Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 11 [8] July 2022 : 49-54

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

ORIGINAL ARTICLE **OPEN ACCESS**

Ecological studies on Kapra Lake with reference to water quality

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ABSTRACT
The Present study aims to monitor the water quality in Kapra Lake. It is located in the Kapra municipality near Sainikpuri in the north-east part of Greater Hyderabad, India. Water samples from the surface were collected at all the sampling stations in 2L polythene containers at monthly intervals for a period of 2 years from June 2019 to May 2021. All the physico-chemical parameters such as chlorides, total hardness, calcium, magnesium, phosphates, sulphates, BOD, total solids and total dissolved solids were higher than permissible limits and dissolved oxygen is in very low concentration compared to the prescribed values by various national and international organizations.In the present study four groups of algae were recorded i.e, Cyanophyceae, Chlorophyceae, Euglenophyceae and Bacillariophyceae. Microcystis, Arthrospira, Oscillatoria, Chlorella, Scenedesmus, Cyclotella, Gomphonema, Nitzschia, Euglena, Phacus were dominant in the lake, they can be used as good indicators of pollution. On the basis of both physico-chemical and biological characteristics the lake water is polluted and eutrophic.
Key Words: *Kapra lake, Physico-chemical parameters, Algae and Water quality.*

Received 16.04.2021 Revised 26.06.2021 Accepted 25.07. 2022

INTRODUCTION

Water quality of the aquatic ecosystem in an urban sprawl is becoming a serious concern which alters the biological characteristics from a clear water body to a turbid planktonic dominated body. The primary consequent hazard of high trophic status of water body is the formation of algal blooms. Eutrophication is a modern term first employed by Hosmani [11] and is often considered to be a natural phenomenon of lake ageing largely due to accelerated activities of man and one which is dependent on the increase of potential soluble inorganic nutrient's both in the sediment and lake water itself. The term 'eutrophic' means well-nourished; thus eutrophication refers to natural or artificial addition of nutrient to water body and to the effects of added nutrients [3].

Population growth, various human developmental activities, industrialization, urbanization, improper management of water resources, exploitation of catchment and command areas have led to severe water quality impairment. Inland water bodies undergo eutrophication due to sewage discharge, improper agricultural practices and urban run offs and disrupt aquatic ecosystems. Water contamination has been one of the principle subjects in the natural issues in India. Water quality, which is affected by different characteristic procedures and anthropogenic exercises, is overall breaking down and as of now an issue of research [1]. Further, regular changes in surface water and ground water quality must be considered as poisons entering water bodies are occasional ward [2].

MATERIAL AND METHODS

Kapra Lake or Oora Cheruvu is a lake located in the Kapra municipality near Sainikpuri in the north-east part of Greater Hyderabad, India. Length of its bund is measured at 1254 Meters. In the early 2000s this lake was deemed pristine and pollution free but in 2012 it was reported as polluted and susceptible to encroachments by the GHMC. According to survey conducted in 2002, the area of the lake was 113 acres (0.46 km^2) but due to land encroachments, area is reduced to 70 acres (0.28 km^2). In 2017, there were reports of Kapra lake choked by illegal construction.

The present investigation center around Kapra lake, which is symmetrically destroyed to a large extent by the dumping of waste, garbage and untreated domestic sewage primarily from the surrounding

residential areas. For the last fifteen years the lake has undergone an extensive urbanization and consequent increasing in housing colonies around its catchment

Sampling stations

Three sampling stations were selected for the collection of water and algal samples. The samples from following sites. Station-I is situated right side of the lake. Station-II is located middle of the bund. Station-III is situated left side of the lake.

Water samples from the surface were collected at all the sampling stations in 2L polythene containers at monthly intervals for a period of 2 years from June 2019 to May 2021.Water samples were collected in separate standard glass bottles (BOD bottles) for the estimation of dissolved oxygen with necessary precautions. All the samples were carried to the laboratory in an ice-box. The samples were analyzed on the same day in the laboratory for different physico-chemical parameters following the standard methods [6, 12].

