon the relative quantities of calcium carbonates and bicarbonates. As these being alkaline when the quantities of carbonates are high. Santhosh and Singh [18] reported that suitable pH range is 6.7 to 9.5 for fish culture whereas above or below this level of pH is stressful to the fishes. The present value of pH is lies between the reported pH range which depicts that water condition is grossly suitable for fish and fisheries.

The electrical conductivity depicts the presence of total soluble mineral contents in water. In the present investigation, observed average value of electric conductivity was 581.71µScm^{-1}. Mishra [15]. Reported an electrical conductivity of 500 µScm^{-1} in Lake Pichola.

Dissolved oxygen (DO) is an important parameter which affects chemical as well as biological reactions in an ecosystem. The average dissolved oxygen during research work was 7.30 mgl^{-1}. Similar trends of DO were also observed by many researchers [26, 27]. Mishra [15] reported a range of DO 5.28 to 6.63 mgl^{-1} in Lake Pichola. Which are slightly lower than the present findings.

Table 2: Water quality parameters of Lake Pichola. BIS- Bureau of Indian Standard

S. No	Parameters	Max	Min	Average	SD	CV (%)	BIS values
1	Air temperature °C	36.88	19.88	30.41	5.98	8.04	-
2	Water temperature °C	30.90	18.75	27.08	4.36	7.71	-
3	Transparency (cm)	72.27	15.91	48.34	17.46	8.64	-
4	pH	8.80	7.20	8.00	0.60	9.68	6.5-8.5
5	EC (µS cm^{-1})	610.00	552.50	581.71	14.06	0.64	750-2250
6	Dissolved oxygen (mg l^{-1})	9.43	4.88	7.30	1.78	18.28	8
7	Free CO_2 (mg l^{-1})	11.75	0.00	2.60	4.19	78.58	-
8	Total alkalinity (mg l^{-1})	177.25	145.50	162.46	9.53	1.90	-
9	Total hardness (mg l^{-1})	183.50	144.00	165.21	12.82	2.17	300
10	Total Dissolves solides (mg l^{-1})	273.51	187.51	234.90	30.00	2.33	500
11	Orthophosphate (mg l^{-1})	0.27	0.15	0.19	0.05	112.56	-
12	Nitrate- nitrogen (mg l^{-1})	0.51	0.36	0.44	0.05	49.19	-

The free Carbon dioxide dissolved in water is the source of carbon that can be assimilated and incorporated into the living matter of all aquatic autotrophs [14]. During the present study free carbon dioxide was present in some months. However, the average value of free CO_2 was 2.60 mgl^{-1}.

Total alkalinity is the measure of the capacity of water to neutralize a strong acid. It is generally imparted by the salts of carbonates, bicarbonates, phosphates, nitrates, borates, silicates etc. together with the hydroxyl ions in free-state. During the present investigation average total alkalinity was found 145.50 to 177.25 mg l^{-1}. Fluctuations in alkalinity might be due to alkaline particles and low production of plankton [6]. Average orthophosphate was 0.19 mg l^{-1} during the present investigation which is coinciding to the observations of other authors [1, 22].

In the present investigation average nitrate value was 0.44 mg l^{-1}. These higher values of nitrates may be due to agriculture runoff from catchment area as well as possible urban sewage in water near B and C stations. Ujjania [26] in Mahi Bajaj Sagar reservoir were similar to the present investigation.

The statistical correlation were observed that water temperature, dissolved oxygen, had a significant positive relation with between EC, free CO_2, total alkalinity, total hardness, orthophosphate. However, negative correlations were also observed during the study period with transparency, nitrate-nitrogen.

4. Conclusion

In any aquatic ecosystem limnological characteristic can affect both fauna and flora. Biodiversity contribute both directly and indirectly to human beings such as food for good health, livelihood, security, social relationship, life and freedom for choice etc. During last few decades' people's interference with aquatic ecosystem and over exploitation of natural resources has resulted in adversely affecting the biodiversity.

From the present investigations, it may be inferred that physico-chemical characteristics of Lake Pichola water varied considerably and comparable to the other freshwater bodies. The results depict that the water of Pichola Lake is adequate with respect to essential nutrients necessary for primary producers which in turn is favorable and conducive for better fish growth and production. All the physico-chemical parameters in general appeared within permissible limits prescribed by different researchers. Hence, it can be inferred that the Pichola Lake is suitable for drinking, irrigation, pisiculture etc. These findings can be useful for the management and conservation of Lake and its fisheries.

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