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STUDY OF WATER QUALITY OF JAIL AND KALWA LAKE, THANE, MAHARASHTRA

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Abstract:

The two lakes namely Kalwa and Jail lake of Thane city are eutrophicated and hence the study were done to find the quality of water for the period of 6 months for various physico-chemical parameters to study the pollution status of the lakes. The Jail lake is found to be relatively more organically polluted and greater degree of eutrophication the Kalwa lake.

Among water quality parameters, a positive correlation was found between chlorophyll and temperature, suspended solids, pH, dissolved oxygen (not with chlorophyll c), CO_2 (only with chlorophyll c). A negative correlation was seen between Chlorophyll and light penetration. The Chlorophyll a and b showed negative correlation with CO_2 silicates and phosphates.

Introduction:

Due to over expanding population and industrial settlements, the demand of freshwater is increasing day by day. Lakes being stagnant water ecosystem face the problem more severely, damaging the water quality and aquatic life.

Thane, the 'Lake City', has only few lakes existing today. The condition of most of the lakes is alarming. Kalwa lake and Jail lake are two of them which serve the recreation purpose and can be used for aquaculture purpose. Hence the study of pollution status of two water bodies namely Kalwa lake and Jail lake was done from September 2002 to February 2003. The variation noted in various physicochemical parameters, their correlation and the water quality is discussed in the paper.

Material and methods:

Study area: The two lakes selected for the present study were namely Kalwa lake with an area of (approx.) 24,266.75 sq. feet and Jail lake with an area of (approx.) 10.938.83 sq. feet. Both lakes are about 5 km away from each other.

During the study period, the surface water samples were collected in clean plastic cans during the morning hours, once in a month from three different stations and from the centre from each lake employing a rowing boat. Later the data was pooled together and represented as monthly data of the lake.

Air temperature, water temperature and light penetration were recorded on the spot. The samples for DO were fixed immediately on the field itself. The remaining parameters were analyzed as per the methods described in Standard method (APHA, 1981), Trivedi and Goel (1984) and Kodarkar *et al.* (1992). Monthly observations were recorded as indicated in Table 1.

Result and discussion:

Table 1. Hydrobiological parameters of Kalawa and Jail lake, Thane, Maharashtra.

Months	Air temp		Water temp		Light		Total Solids		Dissolved		Suspended		pH		Chlorides		Salinity	
	°C		°C		cm		mg/l		mg/l		mg/l				mg/l		ppt	
	K	J	K	J	K	J	K	J	K	J	K	J	K	J	K	J	K	J
Sept-02	28.3	29.7	28.5	29.1	50.4	37.8	560	400	460	234	200	167	7.8	9.3	87	42	0.17	0.11
Oct-02	28.5	26.5	28.7	27.8	50	34.8	933	400	667	300	267	100	7.7	8.7	90	43	0.19	0.11
Nov-02	25.5	20	25.8	21	42.5	22.5	667	1800	467	300	400	1500	8.6	7.9	91	45	0.2	0.11
Dec-02	22.8	24.5	24.3	26	35.5	20.5	400	500	400	300	0	200	7.5	6.5	106	51	0.22	0.12
Jan-03	14	16	13	14.5	34.8	17.5	733	900	400	300	333	600	8.7	8	116	50	0.24	0.12
Feb-03	12.7	15	14	15	36.5	17.5	400	300	333	2000	67	100	8.7	8	120	56	0.25	0.13
Average	22	22	22.4	22.2	41.617	25.4	616	717	455	272	211	445	8.2	8.1	101.7	47.83	0.21	0.12
SD	6.995	5.912	7.085	5.86	7.187	8.931	206.51	570.67	114.93	44.276	154.4	549.983	0.557	0.94	14.32	5.419	0.03	0.01

Months	Dissolved solids		Suspended solids		Dissolved Oxygen		Free CO2		Silicates		Phosphates		Nitrates		BOD	
	mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l	
Sept-02	460	234	200	167	2.9	7.8	5.7	0	42.6	37.35	0.03	0.014	0.16	0.15	5.8	9.9
Oct-02	667	300	267	100	2.5	4	0	0	51.1	37.35	0.038	0.026	0.08	0.16	5.7	5.2
Nov-02	467	300	400	1500	2	0.9	1.03	7.92	49	48.8	0.03	0.2	0.2	0.21	2.3	1.7
Dec-02	400	300	0	200	0.7	1.2	1.25	6.6	53.5	47.05	0.074	0.086	0.27	0.16	0.2	2
Jan-03	400	300	333	600	1.6	0.7	0	9.9	35.95	34.05	0.05	0.086	0.13	0.12	0.8	0.5
Feb-03	333	2000	67	100	1.3	2	0	0	50.9	61.8	0.062	0.062	0.24	0.2	0.6	5.3
Average	455	272	211	445	1.8	2.8	1.33	4.07	47.18	44.4	0.047	0.079	0.18	0.167	2.6	6.6
SD	114.93	44.276	154.35	549.98	0.804	2.704	2.214	4.581	6.626	10.75	0.018	0.066	0.071	0.033	2.566	3.447

Table 2. Chlorophyll estmation from Jail (a) and Kalwa (b) lakes in Thane, Maharashtra.

