MICROBIAL DIVERSITY AND PHYSICO-CHEMICAL ASSESSMENT OF LAKE WATER

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Abstract— **Qualitative assessment of lake water in nearby rural as well as urban areas of Kengeri locality (Bangalore city) was undertaken on a moderate level in the following study. The problem investigated was poor condition of lakes as they were not maintained well thus the water was not in the condition of direct consumption. We used different methods for the assessment like pH of water, odor, BOD or DO, COD estimation of coliforms by MPN, and microbial examination by spread plate method. As a result, we found that lake Byrohalli was the cleanest of all with highest DO of 3.6mg/L after incubation, whereas other two lakes displayed zero dissolved oxygen. COD of lake Byrohalli was least at 0.8 mg/L, while Kommaghatta and Mallathalli had 1.6mg/L and 3.2mg/L respectively. Also the MPN index of Byrohalli lake was least i.e., 350/100ml, while that of Kommaghatta was 540/100ml and Mallathalli with highest index of 1600/100ml. The microbial diversity in bacterial forms was found to be highest in lake Mallathalli followed by Kommaghatta and the least in lake Byrohalli.**

Keywords— **Chemical oxygen demand (COD), Biochemical oxygen demand (BOD), Dissolved oxygen (DO), Most probable number (MPN), coliforms.**

I. INTRODUCTION

The estimation of species surrounding the lake, seasonal variations in terms of time period and range of extremes along with the discharge of effluent into the water body is important with regards to a lake in fragile environment. *(El-Serehy et al., 2018)*
Introduction of non-indigenous species, chemical pollutants, and climate changes along with usage of land can change the physical and chemical composition of a lake. This may also lead to destruction of the naturally available organisms in and near lake like phytoplankton cultural also leading to eutrophication. *(Allinger and Reavie, 2013)*. A man-made lake can be sometimes potentially dangerous as it attracts the pathogens and parasites and other invasions. *(Carolus et al., 2019)*
Eutrophication is a constant reason of lake deaths and a widespread environmental problem. Sometimes the lakes recover when nutrient influx is lowered. Also lowered influx of phosphorus from soils may be useful save lakes from eutrophication in agricultural regions. As this type of eutrophication is unchangeable without proper soil management. *(Carpenter, 2005)*
Reducing phosphorus disposal into lakes is a key rescue tool for controlling Lake Eutrophication. Increased inputs of phosphorus into water bodies degrades water quality and reduce the oxygen levels in central basin hypolimnetic which, in turn, eliminates the thermal habitat mandatory to cold-water organisms and contributes to the removal of important benthic prey species of the fishes. *(Scavia et al., 2014)*
The degradation of aquatic ecosystems due to nutrient enrichment results in excessive cyanobacterial water blooms. It is a serious global problem that may render ecosystem as well as health at risks. Significant amount of research and experimentation has been made possible to recognize the wide range of toxins produced by cyanobacteria. *(Bláha et al., 2009)*.
The enrichment of water bodies by nutrients have a significantly large impact on the magnitude of predator avoidance. *(Turner and Chislock, 2010)*

The north temperate regions contains the lakes of highest densities on earth which are threatened by chloride run-off and ever increasing urban settlements that are salinizing the lake freshwaters and there by deteriorate water quality and ecosystem services provided by lakes. *(Dugan et al., 2017)*
Proper measures needs to be taken to control phosphorus related eutrophication by using sediments having high affinity towards phosphorus is expected to be helpful in subsiding the ageing process of lakes. *(Schindler, 1974)*

II. METHODOLOGY

A. Sample Collection

Lake water samples were collected from three different lakes in the vicinity of Kengeri namely; Mallathalli Lake, Byrohalli Lake and Kommaghatta Lake.
The samples were directly collected into BOD bottles and were taken to the laboratory for further examination.

B. Physical examination

PH of the collected samples was measured using **pH meter**.

The odour of the sample was noted down.

C. Chemical Examination

Chemical examination was carried out using methods for estimation of Dissolved Oxygen (DO) (***Aneja, 2007***) (***Verma and Singh, 2012***) (***Brookman, 1997***), (***Apha-biochemical-oxygen-demand-white-paper***) and Chemical Oxygen Demand (COD) (***Aneja, 2007***) (***Pisarevsky, 2005***) (***Hur et al., 2010***) (***Canelli et al., 1976***) (***Rho et al., 2018***) (***Determination of Chemical Oxygen Demand in Waters and Effluents, 1998***)

D. Microbial examination

The Isolation of microbes by spread plate method, Standard plate count (SPC), and Most Probable Number (MPN) (***Aneja, 2007***), (***Ahmad et al., 2017***) method were carried out as a part of microbial examination along with gram staining. (***Gyure, 2010***) (***Bartholomew and Mittwer, 1952***), (***ASM.org***)

III. EXPERIMENT AND RESULT

A. Physical Examination

3.1.1) **Noted pH**

LAKE	pH
Byrohalli	7.36
Mallathalli	7.83
Kommaghatta	7.99

Table: 1.0 pH of the water samples tested

3.1.2) **Odor**

At the time of water sample collection only Mallathalli sample was having bad odor.
Rest of the sample were odorless.

