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Limnological and Microbiological Study of Jaisamand Lake, Alwar (Raj.)

Dr. Brij Mohan Singh

Associate Professor, Department of Zoology, S. K. Govt. Girls College, Sikar (Rajasthan)

E Mail –(1) singhbrijmohan@yahoo.com, (2) bmsingh19@gmail.com

ABSTRACT

This paper deals with the study of physico-chemical and microbiological parameters of Jaisamand Lake, Alwar. The Jaisamand Lake is the source of irrigation and drinking water for nearby rural areas. The lake has been arising out from the overflow of Siliserh Lake and Ruparail River. Monitoring physico-chemical and microbiological quality of water of this lake has been assessed by observing physical, chemical and bacteriological parameters during the year of 2017-18. High values of temperature, pH, free CO_2, BOD, COD, TDS, TSS, alkalinity, total hardness, Chloride, , Phosphate, Nitrate, Sulphate, the standard plate count (SPC), total coliform, faecal coliform bacteria and low visibility, dissolved oxygen and low Fluoride level gives clear indication of poor quality of water.

INTRODUCTION

Jaisamand Lake was constructed by Maharaja Jai Singh in 1910 AD. It has an earthen embankment of 10.6 meter height and 1.671 kilometers length. The lake has an average depth of about 8.3 feet during post monsoon period. Its productive area is of 500 hectare and average rain fall is 550 mm/year. The water of this reservoir has been used for irrigation and drinking purpose since last 100 years. Disposal of domestic wastes in this lake causes undesirable change in physico-chemical and biological characteristics of water. The pollution of surface water by discharge from human activities is one of the major environmental problems. Organic enrichment of these water bodies results in to high oxygen demand which results low dissolved oxygen in water. An estimation of bacterial production is a crucial step in understanding quantitatively the function and contribution of bacteria in material cycling within given aquatic habitats (Azam *et al*., 1990).

Assessment of indicator bacteria namely coliform is a convenient way to evaluate sanitary condition of any water body in which fishing is being done (Pandey and Pandey, 2000). Freshwater fishes are facing a major challenge due to indiscriminate use of different types of pesticides in agriculture. Majority of studies in this line have been done in piscine, avian and mammalian system. A considerable amount is still remains to be understood regarding the impact of microbiological parameters. No systematic study have been yet made on the physico-chemical and bacteriological parameters of this lake. The present study is an attempt to find out limnological and bacteriological parameters of the Lake so that it would be significant to combating the problems associated with public health.

STUDY AREA

For analysis of quality of water, 4 sites have been selected in the lake. Samplings at different sites were made at monthly intervals from July, 2017to June 2018.

