Biological Forum – An International Journal **15(5): 1362-1368(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Assessment of Water Quality in certain Lakes of Hyderabad, Telangana

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(Received: 14 March 2023; Revised: 15 April 2023; Accepted: 09 May 2023; Published: 12 May 2023)
(Published by Research Trend)

ABSTRACT: Water bodies are essential components in our ecosystem for all living organisms and compose 50-97% of plant and animal weight and about 70% of the human body. All the people depend on water bodies for their day to day activities and the water quality analysis thus becomes a basic requirement for safety purposes and determines the health of our environment. Therefore, the challenge here is periodically monitoring and assessment of water quality for maintenance of quality of water in rivers, lakes and ponds. The main objective of physico-chemical analysis of water was to determine the nutrient status of the medium. Since water contains dissolved and suspended constituents in varying proportions it has different physical and chemical properties along with biological variation. The quality of water may be affected in various ways by pollution. The main objective was to assess the quality of water and degree of pollution. The water was alkaline in the lakes. Carbonates and dissolved oxygen were recorded in low concentration. Organic matter, COD, phosphates and nitrates were recorded in high concentration. Four groups of algae were recorded in the lake i.e., Cyanophyceae, Chlorophyceae, Euglenophyceae and Bacillariophyceae. Among the four groups of algae Cyanophyceae constituted the dominant group. Bacillariophyceae recorded in very low numbers. *Microcystis, Arthrospira, Oscillatoria, Chlorella, Scenedesmus, Cyclotella, Gomphonema, Nitzschia, Euglena, Phacus* were dominant in the lake they can use as good indicators of pollution. On the basis of both physico-chemical and biological characteristics the lake was polluted and eutrophic.

Keywords: Pollution, Lakes, Physico-chemical parameters, Phytoplankton and Cyanophyceae.

INTRODUCTION

Water was the most abundant substance, covering more than 70 percent of the earth's surface and existing in many places and forms, mostly in the oceans and polar ice caps, but also as clouds, rain water, rivers, freshwater aquifers, and sea ice. Water was also found in the ground and in the air, we breathe and was essential to all known forms of life. It was vital for all known forms of life. On Earth, 96.5 % of the planet's water was found in seas and oceans, 1.7 % in groundwater, 1.7 % in glaciers and the ice caps of Antarctica and Greenland, a small fraction in other large water bodies, and 0.001 % in the air as vapour, clouds (formed of ice and liquid water suspended in air), and precipitation. Only 2.5 % of the Earth's water was fresh water, and 98.8 % of that water was in ice (excepting ice in clouds) and groundwater (Bhat, 2014). Less than 0.3 % of all freshwaters was in rivers, lakes, and the atmosphere, and an even smaller amount of the Earth's freshwater (0.003 %) was contained within biological bodies and manufactured products (Sharma, 2015). A lake was a sizable water body surrounded by land and fed by rivers, springs, or local precipitation. A lake's structure has a significant impact on its biological, chemical, and physical features. Lakes can be classified based on a variety of features, including their formation and their chemical or biological condition, as oligotrophic and eutrophic (Wetzel, 2001; Holopainen and Lehikoinen 2022).

Phytoplankton being dominant photoautotrophic organisms in the aquatic environment plays a significant role as a tool in assessing the quality of the water (Diaz *et al.,* 2023). This was because of the high degree of sensitivity these organisms, exhibit to the altering environment. The degree of the contamination with the other substances corresponds to definite micro flora and micro fauna. Thus, there was a possibility to establish the severity and type of pollution by the presence of indicator organisms in a given habitat (Arivukkarasi and Selva Mohan 2023). The distribution and periodicity of the phytoplankton was governed by the seasonal change (Chaurasia and Pandey 2007; Li *et al.,* 2017). In general, biological parameters involve the study of biotic diversity, and its productivity of flora and fauna in relation to the physico-chemical environment prevailing in a specific habitat and has been reported a correlation of productivity of zooplankton of various water ecosystems (Yadav *et al.,* 2003; Rahman *et al.,* 2021; Eramma *et al.,* 2023).

Therefore, the present study was undertaken to assess the quality of water in terms of physic-chemical analysis and phytoplankton enumeration and therefore, we herein present the results of our investigative study.