B. Chemical Examination

3.2.1) **Dissolved Oxygen (DO):** The surface water designated as cold-water fisheries must meet a minimum dissolved oxygen standard of 7mg/L, surface water protected for warm water fish and aquatic life must meet a minimum DO of 5mg/L. DO levels of around 100% saturation are good for aquatic life. (***Michigan Water Quality Standards***)

Fresh Sample	DO(mg/L)	DO after incubation(mg/L)	BOD (mg/L)
Byrohalli	5.46	3.6	1.86
Mallathalli	4.4	0	4.4
Kommaghatta	4.92	0	4.92

Table: 2.0 Dissolved oxygen of the water samples tested

3.2.2) **Chemical Oxygen Demand (COD)** of samples was measured and calculated.

SAMPLE	COD (mg/L)
Distilled water	0
Byrohalli lake	0.8
Kommaghatta lake	1.6
Mallathalli lake	3.2

Table: 3.0 COD of the water samples tested

C. Microbial Examination

[Here S-small, M-medium, L-large, P-pin head]

Table: 4.0 **Microbial Examination of water sample from lake Kommaghatta**

10^{-1}	COLOR	SIZE	APPEARANCE	ELEVATION	VISIBILITY	MARGIN	GRAM STAINING
	Yellow(5)	S, M	Smooth	Raised	Opaque	Irregular	Gram negative coccus
	Pale yellow(209)	S	Smooth	Raised	Opaque	Regular	Gram negative coccus
	Orange (5)	M	Smooth	Raised	Opaque	Circular	Gram negative rods
	Cream(114)	M	Smooth	Raised	Opaque	Irreg., circular, Wrinkled	Gram negative rods
10^{-2}	Cream(3)	S	Smooth	Flat	Opaque	Circular	Gram negative coccus
10^{-3}	Cream(1)	M	Smooth	Flat	Opaque	Circular	Gram positive rods

10^{-1}	Cream(11)	M,S,P	Smooth	Flat	Opaque	Circular	Gram negative rods
10^{-2}	Cream(1)	L	Smooth	Flat	Opaque	Irregular	Gram negative rods
	Yellow(1)	L	Rough	Raised	Opaque	Circular	Gram negative coccus

Table: 5.0 Microbial Examination of water sample from lake Byrohalli

10^{-1}	Orange (72)	M,S	Smooth	Raised	Opaque	Irregular Circular	Gram negative rods
	Cream(220)	M,S,P	Smooth	Flat	Opaque	Irregular, Circular	Gram negative rods
	White(24)	L,M,S	Smooth	Raised, Flat	Opaque	Irregular	Gram negative rods
10^{-2}	Orange(8)	M	Smooth	Flat	Opaque	Irregular	Gram positive coccus
	Orangish White (23)	M,S	Smooth	Flat	Opaque	Irregular, Circular, Wrinkled	Gram negative rods
	Cream(33)	S,P	Smooth	Flat	Opaque	Circular	Gram negative rods
10^{-3}	Cream (9)	M,S	Smooth	Flat	Opaque	Circular	Gram negative rods
10^{-4}	Yellow (1)	M	Rough	Raised	Opaque	Irregular	Gram negative coccus
	Cream (1)	L	Smooth	Flat	Opaque	Irregular	Gram negative rods

Table: 6.0 Microbial Examination of water sample from lake Mallathalli

D. Most Probable Number (MPN)

Note: Color change denote acid is produced by microbe.

Byrohalli	10ml	1ml	0.1ml	MPN index/100ml
Color change	5/5	4/5	1/5	
Gas Production	5/5	5/5	1/5	350
Mallathalli				
Color change	5/5	5/5	3/5	
Gas Production	5/5	5/5	5/5	1600
Kommaghatta				
Color change	5/5	5/5	4/5	
Gas Production	5/5	5/5	2/5	540

Table: 7.0 MPN index of the water samples tested

IV. DISCUSSION

Lakes are the important source of fresh water and several microbes, plants, animals thrive on its water. These natural or man-made water bodies are in plenty in number [167+ according to (**BBMP**)] in the city of Bangalore, but it is a matter of concern that most of them are not in a good condition. The increasing population and rapid urbanization of the city is posing a serious threat to the lakes, some of them have been completely killed (filled up with mud) in order to provide space to make residential building; thus the health of lakes have become a serious issue in the developing smart cities. Study of nearby lakes namely **Byrohalli** lake, **Kommaghatta** lake and **Mallathalli** lake in the vicinity of Kengeri, Bangalore was carried out to check the water quality by performing certain examinations on water samples. Since the above mentioned lakes are inside the city; they are free from industrial pollution. The sample collection was done in the month of February which is not much hot climate in Bangalore city. Even these are not disposed with any kind of human wastes. Although all of these are having metal wire fencing, only two (Kommaghatta and Byrohalli) of them are well maintained, lake Mallathalli was not in good condition; water was stinking with algal bloom on sides. It was dark in color due to improper maintenance and some human interference. It was a mess to collect water sample from that lake. On the other hand, Lake Kommaghatta was well maintained with a proper fencing surrounded by lush green garden having beautiful and rare type of flower, tree and bush variety. It is also used for fishing purpose and we were able to see birds from dinosaur era. Lake Byrohalli did not had much greenery around but it had very clean water which was pulled up using bore wells and sent to nearby areas for water supply. The water samples were collected from these lakes and were examined for various tests like pH, odour, DO, COD and MPN. Also, the spread plating after serially diluting the samples was done for the identification and isolation of various microbial forms.

