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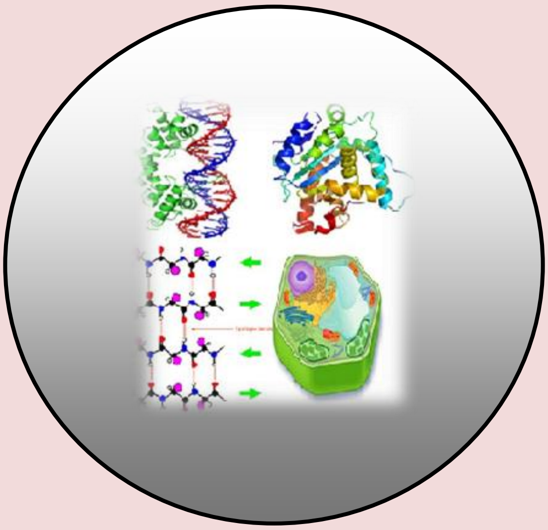

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RESEARCH PAPER

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Role of Macrophytes in reducing the Bacterial Load in two Water Bodies of Different Tropic Status

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ABSTRACT

Aquatic plants play an important role in aquatic systems worldwide because they provide food and habitat to fish, wildlife and aquatic organisms. Plants stabilize sediments, improve water clarity and add to diversity besides suppressing the bacterial population in an aquatic ecosystem. The pathogen removal efficiencies of macrophytes in lakes are not well known. The main objective of the proposed work was to assess the role of various types of macrophytes (submerged, emergent and floating types) in suppressing the bacterial population in ambient waters besides locking up of nutrients from both ambient waters and sediments (Mandi, 1993).

During the present study period Macrophytes of different varieties have been found to reduce the bacterial load in different proportions. The bacterial load reduced by emergent macrophytes varied from a minimum of 2.78 to a maximum of 40.28 %. Bacterial load reduced by free floating macrophytes varied from a minimum of 2.78 to a maximum of 51.39% while by submerged macrophytes it varied from a minimum 40 to a maximum 81%.

The sequence of efficiency in reducing bacterial load by various types of macrophytes is as:

Submerged > free floating > Emergent macrophytes.

During monsoon months low bacterial population recorded in surface waters might be due to dilution factor besides the healthy growth of macrophytes. Healthy submerged macrophytes not only suppress the growth of bacterial population but also reduce the load of nutrients by their uptake mechanism.

Present paper elucidates the role of different macrophytes on monthly basis in Bhoj wetland (a Ramsar site).

Keywords: Macrophytes, Aquatic organisms, Bacterial population, An aquatic ecosystem and Nutrients.

INTRODUCTION

The understanding of many of the natural phenomena in aquatic resources invites attention toward the importance of macrophytes in maintaining the ecological balance of the system besides reducing of the bacterial load.

Several technologies are used to treat domestic wastewater. These can be classified into two groups: conventional and non- conventional treatment plants. The non-conventional systems, which are also called eco-technologies (Nhapi and Gijzen, 2005) include constructed wetlands and waste stabilization ponds. Among these technologies, the widely recommended ones for developing countries are the waste stabilization ponds (WSPs).

The removal of pathogens is of utmost importance since enteric disease is one of the major causes of death in children in developing countries (UNICEF/UNEP, 1990). Other reports indicate that ponds with macrophytes are more efficient in the removal of pathogens than algal ponds (Mandi *et al*., 1993; Garcia and Becares, 1997). There are, however, conflicting reports on the efficiency of pathogen removal in macrophytes and algal ponds.

The use of macrophytes-based ponds for resource recovery calls for a critical examination of the mechanisms involved in pathogen removal. The aim of present investigation is to evaluate the reduction of nutrient & bacteria by macrophytes in water bodies of different tropic status.

Study Area

Two water bodies situated in Bhopal township have been connected under the present investigation. Both of these water bodies are having different trophic status. The two water bodies are Upper lake and Shahpura lake.

In Upper lake effluents entering from the Bairagarh watershed area via Bairagarh nalla pass through various zone of macrophytes belt viz emergent macrophytic belt, floating macrophytes belt and submerged macrophytic belt before reaching pelagic zone On other hand in Shahpura lake effluents mainly enter from the Chunaabhatti, Panchsheel nagar and Charimli watershed areas through respective drains into calumniating a big drain which finally enters into the lake near pollution control board.