MATERIAL AND METHODS

A. Sample collection site

Hyderabad was situated in between 17°20' N and 78°30' E at the elevation of 505 meters above the mean sea level. Hyderabad was twinned with neighboring Secunderabad, to which it was connected by Hussain Sagar. In the present investigation 5 lakes were selected in Hyderabad they are Saroornagar, Fox Sagar lake, Nadimi cheruvu, Durgam cheruvu, Hussainsagar lake. The Present study aims to monitor the quality of Lakes water so as to assess the water quality of the lake.

B. Collection of water samples

The water samples from the surface were collect from the three sampling stations every month in polythene cans for a period of 1 year from April 2021 to March 2022. Water samples were collect in separate 250 ml glass bottles (BOD bottles) for the estimation of dissolved oxygen. All the samples were carried to the laboratory. The samples were analyzed on the same day for different physico-chemical factors following the standard methods. The factors analyzed in the present study include Temperature, pH, Carbonates, Bicarbonates, Chloride, Dissolved Oxygen, Biological Oxygen Demand, Chemical Oxygen Demand, Oxidizable Organic Matter, Total Hardness, Calcium, Magnesium, Phosphates, Sulphates, Nitrates, Nitrites, Total Solids, Total Dissolved Solids and Total Suspended Solids (American Public Health Association, 1995).

C. Phytoplankton Enumeration

Surface water samples for phytoplankton were collected from the 3 sampling stations. One litre of the sample was kept in sedimentation columns after adding 4% Formaldehyde solution. The samples were kept in dark undisturbed for about fifteen days for complete settling of the organisms. Finally, the sample was concentrated to 100 ml. For the frequency measurements of different species of algae at each station, the drop method Pearsall *et al*. (1946) and as described by Venkateswarlu (1969) was adopted and finally the organisms present in 120 high power fields of the microscope (15×45, 30537) and a number of individual species were noted. The microscope was standardized to find out the area of the field. The numbers of organisms per ml were further calculated depending upon the concentration of the sample.

RESULTS AND DISCUSSION

The analysis of various physico-chemical parameters were carried out and the results were presented in Table 1. As evident from the Table 1, temperature exerts a major influence on the biological activities and growth. To a certain point the increase in temperature leads to greater biological productivity, above and below which it falls, and it also governs the kind of organisms (species composition). At elevated temperatures, metabolic activity of an organism increases, requiring more oxygen but at the same time the solubility of oxygen decreases, thus accentuating the stress. Temperature influences water chemistry, e.g., DO, solubility, density, pH, conductivity etc. Water holds lesser oxygen at higher temperatures (Deeksha Dave, 2011; Hamid *et al.*, 2020). Some compounds are more toxic to aquatic organisms at higher temperatures. Additionally, temperature of drinking water has an influence on its taste. However, pH was an indicative of hydrogen ion concentration, and it expresses the intensity of acidity or alkalinity. Any change in pH of water was accompanied by changes in other physico-chemical aspects of the medium. The pH of water determines the solubility and biological availability of certain chemical nutrients such as phosphorus, nitrogen, carbon and heavy metals like lead, copper, cadmium, etc. pH determines how much and what form of phosphorus was most abundant in water (Araoye, 2009; Hamid *et al.*, 2020).

Carbonates were present in low concentration when compared to bicarbonates. Carbonates exhibit a positive relationship with pH. Carbonates exhibited a direct relationship with dissolved oxygen and an inverse relationship was observed with chlorides (Dhere and Gaikwad 2006; Li *et al*., 2013). In the present study the chloride values were very high indicating high salinity and heavy sewage pollution. Chlorides were found to be at high at all the selected stations. The high values of chlorides could be attributed to greater amount of domestic and industrial sewage dumping that off-sets dilution effect which is in agreement with those of published reports (Chauhan *et al.*, 2021; Tamrakar *et al*., 2022). The dynamics of dissolved oxygen concentration was one of the fundamental and important factors influencing the aquatic environment both chemically and biologically (Jai *et al.*, 2019). Dissolved oxygen affects the nutrient availability resulting in the altered productivity of the entire water body. Higher values of dissolved oxygen during winter season were due to the increased algal population and its subsequent increased rate of photosynthesis at lower temperature. On an average basis, the demand for oxygen was proportional to the amount of organic waste to be degraded by aerobically (Hegdae *et al.*, 2005). Hence, BOD approximates the amount of oxidizable organic matter present in the solution and its value can be used as a measure of waste strength. In the present investigation COD values were low in winter, high in summer and moderate in monsoon. The high concentration of COD could be attributed to the accelerated rate of bacterial decomposition and partly to its consumption in the chemical process of oxidation (Janaki Rama Rao *et al.*, 2006). High COD values are indicative of the presence of chemically oxidizable carbonaceous matter as well as inorganic matter such as nitrate and sulphates were observed by Janaki Rama Rao *et al.* (2006). The maximum values in winter could be attributed to the autochthonous organic matter due to the death of Eichhornia crassipes that was abundant in the lake. On the other hand, the maximum monsoon values are attributed to the allochthonous organic matter, the garbage, solid wastes and sewage being dumped in the peripheral portion of the lake and similar observations have been reported in the literature (Mohsin Khan *et al*., 2022).

