Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 11 [11] October 2022 : 86-94

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD

ORIGINAL ARTICLE **OPEN ACCESS**

Assessing the water quality of GudaBishnoiyan Pond, Jodhpur, using Water Quality Index (WQI)

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ABSTRACT

Rapid industrialization, population growth, etc. have deteriorated the water quality thus making the availability of fresh water critical. There are about 19 water bodies in and around Jodhpur and GudaBishnoiyan pond is one of them, about 25 km away from Jodhpur. It was declared Wildlife Conservation Reserve by forest department in 2011 and is home to many migratory birds. Water of this pond was analyzed for 11 physico-chemical parameters namely pH, water temperature, total dissolved solids (TDS), dissolved oxygen, conductivity, nitrate, total phosphate, chloride, calcium, total alkalinity and total hardness using the standard methods from June 2019 to March 2020 by collecting the samples monthly from three stations. pH ranged from 10.37 to 7.67, TDS ranged between 610-129 ppm, Dissolved oxygen ranged from 7.6 to 0.37 mg/l, conductivity ranged from 12600 to 234 µS/cm, total alkalinity ranged from 163-73 ppm of $CaCO_3$, total hardness was found between 180.2-11.26 ppm of $CaCO_3$, calcium ranged from 553.66 to 21.36 ppm, chloride was found between 85.18 to 13.43 mg Cl^-/l, nitrate from 15.45 to 0.013 µgm/l and phosphate ranged from 0.76 to 0.0021 µgm/l. WQI (water quality index) of this pond (after pooling the data of all three stations) was found to be 86.73 which indicates very poor quality of water.

Keywords – Jodhpur, GudaBishnoiyan pond, migratory birds, physico-chemical parameters, water quality index (WQI).

Received 14.09.2022 Revised 30.09.2022 Accepted 14.10.2022

INTRODUCTION

Water, is a precious gift of nature to human being. Fresh water is most crucial part of environment and is essential for the living being. But the total fresh water is only about 2.5% of all water of the earth that makes it a scarce resource. Rapid industrialization along with speedy population growth has made tremendous pressure on the demand of fresh water for the last few decades. The bird distribution is affected by various factors like the food availability, size of wetland and the abiotic factors in the wetlands. For understanding the metabolic events in aquatic ecosystem, study of various physico-chemical parameters is very important as they influence each other; govern distribution and abundance of fauna and flora.

The proposed research work is an attempt to study the different physico-chemical parameters of the Guda Bishnoiyan pond, and assess its quality by calculating water quality index (WQI).

MATERIAL AND METHODS

Rajasthan is situated in North Western parts of India and is the largest state of India with area of 3,42,239 sq km between 23° 30' and 30°11' North latitude and 69°29' & 78°17' East longitude.

Jodhpur is 2nd largest city of state Rajasthan. It was named after its founder Rao Jodha and is also known as Suncity. It is situated in western part of Rajasthan about 300 km away from the border with Pakistan, covers 11.6% of total arid zone of Rajasthan. It lies between 26.28°N and 73.02° E, 231 m above sea level. GudaBishnoiyan pond (Jodhpur) is about 25 km from Jodhpur and 2 km from GudaBishnoiyan village. The pond (Fig 1) lies between latitude 26º 08' 09.8" N and longitude 73º 06' 13.8" E. This pond was declared GudaBishnoiyan Conservation Reserve by forest department in 2011 and has an area of approximately 5.2 hectare.

Physico-chemical parameter analysis

Water of this pond was analyzed for eleven physico-chemical parameters namely pH, water temperature (at site using portable pH meter and thermometer), total dissolved solids (TDS), conductivity (by water analysis kit Systronics model No 371), dissolved oxygen (Winkler method), nitrate (Mullen and Riley method), phosphate (stannous chloride method Murphy and Riley), chloride(argentometric titration method), calcium (flame emission photometric method), total alkalinity (titration method) and total hardness (EDTA titrimetric method) from June 2019 to March 2020 by collecting the samples monthly from three stations namely A,B and C.

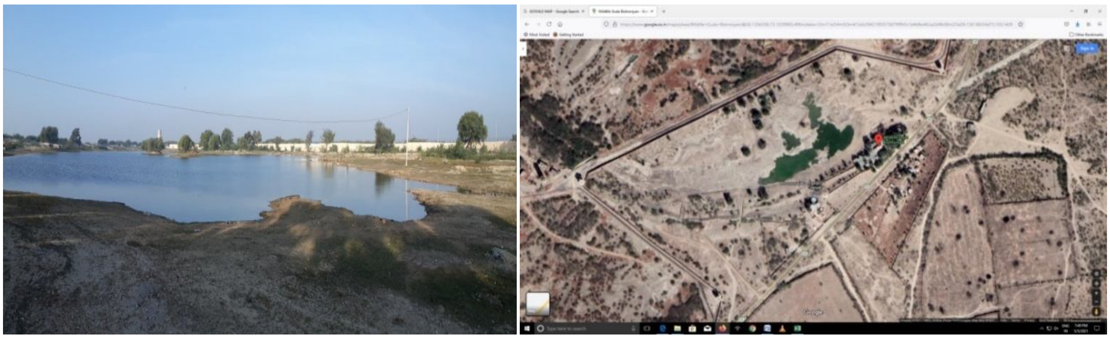

Fig 1. Study area - GudaBishnoiyan pond, Jodhpur

Calculation of water quality index

The calculated values were compared with standards recommended by the World Health Organization (WHO) and Bureau of Indian Standards(BIS). The weighted arithmetic index method [1] was used for the calculation of water quality index in the following steps-

Calculation of Sub Index of Quality Rating (q_n):- The value of q_n is calculated using the following expression.