Sampling of Algae

One litre of surface water samples were collected from three different stations of the lake and samples were kept in the sedimentation column after adding 2-3 ml of 4% formaldehyde solution. The samples were kept undisturbed for about one month for complete settling of the organisms. The samples were concentrated to 100 mL. Finally, the concentrated material was used for frequency measurements and identification of species.

RESULTS AND DISCUSSION

Physico-chemical parameters:

The average values of the physico-chemical variables (June 2019 - May 2021) of the water body studied along with the standards stipulated by ISI (10500:2012) and BIS [9] quality criteria are given in the Table: 1.

In the present investigation the lake water temperature recorded with an average value of 23.55^{0}C at station-I, 23.85^{0}C at station-II and 23.9^{0}C at station-III. The average value of pH is 8.26 at station-I, 8.36 at station-II and 8.41 at station-III.Carbonates were recorded 23.22 mg/L, 23.81 mg/L and 30.8 mg/L at station-I, station-II and station-III respectively. The average values of bicarbonates were 232.15 mg/L at station-I, 232 mg/L at station-II and 241.5 mg/L at station-III.The average values of chlorides were 362.11 mg/L at station-I, 356.74 mg/L at station-II and 357.51 mg/L at station-III.

The average values of DO were 2.69 mg/L at station-I, 1.6 mg/L at station-II and 2.66 mg/L at station-III respectively. Organic matter was observed in high concentration with an average of 16.48 mg/L at station-I, 21.5 mg/L at station-II and 28.69 mg/L at station-III. The average values of BOD were 94.58 mg/L at station-I, 108.3 mg/L at station-II and 137.3 mg/L at station-III respectively. COD values were found in 125.83 mg/L at station-I, 144.9 mg/L at station- II and 182 mg/L at station - III.

The concentration of total hardness is 363.05 mg/L at station-I, 363.23 mg/L at station-II and 418.48 mg/L at station-III. The average values of calcium were found in 81.72 mg/L at station-I, 76.24 mg/L at station-II and 89.76 mg/L at station- III respectively. Average values of Magnesium 68.49 mg/L at station-I, 70.02 mg/L at station-II and 80.05 mg/L at station-III.

. The average values of sulphates were 42.01 mg/L at station-I, 37.13 mg/L at station-II and 35.8 mg/L at station-III respectively. The average values of silica were 0.028 mg/L at station-I, 0.036 mg/L at station-II and 0.025 mg/L at station-III respectively. The average values of phosphates were found in 3.96 mg/L at station-I, 3.10 mg/L at station-II and 3.36 mg/L at station- III respectively. Nitrates values were 6.88 mg/L at station-I, 6.10 mg/L at station-II and 4.01 mg/L at station-III. Nitrites values were found in 0.34 mg/L at station-I, 0.192 mg/L at station-II and 0.26 mg/L at station-III respectively.

Total solids were recorded 767.4 mg/L at station-I, 735 mg/L at station-II and 714.35 mg/L at station-III respectively. The concentration of total dissolved solids were 424.88 mg/L at station-I, 403.7 mg/L at station-II and 421.1 mg/L at station-III. The concentration oftotal suspended solids 342.56 mg/L at station-I, 331.67 mg/L at station-II and 294 mg/L at station-III.

Higher concentrations of chlorides were reported in lake which reveals high pollution levels in the lake and the presence of larger amounts of domestic sewage. Higher concentration of chlorides associated with higher degree of pollution [5]. The total hardness of the lake was very high compared to their permissible limit of BIS [9].The lake water was very hard according to WHO standards. Very high hardness may be due to sewage contamination or addition of detergents. This is in conformity with Basavaraju Simpi *et al*., [7]. High Ca^{2+} content is an indicator of the eutrophic waters. Padma Priya et al., [17] reported higher values of calcium in fertile lakes. The present water body is rich in Ca^{2+} concentration indicating eutrophic nature of the lake.