Total hardness of water was a complex mixture of cations and anions. It was predominantly due to the presence of major cations like calcium and magnesium. It was expressed as magnesium and Calcium carbonate equivalent per liter of water. Effect of these major cations of the growth of flora was of ecological significance. Storm water brings along the large quantities of hardness causing elements. In the present study, the accumulation of calcium content was more in the lakes. This may be due to discharge of sewage from the city. The observations of the current study are in agreement with that of Rajeev Sharma and Ajay Capoor (2010); Rajakumar *et al.* (2006). Though there was no relationship between calcium and magnesium, magnesium showed a direct relation with total hardness. The high values were observed in summer and this could be due to evaporation, increasing the concentration of magnesium.

The major sources of sulphur in natural waters are rocks, fertilizers and waste discharges from industries (Arivukkarasi and Selva Mohan 2023). Sentongo (1998) concluded that the sulphate was largely derived from human activities like sewage and fertilizers. Effluents from paper producing industries commonly contain sulphates in large quantities. The most significant form of inorganic phosphorus was orthophosphate. It was the only directly utilizable form of soluble inorganic phosphorus. Apart from small quantities of phosphates present in a lentic system, domestic sewage, agricultural drainage, cleaning detergents etc. form the major sources of phosphates that markedly contribute to fertilizers effects of fresh waters. Nitrites were observed in traces during the major part of investigation at the lake but exhibited high values on the onset of rain (Mwashra *et al*., 2007; Olubanjo and Adeleke 2021; Arora *et al.,* 2023). Values observed during monsoon reached a peak in July followed by a fall upto February and a slight increase from the month of March up to July. In the present investigation the determination of nitrates was significant in that it was a measure of the status of eutrophication as it gives the content and availability of decomposable organic matter.

Total solids in natural water refer to suspended and dissolved material. Greater content of total solids was recorded in lake Fox Sagar due to high alkalinity. High values were recorded in early summer. This was in accordance to the observations made by Radhika *et al.* (2004). This could be due to washing clothes and other contaminants due to bathing of animals and humans which was usually at a higher proportion. The values of Total dissolved solids did not show a definite pattern in their seasonal variation (Sharma and Walia 2016; Arora *et al.*, 2023). The maximum monsoon or summer values were followed by minimum winter values (Ravikumar *et al.,* 2006). Maximum monsoon values in lake could be attributed to the increased surface runoff into the lake, resulting in an increased level of allochothnous organic matter which results in dissolved solid content. Suspended solids did not show a distinct seasonal variation. This could be attributed to the muddy lake basin and high percentage of Cyanophycean members adding to the other factor.

A. Correlation in between physico-chemical parameters

At station-I, chlorides showed an inverse correlation with carbonates COD showed negative correlation with BOD. Magnesium shows a directly correlated with chlorides, Total suspended solids showed the positive relation with chlorides, COD, Total hardness, negatively correlated with carbonates. Sulphates and phosphates showed positive correlation with chlorides and Nitrates showed positive correlation with carbonates, bicarbonates, calcium and negatively correlated with total dissolved solids. At station-II dissolved oxygen showed a direct correlation with bicarbonates, chlorides, calcium showed the direct correlation with pH, carbonates and magnesium showed the direct correlation with pH, carbonates, BOD. Total solids were negatively correlated with DO, organic matter and positively correlated with carbonates and BOD. Sulphates negatively correlated with carbonates, bicarbonates, DO. Nitrites exhibit positive correlation with COD, total hardness, calcium negatively correlated with magnesium, total dissolved solids. Nitrates exhibit positive correlation with calcium, DO and negatively correlated with carbonates total, dissolved solids. At station-III organic matter showed an inverse correlation with carbonates calcium showed the direct correlation with pH, chlorides, total suspended solids are negatively correlated with bicarbonates and positively correlated with organic matter (Singh *et al.,* 2022). Nitrites exhibit positive correlation with carbonates, bicarbonates, chlorides negatively correlated with magnesium. Nitrates exhibit positive correlation with bicarbonates and negative correlation with total dissolved solids (Olubanjo and Adeleke 2021; Daffi and Wamyil 2021; Jain *et al*., 2022).