Months	Chlorophyll					
	Ch-a		Ch-b		Ch-c	
	A	B	A	B	A	B
Sept-02	-	-	-	-	-	-
Oct-02	-	-	-	-	-	-
Nov-02	-	-	-	-	-	-
Dec-02	.109	.044	.05	.043	3.761	1.179
Jan-03	2.742	5.317	.866	0.206	-0.598	0.393
Feb-03	1.795	4.105	0.592	0.633	-0.146	0.221
Average	1.549	3.155	0.503	0.294	1.006	0.336
SD	1.334	.0415	2.397	2.762	0.305	0.783

Result and discussion:

Temperature:

It is an important abiotic factor as it has effect on certain chemical and biological activities in the organisms attributing in aquatic media.

During the present study the air temperature ranged between 12.7 °C and 28.5 °C near Kalwa lake whereas between 15 °C and 29.7°C in Jail lake. Minima was observed in February near both lakes while maxima in October near Kalwa lake and September near Jail lake. Similarly water temperature recorded was between 13.0 °C and 28.7°C in Kalwa lake and between 14.5 °C and 29.1 °C in Jail lake. Minima observed in January and maxima coinciding with air temperatures. Though both lakes are situated in nearby locations, the temperature difference might be either due to one hour difference between the collection times or due to the geographical difference in the locations.

Water temperature showed significant negative correlation with chlorophyll a and b in both lakes while significant positive correlation with chlorophyll c.

Light penetration:

Secchi depth has been used for many years as a limnological characterization tool for measuring water clarity, growth and decay of plankton and suspended detritus in aquatic media. It is a reliable indicator of the trophic state of a water body.

During the present study, light penetration was more in Kalwa lake (Avg. 41.6 cm) than Jail lake (25.4cm). This shows that the water from Kalwa lake to be more clean than water form Jail lake. The colour of water was always green with thick mat of *Microcystis spp.* In Jail lake. This also reflects the presence of Chlorophyll content in Jail lake.

The light penetration was more in post monsoon month and reduced progressively in further months. More penetration might be due to dilution by rain water and its reduction due to evaporation of water.

The light penetration recorded in different lakes of Thane city at different studies ranges from 4 cm to 105.5 cm .(Somani, 2002; Mani, 1994; Raut, 2006).

Light penetration shows positive significant correlation with Salinity and Dissolved Oxygen in both lakes. In Kalwa lake it shows significant correlation with BOD, while in Jail lake it shows significant negative correlation with chlorophyll. It indicates that light penetration increases with temperature while chlorophyll decreases with temperature and light penetration. The visual observation also confirms the finding as in the month of September with high temperature the lake was not covered with *Microcystis spp., which* gradually increased with low temperature in January.

Suspended solids:

The amount of suspended solids reflects the pollution status of the water body. It may indicate mud, plankton and particulate matter (Pejaver,1984; Tandel,1986). Excessive amount of suspended solids can harm aquatic organisms and seriously interfere with photosynthesis by preventing light penetration.

The suspended solids observed during present study are in the range of 0-400 mg/l in Kalwa lake and 100-1500 mg/l in Jail lake. The results indicate Jail lake to be more polluted as the difference is due to the high density of *Microcystis spp.* present in Jail lake. Suspended solids also show significant relation with chlorophyll.

pH:

In the aquatic ecosystem estimation of pH indicates the metabolism of CO_2 and O_2 in water, as pH is a function of dissolved CO_2 content (Odum,1971). Many Indian lakes report alkaline pH, which is true even for lakes in Thane. Different ranges of pH observed for different lakes were between 6.60 and 8.59 (Jain,1968; Nene,1985; Mani, 1994). Somani (2002) observed the range between 7.15 and 8.97 for Kacharali lake while between 7 and 8.59 in Masunda lake.