$q_n = 100 (V_n - V_{io})/(S_n - V_{io})$

Where: q_n =quality rating for the n^{th} water quality parameter.

V_n =estimated value of the n^{th} parameter at a given sampling station.

S_n = standard permissible value of the n^{th} parameter.

V_{io}= ideal value of the n^{th} parameter in pure water.

All the ideal values (V_{io}) were taken as zero for drinking water, except for pH=7.0 and dissolved oxygen=14.6mg/L [2]

Calculation of Unit Weight (W_n):-

Calculation of unit weight (W_n) for various water quality parameters are inversely proportional to the recommended standards for the corresponding parameters.

$W_n = K/S_n$

Where: W_n= unit weight for the n^{th} parameters.

S_n= standard value for the n^{th} parameters.

K=constant for proportionality.

Calculation of water quality index:

The overall water quality index was calculated by aggregating the quality rating with the unit weight linearly.

$WQI = \Sigma\, q_n W_n / \Sigma\, W_n$

RESULTS AND DISCUSSION

Various physico-chemical parameters were analyzed for the surface water takingmonthly samples from three stations namely A, B and C. Following results were observed:

Water temperature

Water temperature is an important limnological parameter which greatly influences the distribution of autotrophs and heterotrophs in a pond ecosystem. Water temperature was found to be highest at all the three stations being 32°C in August 2019, and was lowest in December 2019 being 18.9, 18.9 and 19.6°C at station A,B and C respectively (Fig 2).The ideal water temperature for biological activities of microorganisms is 20-25°C. Boyd [4] reported the optimum range of water temperature between 25-32°C for tropical climate of a fishpond. Rise in temperature speed up the biochemical reactions and reduce the solubility of gases[5]. Due to the smaller size of the pond, quick reaction to atmospheric temperature changes was noticed[6].Higher temperature in the summer was probably due to greater solar radiations, longer day length, clear atmosphere, and comparatively low water levels.

pH

pH was highest at all the three stations being 10.2,10.28, and 10.37 in December 2019 while lowest was observed in June 2019 (7.67 station A), and in September 2019 (8.18 station B, 8.17 station C). pH was alkaline throughout the study period at all the three stations. (Fig 2)The higher range of pH indicates higher productivity of water [7]. The minimum pH in the summer can be attributed to low photosynthesis due to the formation of carbonic acid [8]. Extremes in pH are stressful along with causing deadly effects to aquatic organisms. Levels of pH too high (> 9) or too low (< 5) can kill aquatic life [9]. The higher values of pH in winter season can be attributed to decreased temperature and high values of dissolved oxygen[10].

Dissolved oxygen

Dissolved oxygen was found to be highest at station A being 7.6 mg/l (June 2019), at station B being 6.12 mg/l (December 2019) and 7.42 mg/l(December 2019) at station C. It was lowest in July 2019 being 0.3712 mg/l, 2.04 mg/l and 11.64 mg/l at station A,B and C respectively. (Fig 2)

The maximum dissolved oxygen was recorded during the winter (station B and station C). High values of dissolved oxygen during winter seasons was due to low temperature and high photosynthetic activities and low values of dissolved oxygen in July 2019 at all the three station was due to high temperature and high rate of oxidation of organic matter. The variation of dissolved oxygen in water depends upon the temperature of the water body, which influences the oxygen solubility in water[5]. Low dissolved oxygen in the summer could be the function of higher water temperature and decomposition of organic matter [11-13],decrease in oxygen holding capacity [14], increased day length and light intensity which after acquiring the optimum values, start acting as limiting factor for photosynthesis and hence decreases oxygen production. Dissolved oxygen is known to affect such attributes as growth, survival distribution, behavior and physiology of aquatic organism [15].

Total Alkalinity

Total Alkalinity was found to be highest at station A being 149mg/l (June 2019), at station B being 163mg/l (December 2019) and 151mg/l at station C (December 2019). It was lowest being 74mg/l at station A(November 2019), 73mg/l at station B (September 2019), and 76mg/l at station C (September 2019). (Fig 2)

"High alkalinity is a function of ion exchange that is calcium ions are replaced by sodium ions and later contributed to alkalinity"[16]. Higher values of alkalinity registered during summer might be due to the presence of an excess of the free CO_2 product as a result of decomposition process coupled with the mixing of domestic waste[17].Evaporation and decomposition of organic matter, photosynthesis, denitrification etc. are the main factors for increasing alkalinity whereas nitrification, respiration etc. are the main factors for decreasing alkalinity [18]. Low alkalinity during autumn may be due to dilution of water [19]. A total alkalinity of > 20 mg/l is necessary for good community production [20]. The "reservoir can be categorized as rich nutrient water body"[21] and highly productive [22].