B. Phytoplankton

Cyanophyceae was the dominant group observed higher concentration of chlorides, magnesium, phosphates, and total suspended solids contributed to the higher number of Cyanophyceae members (Vyas *et al.,* 2008; Berry *et al*., 2017). Cyanophyceae forms exhibited qualitative and quantitative abundance forming blooms almost throughout the period of investigation (Table 3). Blooms of Oscillatoria species were very common in lake Fox Sagar. Bloom of Microcystis and Arthrospira species were present throughout the year thus showing vast degree of tolerance to widely varying environmental conditions prevailing in different seasons of the year. The presence of these blooms indicates eutrophic nature of the lake (Malin *et al.,* 2016; Berry *et al.,* 2017; Kumar *et al*., 2022). It was observed that the cyanophycean fluctuated with the rainfall and temperature. Cyanophycean members constituted 80% of the total algae when the water temperature fluctuated between 24-26°C. The species Oscillatoria and Microcystis were dominant in the lake (Fig. 1). While, Chlorococcales were represented by the species of *Chlorella vulgaris, Coelastrum microsporum, Scenedesmus acutiformis, Scenedesmus armatus, Ankwastrodesmus falcatus, Actinastrum*

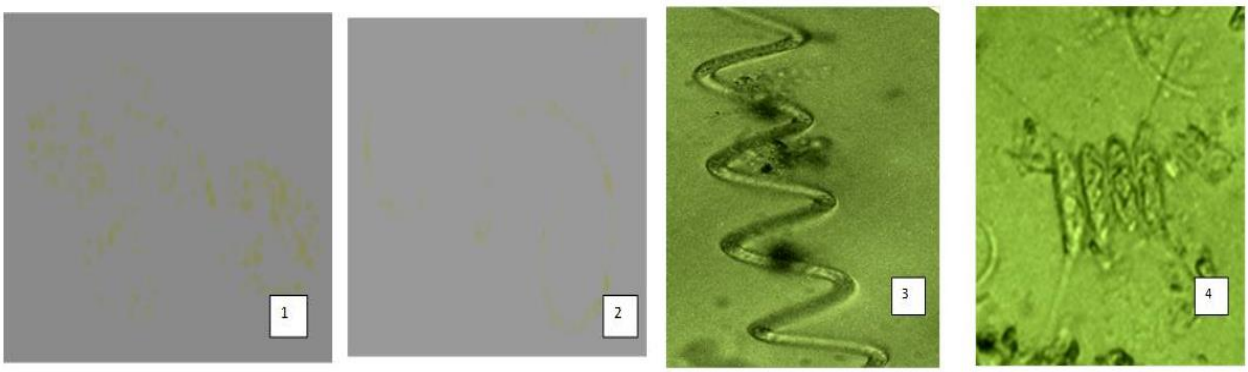
hantzschii, *Scenedesmus quadricauda*. In temperate regions, higher atmospheric or water temperature along with bright sunshine can be favourable factors for the development of Chlorococcales. The high peaks of Chlorococcales are associated with high values of total solids of the lake under study. Similar results showing a negative influence on the growth of Chlorophyceae (Fig. 3) (Swarnalatha, 1990). In the present investigation it was observed that high temperature (25-26°C) and greater amounts of organic matter were favourable for the members of Euglenophyceae to multiply. Oxidizable organic matter fluctuated more or less directly with Euglenophyceae. This indicates that waters rich in organic matter favoured the growth of the class in abundance. Euglenophyceae represented by the species of *Euglena polymorpha, Euglena acus, Euglena proxima, Euglena oxyurwas, Phacus acuminatus, Phacus curvicauda* and *Phacus longicauda* (Fig. 2). One of the most abundant and diversified groups of algae are diatoms. In the present study the diatoms were recorded very less number. Some diatoms existed throughout the period of investigation while many occurred rarely and were not in abundance, due to high concentration of organic matter. In the present investigation it was observed that certain chemical factors like bicarbonates, calcium, nitrates, oxidizable organic matter and silicates had a profound influence on the multiplication of diatoms. In the present investigation higher concentrations of bicarbonates, nitrates, phosphates, and organic matter suppressed the growth of diatoms which correlates with those of published reports (Olofsson, 2018; Zelnik *et al.*, 2020).