High levels of bicarbonates in the lake are due to decomposition of organic matter confirming the presence of high organic content in the lake. Similar observation was made by Amin et al., [5]. The

organic matter concentration is very high in the lake. The most important parameter to assess water quality is DO. Normally lakes that show depletion of dissolved oxygen in hypolimnion during thermal stratification are classified as eutrophic. The present investigation revealed very low values of dissolved oxygen and exhibited inverse relationship with organic matter. This confirms the presence of high concentration of oxidizable organic matter and eutrophic condition. Similar findings were made by Amin Hossaini *et al*., [5].

According to drinking water standards of BIS, BOD should be lower than 6 mg/L [10]. Very high values of BOD were recorded in the lake. Higher BOD values indicate organic contamination, high nutrient loading, decomposition and mineralization of organic matter. The increase in concentration of COD in the lake is may be due to the addition of inorganic matter from domestic sewage, high total solids, low dissolved levels and oxidation of organic waste.

In the present investigation the concentration of nitrates, phosphates and were very high confirming eutrophic condition with high organic pollution, surface runoff from the catchment and sewage contamination. The lake water is unfit for domestic consumption due to high sulphate values. This is in accordance to Javid and Pandit [4]. Total solids and total dissolved solids were found in higher concentration and exhibited positive correlation with BOD and COD in the lake indicating high degree of pollution. Phosphates, nitrates, organic matter and chlorides were major contributors in the increased concentration of total solids and total dissolved solids.

Table - 1: Comparison of the present data with BIS and ISI standards

S.No	Physico – Chemical Parameters	Station – I	Station-II	Station-III	BIS(2003)		ISI 10500:2012	
					P	E	A	P
1	**Temperature**	23.55	23.85	23.9	-	-	-	-
2	**p^H**	8.26	8.36	8.41	5	25	6.5-8.5	No relaxation
3	**CO_3^{2-}**	23.22	23.81	30.8				
4	**HCO_3^-**	232.15	232	241.5				
5	**Cl^-**	362.11	356.74	357.51	250	1000	_	_
6	**DO**	2.69	1.6	2.66	6			
7	**BOD**	94.58	108.3	137.3	3			
8	**OM**	16.48	21.5	28.69				
9	**COD**	125.83	144.9	182	_	10		
10	**TH**	363.05	363.23	418.48	300			
11	**Ca^{2+}**	81.72	76.24	89.76	75	200	75	200
12	**Mg^{2+}**	68.49	70.02	80.05	30	100	30	100
13	**TS**	767.4	735	714.35	_			
14	**TDS**	424.88	403.7	421.1	500		500	
15	**TSS**	342.56	331.67	294				
16	**SO_4^{2-}**	42.01	37.13	35.8	200	400	200	400
17	**PO_4^{3-}**	3.96	3.10	3.36				
18	**SiO_2**	0.028	0.036	0.025				
19	**NO_3^-**	6.88	6.10	4.01	45	45	45	No relaxation
20	NO_2^-	0.34	0.192	0.26	-	-	-	-

Algae:

In the lake four groups of algae were recorded i.e, Cyanophyceae, Chlorophyceae, Bacillariophyceae and Euglenophyceae. Among the four groups of algae Cyanophyceae dominated over the other groups of algae, followed by Chlorophyceae (Figure: 1). The Diatoms were represents very less in number (Table: 2). In general the Cyanophyceae constituted the high peaks during summer and diatoms in winter. Chlorophyceaee dominant in early summer.

The percentage of Cyanophyceae was 80.65% at station-I, 81.63% at station-II and 81.22% at station-III. Cyanophyceae was the dominant group observed higher concentration of chlorides, magnesium, phosphates and total suspended solids contributed to the higher number of Cyanophyceae members. Cyanophyceae exhibited qualitative and quantitative abundance forming blooms almost throughout the period of investigation. Blooms of *Oscillatoria* and *Arthrospira* species were very common in lake.