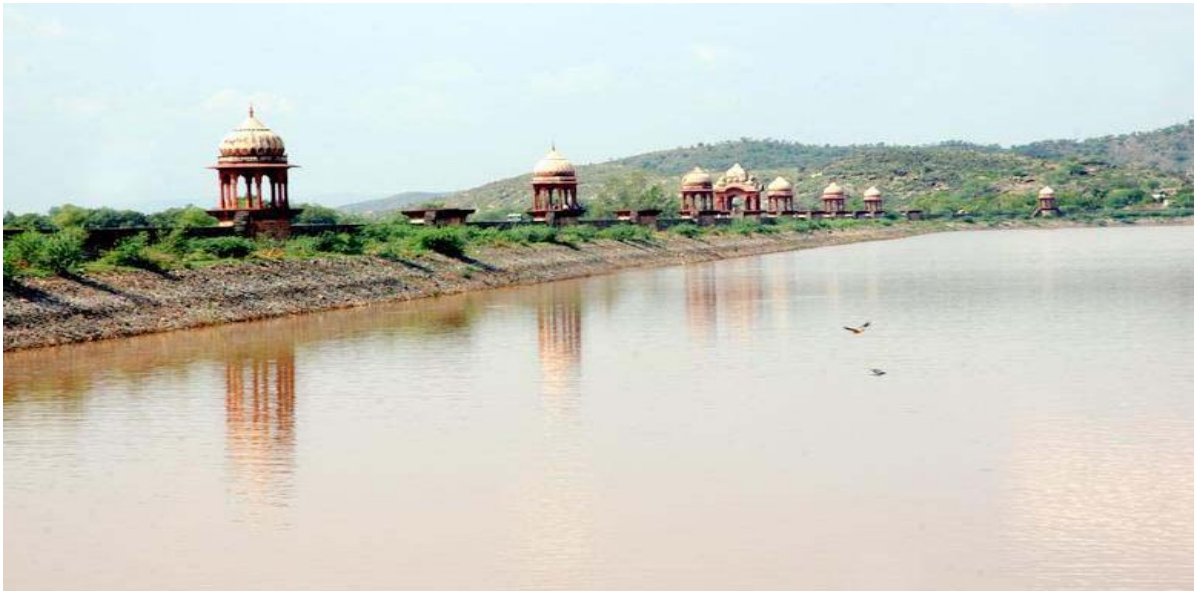

Fig.1 : Jaisamand lake, Alwar

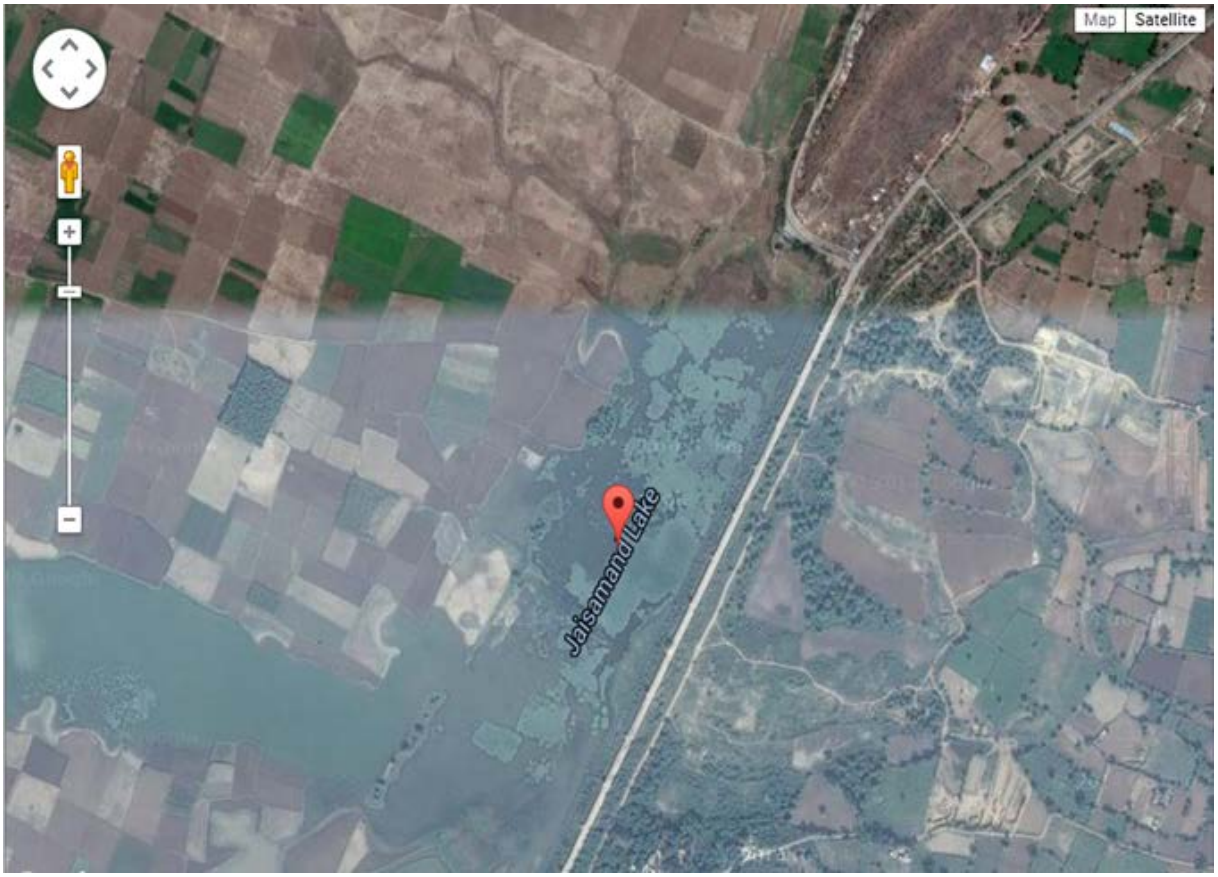

Fig:2 Satellite map of the lake

Meteriological and geological data of dam on the lake

Attribute		Values
Completion year:	:	1910 AD
River	:	Banganga/ Ruparail
Dam type	:	Earthen/Gravity/ Masonry
Purpose of construction	:	Irrigation
Latitude	:	27.492519/ 27^0 $29'$ $33''$ North
Longitude	:	76.585666/ 76^0 $35'$ $83''$ East
Average rain fall	:	550 mm/year
Length of Dam	:	1671 meter
Height of Dam	:	10.6 meter
Designed flood	:	410 Cumec
Seismic Zone	:	III level
Gross storage capacity at FRL:		26.95 mcm
Live storage capacity	:	24.91 mcm
Dead storage capacity	:	2.04 mcm
Maximum depth	:	26 feet
Average depth	:	8.3 feet
Submerged area	:	10, 000 hectare
Basin name	:	Ganga
Distance from main city	:	6 kms

MATERIAL AND METHOD

The water samples from the Lake were collected in pre-washed and well dried glass bottle. The bottles were ringed three times with sample water. The sample water were taken from the surface at a depth of 6-9 inches from four different points, integrated and a representative samples were drawn. The samplings were carried out in the every months of July, 2017 to June, 2018. The temperature of the air 3 feet above the surface of water was measured with mercury thermometer. The water samples were immediately brought in to laboratory for the estimation of

various parameters. The pH was measured in laboratory by the Philips digital pH meter. Conductivity was measured with Orion-115 conductivity meter. Total dissolved solids (TDS) were measured by 100 ml of water sample dried on a hot plate in a pre weighed china dish. The china dish was again weighted to calculate the total dissolved solids per litre of sample by applying the formula