Table 1: Comparison of the present at a with ISI and WHO standards.

Parameters	Saroornagar	Fox Sagar	Nadimi lake	Durgam Cheruvu	Hussain Sagar lake	WHO	ISI
pH	8.25	8.20	8.18	8.4	8.6	6.5 - 8.5	6.5-8.5
CO_3^{2-}	17.30	14.13	12.62	17.13	24.62	.	.
HCO_3^-	213.14	217.63	216.68	237.42	276.68	.	.
Cl^-	364.95	375.99	365.72	385.22	395.72	.	250 mg/L
DO	2.90	3.10	2.95	1.10	0.95	6 mg/L	3 mg/L
OM	17.00	16.43	18.05	20.43	28.45	.	.
TH	529.27	530.08	530.94	510.18	546.94	300 mg/L	300 mg/L
Ca^{2+}	79.15	82.46	82.13	92.46	86.12	200 mg/L	75 mg/L
Mg^{2+}	67.14	70.78	71.21	60.78	62.21	75 mg/L	30 mg/L
PO_4^{3-}	3.60	3.10	3.50	4.2	5.50	.	.
NO_2^-	0.28	0.20	0.25	0.33	0.35		
NO_3^-	6.80	6.25	4.20	7.22	8.20	45 mg/L	.
SO_4^{2-}	43.00	38.00	33.00	48.00	23.00	200 mg/L	150 mg/L

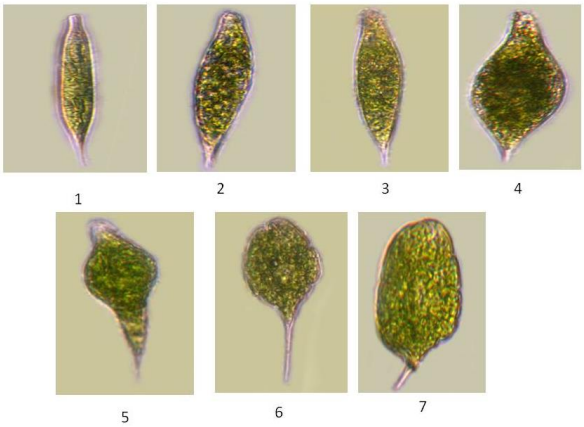
Table 2: Common and dominant species of Phytoplankton.

Groups	Species
Cyanophyceae	*Oscillatoria limosa, Oscillatoria curviceps, Oscillatoria animalis, Oscillatoria chalybea, Oscillatoria ornata, Merismopedia punctata, Microcystis aeruginosa, Arthrospira platensis* and *Chroococcus minutus*
Chlorophyceae	*Eudorina elegans, Chlamydomonas angulosa, Pandorina morum, Chlorella vulgaries, Coelastrum microporum, Scenedesmus acutiformis, Scenedesmus armatus, Scenedesmus quadricauda, Ankistrodesmus falcatus* and *Actinastrum hantzschii*.
Euglenophyceae	*Euglena polymorpha, Euglena acus, Euglena proxima, Euglena oxyuris, Phacus acuminatus, Phacus curvicauda* and *Phacus longicauda*
Bacillariophyceae	*Nitzschia palea, Navicula pupula, Navicula mutica, Navicula rhynchocephala, Gomphonema parvulum* and *Cyclotella meneghiniana*.



1. *Microsystis aerugenosa*; 2. *Anabaenanopsis circularis*; 3. *Arthrospira platensis* and 4. *Scenedesmus quadricauda*

Fig. 1. Identified Cyanophyceae species in the water sample.



1.*Euglena acus* var. major; 2. *Euglena spathirhyncha*; 3. *Euglena acus* var. *longa*
4. *Euglena psuedoviridis*; 5. *Euglena proxima*; 6. *Phacus indicus*; 7. *Phacus onyx*
Fig. 2. Identified *Euglenophyceae* species in the water sample.