Total Hardness

Total Hardness was high in October2019 at station A and station B being 150 and 180.2 mg/l respectively. At station C it was high in November 2019 being 180.2 mg/l. Lowest values were observed at all the three stations in June 2019 being 11.26, 18.02, and 18.77 mg/l at station A, B and C respectively. (Fig 2)

The capacity of water to form precipitates with soap is measure of its hardness which is mainly due to the metallic ions like Ca^{2+} and Mg^{2+} although Fe^{2+} and Sr^{2+} are also responsible. The metals are usually associated with HCO_3^-, SO_4^{2-}, Cl^- and NO_3^-.Although hardness of water cannot be referred as a pollution parameter butit indicates about the quality of water. Waters are often categorized according to degrees of hardness [23]. Higher values of hardness were observed during winter months which may be due to low water level and high rate of decomposition, thus, concentrating the salts[23]. Aquatic ecosystems with high hardness indicate eutrophication [24]. Sawyer [25] classified water on the basis of hardness into three categories that is, soft (0.00 - 75 mgl^{-1}), moderately hard (75.00 - 150.00 mgl^{-1}) and hard (151.00 - 300.00 mgl^{-1}).According to this classification, GudaBishnoiyan pond(average total hardness of all the three station clubbed is 90.24 mg/l)falls in the category of moderately hard water body.

Nitrate

It was highest being 15.45μgm/l and 4.62 μgm/l in July 2019 at station A and station B respectively.At station C it was highest being 6.25μgm/l in June 2019.Nitrate was lowest being 0.2 μgm/l and 0.15 μgm/l at station A and station B respectively in February 2020. At station C it was lowest in September 2019 being 0.013 μgm/l (Fig 3)

Most of the natural waters are deficient in nitrate and have a concentration usually below 5 mg/L, but certain polluted surface water and ground water may have substantially higher quantities. The nitrate has gained major significance because of its implication in infant methaemoglobinaemia [26], a diseases characterized by bluish colouration of skin. In this disease, the normal hemoglobin is converted into met

hemoglobin (methaemoglobin) due to conversion of some or all of the four iron species from the reduced ferrous (Fe^{2+}) state to the oxidized ferric (Fe^{3+}) state, and thus loses its capacity to carry oxygen[26].
The concentration of nitrates is used as indication of level of micronutrients in water bodies and has ability to support plant growth. Growth of phytoplankton is favored by high concentration of nitrate.Eutrophication is usually the result of nitrate and phosphate contamination and is a significant reduction of water quality [27].
The highest amount of nitrate was recorded during monsoon season (June –July 2019, 4.62 to 15.45 µgm/l) due to the possible influx of nitrogen rich water into the pond water from the nearby catchment area areas.

Phosphate

Phosphate was found to be highest at station A being 0.76 µgm/l, at station B being 0.342µgm/l, and 0.6697 µgm/l at station C in month of July 2019.lowest phosphate was observed at station A in December 2019 (0.0031 µgm/l), at station B and station C in March 2020 (0.0021 and 0.0021 respectively) (Fig 3).
Phosphorus in natural waters & wastewaters is usually found in the form of phosphates (PO_4^{3-}).Phosphorus is an essential nutrient for the plants and animals that make up the aquatic food web. Phosphorus is an essential element for plant life, but excess amount of phosphorus in water accelerate problem such as eutrophication [28,29].
The maximum values of phosphate were observed in rainy season and minimum in summer season (except at station A when it was observed in December 2019). Abdar[30] also observed the higher concentration of phosphorus during monsoon months and lower during summer months. The concentration of phosphate decides the amount of algae and the later influences abundance of zooplankton. According to Nagarajan and Thiyagesan[31] the level of phosphate in the water body might affect the availability of prey and this determines the selection of habitat by winter water birds. Natural decomposition of rocks and minerals, agricultural runoff, erosion and direct input by animals/ wildlife are sources of phosphate contamination in water, while point sources are sewage effluents and industrial discharges. The level of phosphate above the permissible limit might harm or damage organs like kidney and might also causes osteoporosis [32]). Phosphorous is recognized as the limiting nutrient in most of the water bodies. Hence, eutrophication and water quality require limiting the entry of the phosphorous [33].

Chloride

It was highest at all three stations being 79.92 mg/l, 82.79 mg/l, and 85.18 mg/l in February 2020. Lowest values were observed at station A and station B in July 2019 being 23.45 mg/l and 13.43 mg/l respectively. At station C it was observed in June 2019 being 20.57 mg/l. (Fig 2)
Chloride is present in all natural water bodies, but its high concentration is an indication of pollution coming from sewage, or industrial effluents. Chloride concentration is used as an important parameter for the detection of contamination by sewage. It occurs as NaCl, $MgCl_2$ and $CaCl_2$ in natural water [34]. The ecological significance of chloride lies in its potential to regulate salinity of water[35]. High chloride content in the water during winter may be due to low volume of water in the reservoir [36].The higher chloride concentrations indicate the presence of organic matter, presumably of animal origin [37],as found in February 2020 at all three stations. The lowest values of chloride were observed during monsoon season (June-July 2019) and can be connected to the dilution of lake by rain water.
Chlorides are antibiotic in nature and the presence of large amount of chloride is lethal to pathogenic bacteria and chloride around 29 mg/l is considered to be favorable for freshwater community [38].However, water becomes eutrophic due to the presence of chloride, phosphate, and nitrates. [39].