Table - 2: Percentage of Phytoplankton

Groups	Station-I	Station-II	Station-III	Average %
Cyanophyceae	80.65	81.63	81.22	81.16
Chlorophyceae	10.75	9.86	9.39	10
Euglenophyceae	5.20	4.83	5.92	5.31
Bacillariophyceae	3.38	3.67	3.45	3.5

Cyanophyceae species were represented by *Oscillatoria limnosa, O. formosa, O. agardhi, O. tenuis, Microcystis aeruginosa, M. viridis, Merismopedia punctata*, *Chroococcus minutus, M. Elegans, M. tenuissima* and *Arthrospira platensis* (Table: 3).

Chlorophyceae was 10.75% at station-I, 9.86% at station-II and 9.39% at station-III. Among the Chlorophyceae Chlorococcales dominated the lake. The periodicity and diversity of Chlorococcales and the role of physico-chemical parameters of the lakes in regulating them was studied from time to time. In temperate regions higher atmospheric or water temperature along with bright sunsine are concidered as 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.

Chlorella vulgaris, Ankistrodesmus falcatus, Coelastrum microporum, Crucigenia qudrata, C. rectangularis, Scenedesmus accuminatus, S. acutus, S. quadricauda, S. dimorphus, S. quadricauda var. quadrispina, Actinastrum hantzchii, Pandorina morum, Pyrobotrys incurva, Asterococcus limneticus and *Micractinium pusillum* were observed in the lake.

Euglenophyceae was 5.20% at station-I, 4.83% at station-II and 5.92% at station-III. Euglenophyceae formed comparatively lower fraction of the phytoplankton in the waters of the present investigation. Jyothi and Narasimha Rao [13] found that high value of phosphates and low concentration of dissolved oxygen favour the growth of Euglenophyceae. Kumar and Sinha, [15]observed that the species of *Euglena, Trachelomonas, Phacus, Lepocinclis* are always encountered due to rich oxidizable organic matter in water. Highest concentration of organic matter is helpful for their development.

Euglenoid flagellates occur in polluted environments in a medium rich in organic matter and under stagnant conditions [16]. They are maximum during the months of summer and winter. Krishnamoorthi and Selvakumar [14] observed more number when pH is between 8.0 and 9.0.

Euglenophyceae is represented by blooms of *Euglena polymorpha, Euglena acus, E. viridis, Euglena proxima, Euglena oxyuris, E. elongata*, *E. gracillis, Trachelomonas hispida, Phacus acuminatus, Phacus curvicauda* and *Phacus longicauda.*

Bacillariophyceae was 3.38% at station-I, 3.67% at station-II and 3.45% at station-III. One of the most abundant and diversified groups of algae are Diatoms. In the present study the diatoms were recorded very less number.In the present investigation it was observed that certain chemical factors like bicrabonates, 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.