$$TDS = \frac{W2-W1}{V} X\ 1000$$

Where, W_2 – weight of china dish after evaporating the total volume to dryness

W_1 – weight of empty china dish

V- Volume of sample evaporated to dryness

Total hardness and alkalinity were determined with titration with EDTA, and hydrochloric acid. Free CO2 and chloride were determined by titrimetric method. Dissolved oxygen by curing Wrinkler`s azide modification method. Spectrophotometer was used to determine phosphate and nitrate level. Sulphate was determined by Persulphate acid digestion method. For bacteriological examinations samples were collected in 125 ml pre-sterilized (at 121°C) borosil bottle and analyses was carried out within 6 hours of sample collection using standard methods outlined in WHO (2005), Trivedi *et.al.*, (1987), APHA (1989), Pandey and Sharma (2003). Standard plate counts (SPC) for assessing bacterial load was made by pure plate technique. Total and fecal coliform was determined by multiple tube fermentation technique (MTF technique) using McConkey broth media.

RESULT AND DISCUSSION

Table 1 : The following data were collected from July, 2017 to June,2018

SN	Parameters ↓	July 17	Aug 17	Sept. 17	Oct. 17	Nov 17	Dec 17	Jan. 18	Feb. 18	Mar. 18	Apr. 18	May 18	June 18
1	Temp °C	23.2	22.6	21.6	20.9	19.2	18.0	17.9	21.6	28.2	29.9	31.2	31.7
2	pH	7.2	6.8	7.3	7.6	8.1	6.9	7.4	7.0	8.3	8.2	8.3	8.3
3	Transparency	60.75	61.75	58.5	92.5	82.5	67.25	12.0	10.5	9.75	7.5	6.0	9.5
4	Conductivity µs cm^{-1}	203	186	171	182	167	122	146	165	155	176	166	180
5	DO	9.04	8.79	9.05	8.82	6.40	5.21	8.85	9.06	12.5	15.1	15.5	11.19