Calcium

Calcium was found highest at all three stations in June 2019 being 553.66 mg/l,534.2 mg/l and 531.9 mg/l respectively. It was lowest at all three stations in October 2019 being 24.6 mg/l, 22.21 mg/l and 21.36 mg/l respectively. (Fig 2)
It has no hazardous effects on human health, but high concentration is not desirable for washing and bathing due to non-formation of lather.Jhingran[14] suggested that calcium is one among the most abundant ions in freshwater and plays a pivotal role in shell construction, bone building and plant precipitation. Calcium functions as an indication of pollution and eutrophication [40]. According to Solanki [41] shrinkage of water volume increases the concentrations during summer as observed in present investigation.

Total Dissolved Solids (TDS)

It was recorded highest in March 2019 (435 mg/l) at station A and in June 2019 being 610 mg/l(station B) and 609 mg/l (station C). Lowest was recorded at station A in October 2019 (134 mg/l) in September 2019 at station B (129 mg/l) and in September 2019 station C (132 mg/l) (Fig 2).

The TDS in water is due to the presence of Calcium, Magnesium, Sodium, Potassium, Bicarbonate, Chloride and Sulphate ions[5]. Water at a TDS level of above 500 mg/l is unsuitable for flora and tastes unpleasant to drink[42]. Excess amount of TDS may be due to the presence of higher rate of evaporation during the summer season[43] and also by the increased amount of surface runoff [44].

Conductivity

Highest values were recorded at all three stations in June 2019 being 8820 µS/cm, 12600 µS/cm and 12600 µS/cm at station A, B and C respectively. Lowest conductivity was measured in December 2019 at all three stations being 234 µS/cm, 237µS/cm, and 239 µS/cm at station A, B and C respectively (Fig 4)

Electrical conductivity (EC) is a useful tool to evaluate the purity of water [45], and is a measure of water capacity to convey electric current. It signifies the amount of total dissolved salts [46].

It is dependent on concentration of ions and temperature of the water body. A total load of salts in a water body is directly related to its conductivity [47]. Conductivity is also regarded as an indication of freshness or otherwise of a water body [48,49]. It has been reported that high values of conductivity are an indication of pollution [49].The BIS standard for electrical conductivity is 300 µmhos/cm. Garg [50] classified conductivity value greater than 500 µmhos/cm as eutrophic.As the conductivity is directly related to the presence of dissolve salts, its magnitude can give the fair idea of the level of dissolved solids[51]. The highest electrical conductivity recorded during summer was 12600 µS/cm and lowest was observed in winter being234 µS/cm.During summer, a high level of conductivity indicates the pollution status as well as trophic levels of the aquatic body [52]. The mean value of conductivity (1711.3 µS/cm) shows that the level is high. Conductivity levels below 50 µmhos/cm are regarded as low,it is regarded as medium between 50-600 µmhos/cm while the values above 600 µmhos/cm are considered high conductivity [53,54].

Water Quality Index (WQI)

Water Quality Index is calculated by combining multiple water-quality factors into a single number by normalizing values to subjective rating curves. The WQI convert the complex scientific information of these variables into a single dimensionless number. It is an easy way to make public understand the level of pollution and can help in water quality management of any water body.

The average value of pH,calcium and conductivity (after clubbing data of station A, B and C) was more than the standard values prescribed for these parameters, while values of dissolved oxygen, total alkalinity, total hardness,nitrate, phosphate, chloride, total dissolved solids.(Table 2and Table 3).

The analysis of Guda Bishnoiyan pond, Jodhpur revealed that the WQI of the pond (calculated after clubbing data of station A, B and C reveal the value of 86.73, (Table 4) which indicate the poor quality of water and not suitable for drinking[3]

Table 1: Water Quality Index (W.Q.I.) and status of water quality [3]

Water Quality Index value	Water Quality Status
0-25	Excellent Water Quality
26-50	Good Water Quality
51-75	Poor Water Quality
76-100	Very Poor Water Quality
> 100	Unfit for drinking

Table 2: Parameter-wise W.H.O. / BIS standards

Sr.No	Parameter	WHO / BIS Standards
1	pH	7.0-8.5 (8.0)
2	Dissolved Oxygen (mg/L)	5.00
3	Total Alkalinity (mg/L)	120
4	Total Hardness (mg/L)	300
5	Nitrate (mg/l)	45
6	Phosphate (mg/l)	5
7	Chloride (mg/L)	200
8	Calcium (mg/L)	100
9	Total Dissolved Solids (mg/L)	500
10	Conductivity (µS/cm)	300

Table 3: Average measured value of different parameters at three stations

Parameter	Station A	Station B	Station C	Average
pH	8.82	9.0360	9.0630	8.9730
Dissolved Oxygen	3.86	4.5094	4.9360	4.4351
Total Alkalinity	102.5000	104.8000	104.1000	103.8000
Total Hardness	86.9500	94.9700	88.8000	90.2400
Nitrate	0.0028	0.0014	0.0016	0.0019
Phosphate	0.0001	0.00008	0.00018	0.0001
Chloride	44.1100	44.2160	42.4000	43.5753
Calcium	151.4300	148.7300	148.2780	149.4793
Total Dissolved Solids (TDS)	220.7000	238.7000	239.5000	232.9666
Conductivity	1459.5	1834.4	1840.000	1711.3

Table 4: Calculation of Water quality index (WQI)