During the present investigation, the pH was always towards alkaline side in both the lakes except in December 2002 in Jail lake (pH 6.5). The pH of Kalwa lake was higher than Jail lake except in September and October 2002. There was no difference in the average pH of both lakes. In September 2002 the pH of Jail lake was highly alkaline. The constant transformation process of organic matter accumulated at the bottom into humic substance becomes the buffering factor controlling the changes in reaction (Gorniak,1996). Such reactions in both the lakes must have maintained the alkaline pH. It does not show any relation with temperature or other parameters except chlorophyll where correlation is significantly positive.

Chlorides and Salinity:

The chlorides control the salinity of water and osmotic stress on biotic communities (Salaskar and Yeragi, 1997; Malathi, 1999). The most important source of chlorides in the fresh water is the discharge of domestic and industrial sewage. The concentration of chlorides is thus the indicator of pollution (Ambasht, 1971; Kodarkar *et al.* 1991). They also indicate presence of organic matter in the water body (Thresh *et al.* 1994).

During the present study, the chlorides were present in the range of 87 to 120 mg/l in Kalwa lake and 42 to 56 mg/l in Jail lake. Among the two, Kalwa lake showed higher chlorides than Jail lake, which might be due to position of the lake as it is near to Thane creek.

During the present investigations, chlorides were high in the month of December and January in both lakes, which might be due to the evaporation of water in post monsoon season.

Dissolved Oxygen (DO):

Dissolved oxygen (DO) plays an important role in maintaining the presence and distribution of aquatic life. Aquatic macrophytes, benthic algae and phytoplankton add to the DO during photosynthesis in addition to wave action, turbulence or surface water agitation. At the same time, the zooplankton and other animal fauna may utilize this DO for respiratory activity. Hence, large variation is seen in DO levels of lakes, at different times or in different seasons.

During present study, similar conditions are recorded. DO variation is seen in the range of 0.7 to 2.9 mg/l in Kalwa lake while 0.7 to 7.8 mg/l in Jail lake. Thus, variation in DO was remarkable in Jail lake. This can be attributed to the bloom of *Microcysits spp.*, photosynthetic activity of which might have released more DO.

According to Arumugam and Furtado (1979) higher level of DO is indicator of eutrophication while Salakar and Yeragi (1997) stated that persistent low DO value in the lake indicate a very high degree of organic pollution. DO level can be lowered down during phytoplankton blooms, as the dead plankton are degraded by bacteria utilizing DO (Lavington, 1982) or DO can be used by organic waste (Trivedi and Godel, 1984). This may lead to anoxic conditions. The DO levels in both the lakes were always below the critical value except in two months in Jail lake September - 7.8 mg/l and October-4 mg/l.

According to the findings of various researchers, the DO in different lakes of Thane city ranged between 0- 12.7 mg/l (Nene 1985; Mani 1994; Somani 2002, Raut, 2006). During the present study, both lakes showed higher DO in September and October 2002 than the remaining months.

Somani (2002) commented that in Kacharali lake high DO values were in winter, while in Masunda lake they were high in rainy season. During the present study in both the lakes high DO values were observed in post rainy season.

The dissolved oxygen shows high positive correlation with BOD, chlorophyll a and chlorophyll b while high negative correlation with phosphates and chlorophyll c.

Biological Oxygen Demand-BOD:

It is the measure of degradable organic matter present in water and can be defined as the amount of oxygen required by the microorganisms in stabilizing the biologically degradable organic matter under aerobic condition.

During the present study, the BOD rang in Kalwa lake was between 0.2 to 5.8 mg/l while in Jail lake it is 0.5 to 17 mg/l. The average BOD of Kalawa lake (2.6 mg/l) is less than Jail lake (6.6mg/l). Though there is no much difference in average BOD, the Jail lake seems have more BOD. But compared to the other BOD values these vales are negligible which might be due to photosynthetic activity of phytoplankton.

Free Carbon di-oxide:

Carbon di-oxide is added to aquatic ecosystem by directly being mixed from atmosphere. In addition to this, the other sources are rain water, inflowing ground water and the respiration of aquatic flora and fauna. The decomposition of organic matter from aquatic ecosystem also adds to CO_2 in water (Datta Munshi and Datta Munshi,1995), but as it gets constantly released in air the amount of free CO_2 is kept low in water. The photosynthetic activity of aquatic flora also reduces the free CO_2 in water.

During the present study free CO_2 was 0 mg/l for three months in Kalawa lake, while it was in the range of 1.03 to 5.70 mg/l in remaining three months. The low free CO_2 in most of the months can be attributed to the large surface area and the movements of water due to it's usage by the nearby inhabitants. Similarly, fishing activity also goes on this lake.