	mg/lit.												
6	Free CO_2 mg/lit.	8.8	6.0	22	13.2	15.4	28.6	30.2	3.5	4.2	4.4	3.4	7.6
7	BOD mg/lit.	3.2	3.5	10.2	7.6	6.4	12.2	12.0	8.5	5.2	2.8	2.2	1.6
8	COD mg/lit.	4.8	4.5	3.9	5.5	7.3	10.6	9.7	9.9	7.4	5.3	2.2	2.3
9	TDS mg/lit.	714	803	758	685	692	733	301.1	1201.1	1501	1586	1713	2075
10	TSS mg/lit.	125	200	70	62	25	62	54	154	133	128	163	169
11	Alkalinity mg/lit.	366	445	788	766	486	555	444	463	580	676	787	790
12	Hardness ppm	196	195	199	169	183	198	196	203	206	210	223	235
13	Chlorides mg/lit.	512	549	455	550	590	362	256	245	268	266	248	256
14	Fluoride mg/lit.	0.012	0.001	0.012	0.008	0.005	0.008	0.004	0.005	0.012	0.010	0.008	0.007
15	Phosphates mg/lit.	953	706	443	546	776	493	466	560	233	320	441	646
16	Nitrate mg/lit.	4.333	3.467	4.533	4.411	3.867	2.633	9.67	9.07	4.85	5.52	6.97	6.23
17	Sulphate mg/lit.	88.2	112	107.5	98.0	72.6	65.6	66.6	114.2	157.7	182.3	204	246
18	SPC (Standard plate count)	$58x10^3$	56 $x10^3$	46 $x10^3$	43 $x10^3$	39 $x10^3$	$35x10^3$	38 $x10^3$	42 $x10^3$	42 $x10^3$	48 $x10^3$	49 $x10^3$	47 $x10^3$
19	Total coliform Per ml	2400	2385	2140	1866	1212	748	885	1003	1262	1569	1499	1609
20	Faecal coliform per ml	2303	2400	2215	1602	798	340	297	333	369	1026	265	445

Temperature: The most common physical assessment of water quality is the measurement of temperature. Temperature impacts both the chemical and biological characteristics of surface water. The temperature of this lake was fluctuated between 17.0 (in January) to 28.9 ˚C in June 2018. Higher temperature in June,18 was probably due to the increase load of suspended solids, soil particles and decomposed organic matter in the lake because they absorb more heat and along with the exposure of scorching heat on less amount of water.

pH- The pH exhibit slightly acidic and alkaline in nature and ranged between 6.8 to 8.3 ˚C. Minimum pH was found in July, 2017 and January, 2018, and maximum in march, may and June, 2018. This was probably due to much more concentration of OH^- ions released from the

dissociation of alkaline salts. High pH induces the formation of tri halomethanes which are toxic (Kumar *et al.*2010). Acidic nature of lake water in monsoon and winter could be attributed to reduced photosynthetic activity.

Transparency- The unique triangular size 20 cm black and white painted disc immediately disappears on immersion indicating zero or nil transparency. It may due to hyper turbidity and salinity of the lake.

Electrical conductivity- Electrical conductivity is measure of total amount of ions in the water body and therefore serves as a useful indicator of its chemical richness. Specific conductance in the lake water indicates its resistance to electrical flow, declining with increasing ionic content of the lake water. EC in the lake water ranges from 122 µs cm^{-1} (Dec, 17) to 203 µs cm^{-1} (July, 2017). High value of EC during summer indicating exceptionally high amount of dissolved ions in the lake water.

Dissolved Oxygen - The dissolved oxygen content of water indicates health of an ecosystem and provides a broad indicator of water quality. The value of DO range from the table is 5.21 to 15.5 mg/litre. The decomposition and oxidation of organic matter reduce the solubility of oxygen in water. The low value during the monsoon may be due to high load of suspended particles, soil particles; decomposed organic matter which reach the water and reduce the penetration of light that in turn lowers the photosynthesis. The deficiency of the oxygen in the water is shelter for bacteria and other pathogens, which are anaerobic and injurious to human health. In winter O_2 holding capacity of water increases, may be due to its high solubility at low temperature and less degradation of organic matter. Similar results were also reported by Singh Brij Mohan and Sharma Ramesh Chandra (2014).