Parameter	Measured value	Standard value	Ideal value	Unit factor	Quality rating	$q_n * W_n$
	V_n	S_n	V_{io}	W_n	q_n	
pH	8.9730	8	7	0.2159	197.3000	42.6020
Dissolved Oxygen	4.4351	5	14.6	0.3455	105.8800	36.5794
Total Alkalinity	103.8000	120	0	0.0144	86.5000	1.2452
Total Hardness	90.2400	300	0	0.0058	30.0800	0.1732
Nitrate	0.0019	45	0	0.0384	0.0043	0.0002
Phosphate	0.0001	5	0	0.3455	0.0024	0.0008
Chloride	43.5753	200	0	0.0086	21.7870	0.1882
Calcium	149.4793	100	0	0.0173	149.4790	2.5821
Total Dissolved Solids (TDS)	232.9667	500	0	0.0035	46.5932	0.1610
Conductivity	1711.3000	300	0	0.0058	570.4330	3.2846
				ΣW_n= 1.001		Σq_n*W_n = 86.8165
	$WQI=\Sigma q_nW_n/ \Sigma W_n$ = 86.8165/1.001 = 86.73					

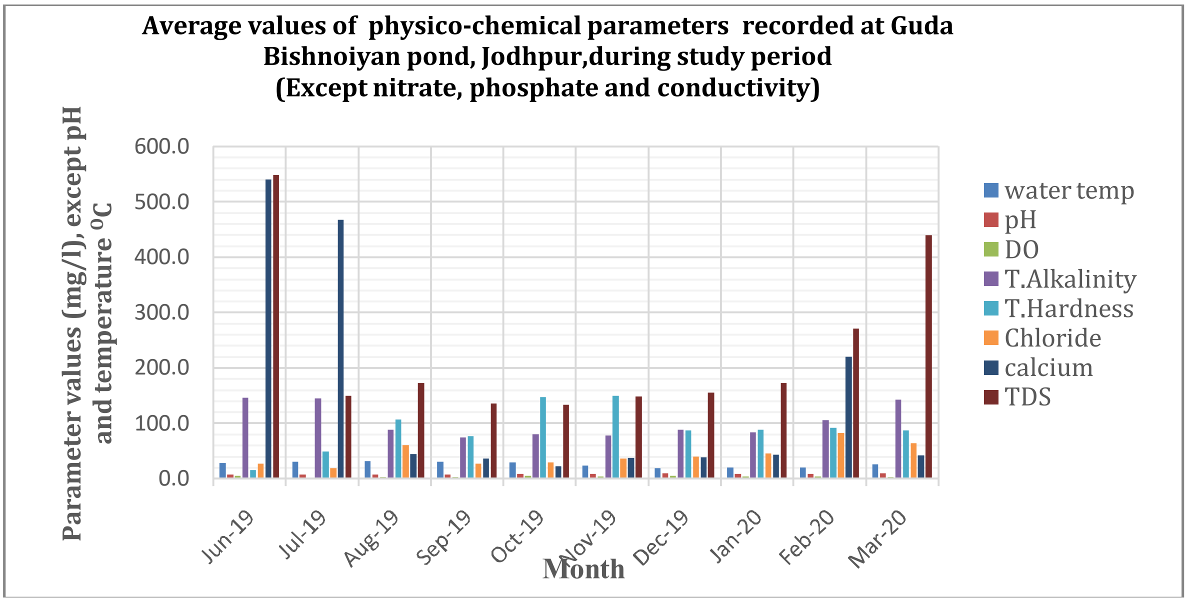

Fig 2. Average values of physico-chemical parameters recorded at GudaBishnoiyan pond, Jodhpur, during study period (Except nitrate, phosphate and conductivity).

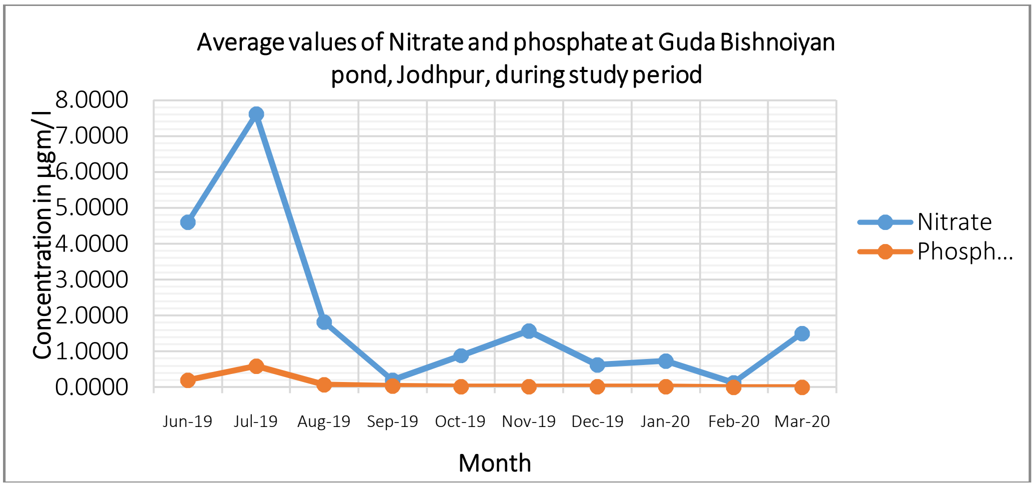

Fig 3. Average values of Nitrate and phosphate at GudaBishnoiyan pond, Jodhpur, during study period.