In Jail lake though continuous presence of *Microcystis spp.* was noted, the free CO_2 was comparatively high in 3 months i.e. from 6.6 to 9.9 mg/l while for 3 months it was 0 mg/l. The free CO_2 was thus much more than even noted by Somani *et al.* (2001) in other lakes from Thane, which might be the indicator of degradation of organic matter. The three months when free CO_2 levels were very high, thick mat of *Microcystis spp.* was recorded which had formed black green scum above the surface showing large decomposition activity. The free CO_2 also shows significant correlation with chlorophyll; negative with chlorophyll a and b while positive with chlorophyll c.

Silicate:

Silicate is an essential element as it is required for growth of diatoms and having the covering of silica shell. Silicates thus affect the growth and composition of phytoplankton (Lund, 1964; Egge and Aksenes, 1992). In natural water, normally the range of silicates remains from 2 to 25 ppm (Cole, 1979) and rarely it goes more than 60 mg/l. During the present investigation, the range of silicates seen in Kalawa lake was between 35.95 and 53.50 mg/l while in Jail lake it was 34.05 to 61.80 mg/l. It shows negative significant correlation with chlorophyll a and b.

Phosphates:

Phosphate is considered as the most critical single element for biological productivity (Banerjee, 1967; Ketchum, 1967). Increased concentration of phosphates is taken up by the phytoplankton, which leads to algal blooms. As per the previous studies on lakes of Thane city, the phosphates are reported in the range of 0.01 to 0.79 mg /l (Mani, 1994; Pejaver *et al*, 2002; Pejaver and Raut, 2002; Pejaver and Somani, 2002; Somani, 2002).
The inverse relation was found in the phytoplankton density and PO_4 –P. The same observation was done by Olsen and Sommerfield (1977). Many algae including diatoms utilize this vital element when available in excess than their actual requirement and draw upon the same during the subsequent period of scarcity (Ketchum, 1957; Lund, 1949). Phosphates also show negative correlation with chlorophyll a and b.

Nitrates:

Most of the unpolluted sources of water are deficient of nitrates because it exists only in few natural sources (Trivedi and Goel, 1984). Biological oxidation of organic nitrogenous substances present in domestic and industrial sewage and nitrifying bacteria add nitrates to water body. While utilization by green plants and denitrifying bacteria help in reduction of nitrates.

The range of the nitrates recorded in different lakes of Thane is 0.06 to 0.21 mg/l. (Pejaver and Somani, 2002; Somani, 2002). In present study, the range of nitrates was between 0.080 and 0.270 mg/l in Kalwa lake and 0.120 and 0.210 mg/l in Jail lake, which do not differ much from other lakes in Thane city.

Chlorophyll:

They observed that chlorophyll a values reduced with decrease in total nitrogen in lake waters. According to French and Petticrew, 2007, Chlorophyll *a* concentration was maximum during the late summer/early autumn when near-surface total phosphorus ([Tot-P]) and total dissolved P concentrations, pH, and water temperature were highest. High nutrient content leads the water to eutrophication and eutrophicated water shows higher values of Chlorophyll a (Ishida and Mitamura, 1986).

During the present study, chlorophyll estimation was done only for last three months. The chlorophyll a ranged from 0.109 to 1.795 mg/l in Kalwa lake while between 0.044 and 5.317 in Jail lake, indicating Jail lake to be more productive. This lake shows mostly the green colour due to the growth of phytoplankton specifically *Microcystis spp.* The chlorophyll a showed inverse relation with chlorophyll c.

The TSI (Trophic State Index) or Carlson Index was calculated for both lakes by using following equation :

$$TSI= 60-14.41 (\ln SD),$$

where SD is Secchi Disk Depth.

Determination of trophic status of lakes:

The results were as indicated in Table 2. A lake which has TSI greater than 60 are classified as eutrophic lakes.

Lakes / Months	Kalawa lake	Jail lake
Sept-02	64.29	66.09
Oct-02	64.34	66.61
Nov-02	65.35	69.34
Dec-02	66.48	69.92
Jan –2	66.61	70.91
Feb-02	66.31	70.91
Avg.	65.56	68.96

Conclusion:

According to the various parameters studied and calculation of TSI using Secchi disk transparency, it is concluded that both lakes are eutrophic in nature and on the verge of going hypertrophic leading to extreme environmental degradation, succession and final disappearance. Also water in both the lakes is found to be of 'E' grade (can be used for irrigation, industrial cooling and controlled waste disposal) quality as it has low DO and high BOD. (Singh and Anandh (1996). It needs a long term plan for reversal of eutrophication and pollution control which can improve the water quality and make the lakes suitable for both recreation and aquaculture purpose with water quality of B grade as recommended by the Ministry of Environment & Forests (MOEF) in its revised guidelines of National Lake Conservation programme (NLCP).

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