Free Carbon dioxide- Free CO_2 is one of the essential constituents of an aquatic ecosystem. The abundance of CO_2 exerts certain specific effects on aquatic biota. During the study period, the value of free Carbon dioxide varied between 3.4 (May, 2018) to 30.2 mg/litre (Jan., 2018). Carbon dioxide exhibited an inverse relation with dissolved oxygen. A gradual rise in dissolve oxygen and fall of free carbon dioxide level had probably disrupted the equilibrium between these two gases. Cole (1975) noted that free CO_2 supply rarely limits the growth of phytoplankton. Alternately the bicarbonates are utilized as a source of carbon by the photosynthetic activity of phytoplankton.

BOD (Biological oxygen demand) - BOD represents the amount of oxygen that microbes need to stabilize biologically oxidizable matter. It is found to be more sensitive test for organic pollution. BOD value of the lake water ranged between 1.6 to 12.2 mg/lit. Highest BOD (12.2mg/lit.) was observed in winter (Dec, 2017) and lowest was in June, 2018. Increased temperature and sedimentation load reduce BOD (Pyatkin and Krivoshein, 1980). According Indian standards, desirable limit of BOD is 4.0 mg/l. and permissible limit is 6.0 mg/l. Biological oxygen demand below 3 mg/l or less is required for the best use.

COD (Chemical Oxygen Demand) - The estimation of COD is of great importance of waters having unfavourable conditions for the growth of microorganisms. The COD values ranged from 2.2 to 10.6 Mg/litre. Its higher value during winter may be due to higher organic load.

TDS (Total Dissolved Solids) – water, the universal solvent has large number of salts dissolved in it, which largely govern the physicochemical properties and inturn have an indirect effect on aquatic organisms. The total dissolved solids fluctuated in this lake were between 302(Jan, 2018) to 2085 mg/litre (in June, 2018) which show hard water character. This observation is supported by the study of Sumitra *et al.*(2007). Higher concentration of TDS may also due to discharge sewage and organic matter by interference of man. WHO has 500 mg/l as maximum tolerance limit for TDS.

TSS (Total Suspended Solids)- TSS include things such as mud, algae, detritus and faecal material. The range of TSS between 25 to 2075 mg/l. , which indicates high level of turbidity and contamination of the lake. Low level of suspended solids (< 25 mg/litre, Maitland ,1990) are desirable for fish culture as high level of turbidity affects photosynthetic process and high particulate matter clogs fish gills (Sachidanandamurthy and Yajurvedi, 2005). The amounts of the suspended solids in the lake were not within the permissible limit as per Indian standard (i.e.1000 mg/l).

Alkalinity – The total alkalinity fluctuated between 368.5 to 789 mg/ litre throughout the year, with the highest value in the month of June 2018. According to ISI, permissible limit of alkalinity in the water is 600 mg/l. The alkalinity in water is caused by carbonate, bicarbonate and hydroxyl ions. Carbonate alkalinity is an environmentally critical parameter in maintenance of buffering capacity of aquatic life forms. It had been assumed that in tandem with pH which has a complex interrelationship, is responsible for poor species diversity in aquatic life forms, including total absence of large crustaceans, brachiopods, decapods (Prawn, Shrimp etc.). Due to alkalinity value correlate positively with the pattern of rainfall and this implies that surface run-off from the Silisher Lake contains substances which contribute to alkalinity.

Hardness- The mean value of hardness has been found to vary between 169 (October, 2017) to 235 ppm (June, 2018) which show in the desirable limit as per Indian standard (ICMR,2006). Total hardness of water is due to the presence of bicarbonate, sulphate , chloride, and nitrates of Ca and Mg (Kumar *et al.* 2010). Maximum permissible limit for total hardness is 600 mg/l as per Indian standard. The higher hardness may be ascribed to accumulation of dissolved materials due to increasing pollution from tourist wastage of eatables and surrounding domestic sewage. Hardness has got no adverse effect on human health. Water with hardness above 200 mg/l may cause scale deposition in the water distribution system and more soap consumption.