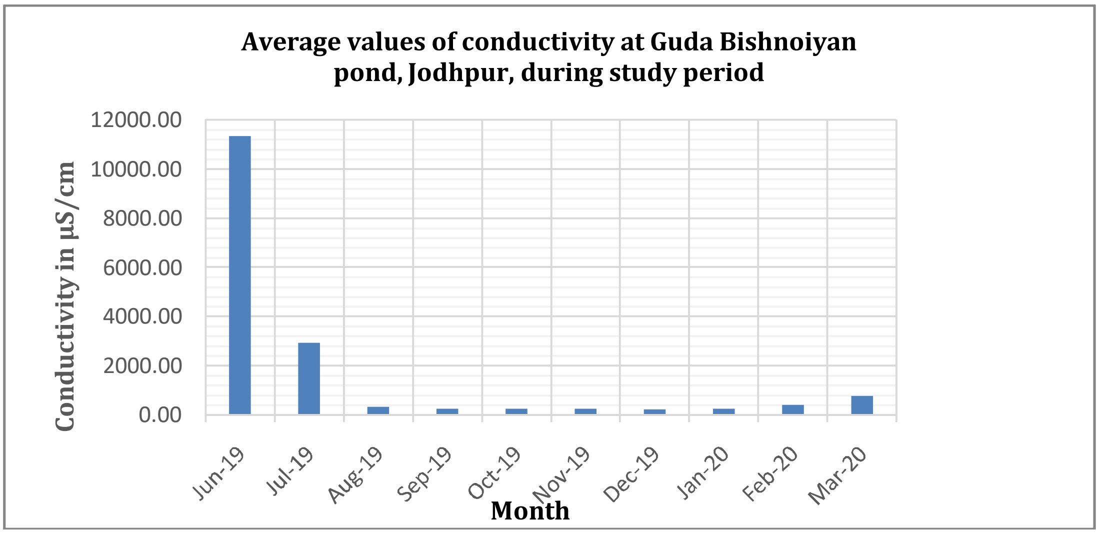

Fig 4. Average values of conductivity at GudaBishnoiyan pond, Jodhpur, during study period.

CONCLUSION

Higher temperature was recorded in the Guda Bishnoiyan pond in summer due to greater solar radiations, longer day length, clear atmosphere, and comparatively low water levels. pH was alkaline throughout the study period at all the three stations. Dissolve oxygen was low in the pond being 5.68mg/l on an average. Higher values of alkalinity were registered during summer which might be due to the presence of an excess of free CO_2 product as a result of decomposition process, coupled with the mixing of domestic waste. GudaBishnoiyan (average total hardness 90.24 mg/l) falls in the category of moderately hard water body. The highest amount of nitrate and phosphate were recorded during monsoon season. The present investigation recorded chloride content to be 44.24 mg/l, which indicate polluted status of the water body. Shrinkage of water volume increases the concentrations during summer, which was observed in the present investigation. Excess amount of total dissolved solids was recorded in summer due to the presence of higher rate of evaporation. During summer, a high level of conductivity was recorded, which points toward the pollution status of the pond. The water quality index (WQI) analysis of the pond GudaBishnoiyan, revealed the value of 86.73, which indicate the poor quality of water, not suitable for drinking.

GudaBishnoiyan pond is one such pond around Jodhpur which provides home to migratory birds like ***Demoiselle crane*** *(Anthropoidesvirgo)* flocking in large number every year, staying here for about 4- 5 months. Survival of migratory birds depends upon the availability of food quality and quantity; production of which is directly influenced by the physico-chemical characteristics of water. The present study can be helpful in framing policies for developing the eco - tourism of this area.

CONFLICT OF INTEREST

Conflict Of Interest Statement: We declare that we have no conflict of interest.

AUTHOR'S CONTRIBUTION

Both authors (Punit Saraswat and Shreya Mathur) have equally contributed to the research paper.