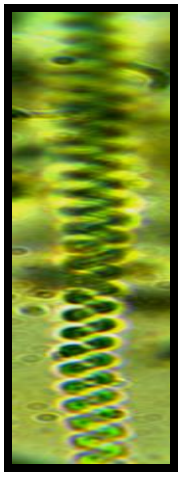


Fig. 3. Identified Cyanophyceae species, Spirulina in the water sample.

Table 1: Comparison of the present data with ISI and WHO standards.

Parameters	Saroornagar	Fox Sagar	Nadimi lake	Durgam Cheruvu	Hussain Sagar lake	WHO	ISI
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Mg^{2+}	67.14	70.78	71.21	60.78	62.21	75 mg/L	30 mg/L
PO_4^{3-}	3.60	3.10	3.50	4.2	5.50	.	.
NO_2^-	0.28	0.20	0.25	0.33	0.35		
NO_3^-	6.80	6.25	4.20	7.22	8.20	45 mg/L	.
SO_4^{2-}	43.00	38.00	33.00	48.00	23.00	200 mg/L	150 mg/L

Table 2: Common and dominant species of Phytoplankton.

Groups	Species
Cyanophyceae	*Oscillatoria limosa, Oscillatoria curviceps, Oscillatoria animalis, Oscillatoria chalybea, Oscillatoria ornata, Merismopedia punctata, Microcystis aeruginosa, Arthrospira platensis* and *Chroococcus minutus*
Chlorophyceae	*Eudorina elegans, Chlamydomonas angulosa, Pandorina morum, Chlorella vulgaries, Coelastrum microporum, Scenedesmus acutiformis, Scenedesmus armatus, Scenedesmus quadricauda, Ankistrodesmus falcatus* and *Actinastrum hantzschii*.
Euglenophyceae	*Euglena polymorpha, Euglena acus, Euglena proxima, Euglena oxyuris, Phacus acuminatus, Phacus curvicauda* and *Phacus longicauda*
Bacillariophyceae	*Nitzschia palea, Navicula pupula, Navicula mutica, Navicula rhynchocephala, Gomphonema parvulum* and *Cyclotella meneghiniana*.

CONCLUSIONS

The physic-chemical characteristics exhibited certain interrelationships. The pH and carbonates are directly correlated. The pH and carbonates are inversely proportional to bicarbonates. Chlorides showed an inverse correlation with carbonates. Dissolved oxygen shows an inverse correlation with organic matter and biological oxygen demand. The total hardness negatively correlated with carbonates. Sulphates and phosphates showed positive correlation with chlorides. Nitrates showed positive correlation with carbonates, bicarbonates, calcium and negatively correlated with total dissolved solids. The biological parameters include the estimation of phytoplankton community structure and their distribution in various seasons. The taxa recorded in the lakes have been classified under four classes Cyanophyceae, Chlorophyceae, Bacillariophyceae and Euglenophyceae. Temperature, organic matter, phosphates and nitrates are influenced the growth of Cyanophyceae. Whereas, the Chlorophyceae was influenced by temperature and oxygen. Silicates and oxygen are responsible for the growth of diatoms. The euglenophyceae influenced by temperature, organic matter and nitrates. All the physic-chemical parameters are well above the permissible limits. Hence on the basis of both physico-chemical and biological parameters the lake was polluted. From the foregoing account it can be concluded that the lakes are highly polluted and eutrophic in nature.

FUTURE SCOPE

The present paper focuses on monitoring environmental conditions, drinking water quality, treatment and disinfection of waste water etc. It also focuses on conservation of aquatic life, Assessing of surface and subsurface water quality. This study will be of great help to various agencies which take care of the water supply and water pollution control since this forms a significant tool for easy understanding and thereby making their applicability uncomplicated.

Acknowledgement. The authors extend their sincere thanks to Dr. J. Achyutha Devi, Principal, R.B.V.R.R. Women's College for the financial support given for this work and also for her constant encouragement during the tenure of the study.
Conflict of Interest. None.

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How to cite this article: A. Rajani, A. Kavitha and P. Manjula (2023). Assessment of Water Quality in certain Lakes of Hyderabad, Telangana. *Biological Forum – An International Journal, 15*(5): 1362-1368.