Chloride- The mean value of chloride content in the lake is 379.75mg/litre. The peak chloride values during the early monsoon tend to increase sharply till the post monsoon approaches. The peak chloride value can be attributed to the surface run off, rich in animal origin and organic waste. Kavita Sahni and Pooja Solutia(2011) have also found similar results during the study on Mansagar Lake, Jaipur.

Fluoride- In the present study, the values of fluoride varied between 0.001 to 0.012 mg/l. The fluoride level is very low in the lake water. The mean value of fluoride content in the lake is 0.00775 mg/lit. This level is not harmful to the aquatic life which is much less than normal level of fluoride standard (1.5ppm) determined by WHO. Gupta and Verma (2007) in their study on Deeg town, Bharatpur, observed fluoride to range between 2.11 to 2.27 mg/l in PHED water supply. Fluoride showed positive correlation with depth of visibility, pH, dissolved oxygen, total

hardness, nitrate, phosphate, GPP and NPP. Trophic status of an ecosystem depends upon rate of energy flow which may be assessed by estimating primary production.

Phosphate- Phosphate value was estimated and ranged between 233 to 953 mg/lit. Indicating good biotic utilization by the variety of aquatic biotic life forms and that it is not a limiting factor to biological growth in the lake. Further phosphate values indicate eutrophication trends in the lake.

Nitrate- In most of the natural aquatic ecosystems often nitrogen is a limiting factor to plant production. The range values of nitrates recorded were 2.63 to 9.67 mg/lit. The natural concentration rarely exceeds 10 mg/lit. (Lind, 1979).

Sulphate- Sulphate (So_4^{-2}) is a major anion abundant in freshwater lake. Sulphate ion concentration was minimum (65.6 mg/l) in rainy and winter season and maximum (246 mg/lit.) in summer. Water bodies located in arid and semiarid zones of Rajasthan are rich in sulphate (Ranu, 2001). Concentration of sulphate has laxative effect which is enhanced when sulphate is consumed with magnesium. Water containing $MgSO_4$ (1000 mg/l) acts as purgative in human adult.

MICROBIAL STATUS

The coliform bacterium is the primary bacterial indicator for fecal pollution in water. As per the results of present study shown in table no.-1, all the microbial parameters were found low range than laid for fresh waters by CPCB (Trivedi *et al.,* 1987). The maximum number of Total coliform was found to be 2400/ 100ml in july,2017 and the minimum number of total coliform were found to be 748/100 ml in Dec, 2017. The maximum numbers of faecal coliform were found to be 2400/100 ml in Aug, 2017 and the minimum number of faecal coliform were found to be 265/100 ml in May,2 018. It is observed that the trends in table 1 indicate higher bacterial population with the commencement of monsoon and relatively lower bacterial density during winter. This is in conformity to observations of Singh (1985) , Patralek (1992), Parihar *et al.* (2003) and Mohan *et al.*, (2007) .

The fairly high values of total coliform and faecal coliform are indicative of increasing microbial pollution of the lake by organic means particularly through the discharge of sewage and domestic effluents in to the lake. The total coliforms and faecal coliform were found maximum in monsoon which is due to mixing of discharge of excreta. Therefore a potential health risk exists due to presence microbial pathogen in water.

Table 2: Suggested values of coliform/100ml for beneficial use of water (Pandey and Sharma, 1999).

SN	Quality	Grade	Bathing and swimming	Public water supply
1	Excellent	I	<10	<100
2	Good	II	4	200

3	Satisfactory	III	250	800
4	Poor	IV	1500	1000
5	Unacceptable	V	>6000	>8000

Abbreviations

1. MPN- Most probable Number

2. SPC- Standard Plate Count

3. FCC – Faecal coliform count

4. FSC – Faecal streptococcus count

5. TCC - Total Coliform count

CONCLUSION

The conclusion from the present investigation may be drawn that maximum parameters were present at the level of pollution except few ones like fluoride in the lake water. Jaisamand Lake is going to be contaminated day by day with human activities and ultimately eutrophication affects aquatic life, unsafe for human use. Excessive silting ultimately leads extermination of the lake. The result of bacterial parameter studies exceeds the drinking water permissible limits suggested by WHO, ICMR and ISI. Therefore water from this lake is very unsafe and must be used only after suitable treatment process.

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