REFERENCES

1. Brown, R. M., McClelland, N. I., Deininger, R. A., & O'Connor, M. F. (1972). A Water Quality Index — Crashing the Psychological Barrier. In: Thomas, W.A. (eds) Indicators of Environmental Quality. *Environmental Science Research*, *1*, 173-182. Springer, Boston, MA. https://doi.org/10.1007/978-1-4684-2856-8_15
2. Tripathy, J. K., &Sahu, K. C. (2005). Seasonal Hydrochemistry of Groundwater in the barrier spit system of the Chilika lagoon, India. *Journal of Environmental Hydrology*, *12*, 1-9.
3. Chaterjee, C., &Razuddin, M. (2002). Determination of Water Quality Index (W.Q.I.) of a degraded river in Asanil Industrial area, Ranigunj, Burdwan, West Bengal. *Nature, Environment and Pollution Technology,1*(2), 181-189.
4. Boyd, C. E. (1998). Water quality in ponds for aquaculture, *Research and Development Series. Number 43.International Centre for Aquaculture and Aquatic Environments, Alabama Agricultural Experimental Station, Auburn University, Alabama*.
5. Gautam, A., & Shrivastava, P. (2017). Study the physico-chemical analysis of pond water of Bhopal, where macrophytes are surviving. *International Journal of Biology Research*, **2**(4), 152-156.
6. Welch, P. S. (1952) *Limnology* (2nd ed.) McGraw Hill Book Co., New York and London.
7. Khan, I. A., and Khan A. A. (1995). Physical and chemical condition in Seika Jheelat, Aligarh, *Ecol*, *3*, 269-274.
8. Bais, V. S., Agrawal, N. C., &Tazeen, A. (1995). Comparative study on seasonal changes in phytoplankton community in the Sagar lake and military engineering lake (M.P.). *J. Freshwater Biol*, 7, 19-25.
9. Younos, T. (2007). Nutrient in lakes and reservoirs-A literature review for use in nutrient criteria development. Special Report. Virginia Water Resources Research Center, *Virginia Tech*, 112.
10. Pandey, B. N., Mishra, A. K., Das, P. K. L., & Jha, A. K. (1993). Physico-chemical characteristics of swamps of Libri river, Purnia (Bihar). *Acts. Ecol*, *15*(2), 98-102.
11. Badge, U. S. & Verma A. K. (1985). Limnological studies on J.N.U. lake. New Delhi, India. *Bull. Bot. Soc.Sagar*, 32, 16-23.
12. Verma, P. (2009). Ecology and economic valuation of Lake Surinsar, Ph.D. Thesis, University of Jammu, Jammu.
13. Thirupathaiah, M., Sravanthy, C., &Sammaiah, C. (2012). Diversity of zooplankton in Lower Manair reservoir, Karimnagar, A.P., India. *International Research Journal of Biological Sciences,1*(7), 27-32.
14. Jhingran, V. G. (1991). *Fish and fisheries of India*. (3rd ed.). Hindustan Publication, New Delhi.
15. Nduka, J. K., Orisakwe, O. E., &Ezenweke, L. O. (2008). Some Physiocochemical Parameter of Potable Water Supply in Warri, Niger Delta Area of Nigeria. *Scientific Research and Essay*, *3*(11), 547-551.
16. Sharma, G. & John, R. V. (2009). Study of Physcio-Chemical Parameters of waste water from dyeing units in Agra city. *Poll, Res*., *2*(3), 439-442.
17. Kumar, D. G., Karthik, M., &Rajakumar, R. (2017). Study of seasonal water quality assessment and fish pond conservation in Thanjavur, Tamil Nadu, India. *Journal of Entomology and Zoology Studies*, *5*(4), 1232-1238.
18. Cook, R. B., Kelly, C. A., Schindler, D. W. & Turner, M. A. (1986). Mechanisms of hydrogen ion neutralization in an experimentally acidified lake. *Limnology and oceanography*, *31*(1), 134-148.
19. Trivedi, R. K. & Goel, P. K. (1984). *Chemical and biological methods for water pollution studies* (1st ed.). Environmental Publications, Karad, India. 251.
20. Wurts, W. A. &Durborow, R. M. (1992). Interactions of pH, carbon dioxide, alkalinity and hardness in fish ponds. *Southern Regional Aquaculture Centre. Department of Agriculture*, *U.S.*
21. Spence, D. H. N. (1964). *The macrophytes vegetation of lochs, swamps and associated fens*. In: The Vegetation of Scotland (ed. J. H. Burnett), Edinburgh:Oliver & Boyd. 306-425.
22. Jhingran, V. G. (1991). *Fish and fisheries of India*. (3rd ed.). Hindustan Publication, New Delhi.
23. Kiran, B. R. (2010). Physico-chemical characteristics of fish ponds of Bhadra project at Karnataka, *RASAYAN-J.*Chem., 3(4), 671-676.
24. Rai, H. (1971). Limnological Studies on the River Yamuna at Delhi. Part I. Relation between Chemistry and the state of pollution, *Arch Hydrobiol*, *73*, 269-393.
25. Sawyer, C. H. (1960). *Chemistry for sanitary Engineers*. McGraw Hill Book Co., New York.
26. Goel, P. K. (2009). *Water Pollution Causes, Effect and Control* (Revised 2nd ed.). New Age International (P) Ltd. Publisher, 223.
27. Sujila, T., Kumari, S. B., Mohan Kumar, M., Drishya, M. K., &Gopinathan, S. (2018). Studies on the physico-chemical parameters to assess the water quality of river Mampuzha, *International Journal of Pharmacy and Biological Sciences*, *8*(3), 1064-1074.
28. Kumar, S., Ghosh, N. C., Singh, R. P., Sonkusare, M. M., Singh, S., & Mittal, S. (2015). Assessment of Water Quality of Lakes for Drinking and Irrigation Purposes in Raipur City, Chhattisgarh. *India Int. Journal of Engineering Research and Application*, *5*(2), (Part -3), 42-49.
29. Handa, B. K. (1990). Contamination of Groundwater's by phosphate. Bhu-jal News, *5*24-36.
30. Abdar, M. R. (2013). Physico-chemical characteristics and phytoplankton of Morna Lake, Shirala (M.S.) India, *Biolife*, *2*(1), 1-7.