On considering and comparing our work with previous studies, it can be surely said that the obtained DO values do not meet the standard minimum requirements as only Byrohalli lake had DO of 5.46mg/L which is just on the border line as compared to the DO levels recorded at lake **Mallital** 7.9mg/L to 8.6mg/L of Nanital *(Sharma, 2014)* city whereas the BOD levels were as low as 2.8mg/L to 3.5mg/L which is as good as the BOD 1.86mg/L (Table 2.0) of lake Byrohalli. The 24DO levels of some of the urban **lakes in Thane *(Nabar et al., 2014)*** district were 6mg/L, 5mg/L ,4,mg/L with the BOD values of 2mg/L, 3mg/L, 3mg/L respectively with a pH of range 6.5 to 8.5.

According to Indian standard the BOD of 3mg/L to 5mg/L *(BIS, 1991)* is considered good enough. The other two lakes of Mallathalli and Kommaghatta were having BOD of 4.4mg/L and 4.92mg/L (Table 2.0) respectively, which is comparatively very less than that of the **lakes of Chennai *(K.Raji and Abraham , 2018)*** ranging from 9 to 34mg/L of BOD. One recent study in **Lalbagh *(Gorain et al., 2018)*** lake of Bengaluru city was found to be contaminated excessively with heavy metals due to immersion of religious idols leading its BOD and COD from 17.5 and 135.5 to 27.4 and 237.5 mg/L respectively. On the other hand, COD values ranged from 0.8 to 3.2mg/L (Table 3.0) which is very less as compared to other lakes studied by different people which ranged up to 104.11mg/L in case of **Ramgarh lake *(Barnwal et al., 2015)***, Gorakhpur, U.P. Lakes of Chennai ranging from 12.8mg/L to 102mg/L kind of high scale variations. pH noted was fairly ok in the range of 7 to 8 (**Table 1.0**) which is almost neutral; as pH (Road and Grove 2004) 6 to 9 is recommended good for aquatic life. Also the pH at **Bitter lake *(El-Serehy et al., 2018)*** was around 8.04 to 8.30 and lakes of Chennai ranged from 6.1 to 8.87.

Microbial examination(MPN) *(Aneja, 2007) (Ahmad et al., 2017)* obtained was very high which denotes that the water contained high number of Coliforms in case of lake **Mallathalli** with MPN equal to 1600/100ml (**Table 7.0**) water followed by **Kommaghatta** lake with 540/100ml (Table 7.0) range and the least polluted was found to be **Byrohalli** lake with 350/100ml (**Table 7.0**) vaFlue at standard MPN index which can be compared with the MPN range of **Chennai lakes** from 34/100ml to /900/100ml and that of in lakes of Thane district was 50/100ml, 500/100ml, and 5000/100ml. Also a significant of gram negative colonies of bacteria (rods and coccus) were obtained which gives a rough picture of lake water quality (**Table 4, 5, 6**).

V. CONCLUSION

The results of the current study indicated that the lakes of Mallathalli and Kommaghatta were in bad condition in terms of its water quality as they are in closer proximity to the city thus, affecting all the life forms linked to them, while lake Byrohalli (in outskirts of city) was in much good condition as compared to the other two lakes.

Impurities in the lake water causes degradation of water quality. As the summer approach; lake spoiling parameters increases while it decreases/dilutes in rainy season. This increases the nitrogen content simultaneously causing more microbial growth and thus leading to eutrophication of lake. This leads to depletion of oxygen in water which kills the fishes that feed on malarial larvae causing outburst of disease. Also, the microbes at the bottom of lake cannot degrade the waste as there is lack of oxygen in water. These are very common problems for every lake ecosystem, mostly due to human activities and sometime due to natural ageing; lakes die. To overcome these problems serious steps, need to be taken like proper treatment of waste water before releasing it into water, regular checking of water quality and aquatic life in water. Strict rules against breaking of water pollution laws, prohibition of discharge of any kind of waste into water bodies. In country like India, there is a one major practice of discharge of religious offerings into water bodies. This is practiced all over the country in the name of faith. To stop these practices, people need to be educated about the effects because even if the government does cleaning of water bodies (as it happened in case of river Ganga cleaning) or our locality it is our duty to maintain it clean. Millions of rupees was spent on cleaning of Ganga water but still it is not clean. This cannot be achieved by one person or a group of people, everyone needs to do their part in keeping surroundings clean; be it air, land or water as at the end everything gets stuffed into the water bodies.

VI. ACKNOWLEDGEMENT

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