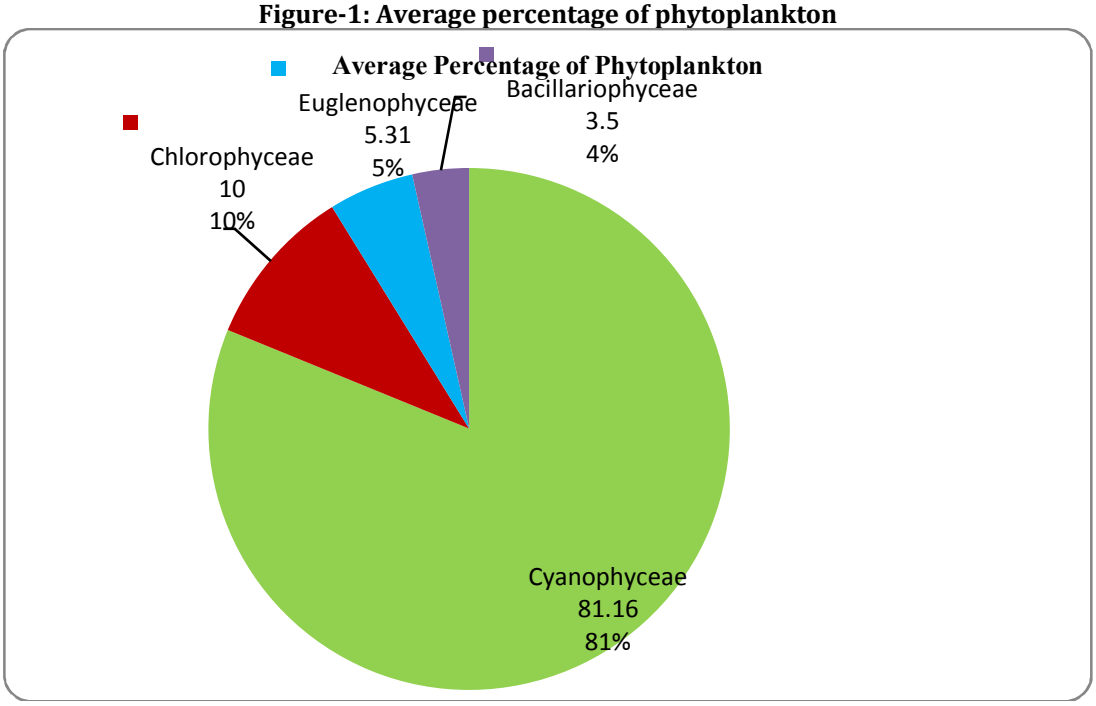
Diatoms were represented by blooms of *Cyclotella meneghiniana, Navicula rhynchocephala and Nitzschia palea* .

In the present observation all the above species are present throughout the period of investigation, which indicates eutrophic nature of the lake (Table: 3).

Table - 3: Common and Dominant species of Phytoplankton in Kapra lake

Group	Dominant Species
Cyanophyceae	*Oscillatoria limnosa, O. formosa, O. agardhi, O. tenuis, Microcystis aeruginosa, M. viridis, Merismopedia punctata, M. Elegans, M. tenuissima, Chroococcus minutus* and *Arthrospira platensis.*
Chlorophyceae	*Chlorella vulgaris, Ankistrodesmus falcatus, Coelastrum microporum, Crucigenia qudrata, C. rectangularis, Scenedesmus accuminatus, S. acutus, S. quadricauda, S. dimorphus, S. quadricauda, Actinastrum hantzchii, , Pandorina morum, Pyrobotrys incurva, Asterococcus limneticus* and *Micractinium pusillum.*
Euglenophyceae	*Euglena polymorpha, Euglena acus, E. viridis, Euglena proxima, Euglena oxyuris, E. elongata, E. gracillis, Trachelomonas hispida, Phacus acuminatus, Phacus curvicauda* and *Phacus longicauda.*
Bacillariophyceae	*Cyclotella meneghiniana, Navicula rhynchocephala and Nitzschia palea* .

Figure-1: Average percentage of phytoplankton



CONCLUSIONS

The water was alkaline in Kapra lake. Carbonates and dissolved oxygen were recorded in low concentration, organic matter, COD, phosphates and nitrates were recorded in high concentration. Cyanophyceae, Chlorophyceae, Euglenophyceae and Bacillariophyceae were recorded in the lake. Among the four groups of algae Cyanophyceae constituted the dominant group. Bacillariophyceae recorded in very low numbers. pH, dissolved oxygen, organic matter, phosphates, nitrates influenced the growth of Cyanophyceae. Temperature, organic matter, phosphates, nitrates influenced the growth of Euglenophyceae. Bacillariophyceae influenced by silica and dissolved oxygen.

Microcystis, Arthrospira, Oscillatoria, Chlorella, Scenedesmus, Cyclotella, Gomphonema, Nitzschia, Euglena, Phacus were dominant in the lake, they can be used as good indicators of pollution. On the basis of both physico-chemical and biological characteristics the lake water is polluted and eutrophic.

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CITATION OF THIS ARTICLE

K. Jagan, Y. Seeta and P. Manikya Reddy· Ecological studies on Kapra Lake with reference to water quality. Bull. Env.Pharmacol. Life Sci., Vol 11 [8] July 2022 : 49-54