31. Nagarajan, R., &Thiyagesan, K. (1996). Water birds and substrate quality of the Pichavaram wetlands, southern India. *Ibis*, *138*(4), 710-721. https://doi.org/10.1111/j.1474-919X.1996.tb04773.x
32. 32. Slatopolsky, E., Calgar, S., Pennell, J. P., Taggart, D. B., Canterbury, J. M., Reiss, E., & Bricker, N. S. (1971). On the pathogenesis of the uremic state: An exposition of the 'trade-off hypothesis'. *N Engl J Med*, *286*, 1093–1099.
33. Holman, I. P., Whelan, M. J., Howden, N. J. K., Bellamy, P. H., Willby, N. J., Rivas-Casado, M., &McConvey, P. (2008). Phosphorus in groundwater-an overlooked contributor to eutrophication. *Hydrological Processes*, *22*, 5121-5127. https://doi.org/10.1002/hyp.7198
34. Freeda D. G. R., Arunkumar, K., &Valarmathy. (2006). Portability of drinking water sources of Eleven Villages in Perambalur District, Tamil Nadu. *Pollution Research*, *25*(1), 171-174.
35. Nag, A., & Gupta, H., (Joshi). (2014). Physicochemical analysis of some water ponds in and around Santiniketan, West Bengal, India. *International Journal of Environmental Sciences*, *4*, 676-682. doi: 10.6088/ijes.2014040404507
36. Thapa, J. B., &Saund, T. B. (2012). Water Quality Parameters and Bird Diversity in Jagdishpur Reservoir, Nepal. *Nepal Journal of Science and Technology*, *13*(1), 143-155.
37. Tresh, J. C, Suckling, E. V., & Beale, J. F. (1944). Chemical and zooplankton studies of lentic habitats in North Eastern New South Wales. *Australian Journal Marine Freshwater Research*, *21*, 11-33.
38. Naveed, A., Naik, K. L., and Hosetti, B. B. (2007). Limnological studies of Gudavi Wetlands, Sorab, ShimogaKaranataka Dayananda, G.Y. *Environment Conservation Journal*, *8*(3), 47-54.
39. Schimitz, R. J. (1996). *Introduction to water pollution biology*. Asian Book PVT. Ltd., New Delhi, India.
40. Khabrade, S. A, & Mule, M. B. (2005). Studies on physico-chemical parameters of Pundi water reservoir from TasagonTahsit (Maharashtra). *In: Fundamentals of Limnology* (Arvind Kumar ed., pp. 206-214). *APH publishing corporation*.
41. Solanki, H. A. (2001). Study on pollution of soils and water reservoir areas of Baroda, Ph.D. Thesis Submitted to Bhavnagar University, Bhavnagar.
42. Choudhary, P., Dhakad, N. K., & Jain, R. (2014). Studies on the Physico-Chemical Parameters of Bilawali Tank, Indore (M.P.) India. *IOSR Journal Of Environmental Science, Toxicology And Food Technology*, *8*(1), 37-40.
43. Hutchinson, G. E. (1957). *A Treatise on Limnology: Geography, Physics and Chemistry*. John Wiley and Sons, New York, I 1015.
44. Pawar, A. L. (2010). Seasonal variations in physico-chemical quality of Lonar Lake water. *Journal of Chemical and Pharmaceutical Research*, *2*(4), 225-231.
45. ICMR. (1975). Manual of Standards of Quality of Drinking Water Supplies, Indian Council of Medical Research, New Delhi.
46. Dahiya, S. & Kaur, A. (1999). Physico chemical characteristics of underground water in rural areas of Tosham subdivisions, Bhiwani district, Haryana, *J. Environ Poll*, *6*(4), 281.
47. National Agricultural Extension and Research. (1996). Water Quality Management in Fish Culture, Extension Bulletin No. 98 Fisheries Series No 3. Liaison Services Ahmadu Bello University, Zaria.
48. Acharya, G. D., Hathi, M. V., Patel, A. D., & Parmar, K. C. (2008). Chemical properties of groundwater in Bhiloda Taluka Region, North Gujarat, India. *E-Journal of Chemistry*, *5*(4), 792-796.
49. Ogbeibu, A. E., & Victor, R. (1995). Hydrological Studies of Water Bodies in the Okomu Forest Reserves (Sanctuary) in South Nigeria. *Physicochemical Hydrology Trop. Fresh water Biol*, *4*, 83-100.
50. Garg, J., Nicola, B., Boris, K., & Nicola, M. (2011). Role of Disorder and Anharmonicity in the Thermal Conductivity of Silicon-Germanium Alloys: A First Principles Study. *Phys. Rev. Lett,106*, 045901. https://doi.org/10.1103/PhysRevLett.106.045901
51. Nighojkar, A., &Dohare, E. R. D. (2014). Physico-Chemical Parameters for Testing of Present Water Quality of Khan River at Indore, India. *International Research Journal of Environment Sciences*, *3*(4), 74-81.
52. Ahluwalia, A. A. (1999). Limnological Study of wetlands under Sardar Sarovar command area. Ph.D. Thesis, Gujarat University, Ahmedabad.
53. Singh, S., & Gupta, B. K. (2014). Status of Biomonitoring and Potability with strategy of its Mitigation of Ground water of Town Deeg (bharatpur) Rajasthan: Correlation with Hydro-Biochemical Profile., *Proc. of national con. on environment: Ancient and modern perspectives (NCE2014)*, held at Bharatpur, Rajasthan on 4-6 Dec.
54. Needham, J. G., & Needham, P. R. (1962). *A Guide to the Study of Freshwater Biology*. (2nd Ed.). Holden-Day Inc.,108.

CITATION OF THIS ARTICLE

P Saraswat and S Mathur. Assessing the water quality of GudaBishnoiyan Pond, Jodhpur, using Water Quality Index (WQI). Bull. Env.Pharmacol. Life Sci., Vol 11 [11] October 2022 : 86-9**4**