MATERIAL AND METHODS

Sampling and analytical methods are especially important because all subsequent decisions about water uses and water quality control activities depend heavily on the validity of data thus compiled. Samples for the analysis were collected from Upper lake and Shahpura Lake. In Upper lake five sampling stations selected for the analysis are Site 1 (inlet water from near Bairagarh nalla), Site 2 Emergent macrophytes, Site 3 Submerged macrophytes, Site 4 Free floating macrophytes and Site 5 pelagic zone. However, in Shahpura lake four sampling stations selected for the analysis are inlet water (Site1) from near panchasheel nalla , Emergent macrophytes (Site2), free floating macrophytes (site3) and pelagic zone (Site4) center of lake.

The water sample was collected on monthly basis from 7.00 to 9 AM. Total coliform counts were determined by Most probable number method and Standard plate count analysed according to APHA 23rd edition, 2017.

RESULT AND DISCUSSION

Coliform group include "the entire aerobic and facultative anaerobic, Gram-negative, nonspore forming rod-shaped bacteria.". Total coliforms (TC), however, are ubiquitous in surface waters, and they include many bacteria from the family Enterobacteriaceae that are not derived from human or other animal pollution sources. Contrary to *Faecal streptococci* the detection of coliforms in wastewater indicates only a possible contamination by feces, as these organisms are capable not only of surviving but also in some cases, of multiplying in water and on soil particles and plants. (APHA, 2017)

In Upper lake maximum value of total coliform (1200/100ml) was recorded during monsoon and the minimum (72/100ml) during winter. Same trend was observed in Shahpura lake also were minimum total coliform (700/100ml) were recorded during winter and maximum (3600/100ml) during monsoon.. Maximum counts observed in monsoon season, can be attributed to the influx of runoff from the catchment besides the decomposing of macrophytes and municipal sewage. Continued entry of domestic sewage in some areas lead to death and decay of macrophytes several macrophytes are in degrading stage during the monsoon period which also influence the growth of bacterial population thus posing pollution problems along with proliferation of bacterial population.

Collins (1963) suggested that the rains bring in particulate matter, which serves as sites of adsorption for bacteria, thereby increasing the bacterial load.

The presence of fecal coliform bacteria in aquatic environments is often used as an indicator of contamination with fecal material and other possible pollutants. (Rivera et al., 1995, Reed et al., 1995, Tyrrell et al., 1995, Tanner et al., 1995, Williams et al., 1995, Ottova et al., 1997, Hernandez et al. 1997). The reduction of nutrient in each Macrophytes belt improves the quality of gray water that is why maximum reduction of nutrients founded in the ambient water collected from palegic zone. Decamp and Warren (2000) found that the concentration of E. coli decreased exponentially with distance along the length of a Sub surface flow constructed wetland.

Significant site variation in MPN count was recorded in Upper lake during both the years (2016-18) which is further confirmed by ANOVA as the calculated values were higher than the tabulated values (2.78) df=4 at 0.05% level of significance with (Table 4 and 5).

Table 1. Reduction of total coliform (MPN) at different sites of Upper Lake.

Months	Year	Load	Emergent Macrophytes	Submerged Macrophytes	Free Floating Macrophytes
June	2016-17	940	1.06	51.06	23.40
	2017-18	720	11.11	47.22	15.28
July	2016-17	1100	14.55	58.18	31.82
	2017-18	940	23.40	59.57	31.91
August	2016-17	930	0.00	53.76	33.33
	2017-18	1200	22.50	40.00	46.67
November	2016-17	640	3.13	54.69	43.75
	2017-18	720	13.89	68.06	51.39
December	2016-17	460	10.87	76.09	21.74
	2017-18	640	32.81	76.56	43.75
January	2016-17	360	2.78	74.44	2.78
	2017-18	380	23.68	81.05	26.32
May	2016-17	720	40.28	51.39	36.11
	2017-18	640	29.51	54.10	29.51

Table 2. Reduction of SPC /ml by Macrophytes at Upper lake.

Months	**Year**	**Load of SPC/ml**	**Emergent Macrophytes**	**Submerged Macrophytes**	**Free Floating Macrophytes**
June	2016-17	32254	12.15	31.43	6.52
	2017-18	34544	20.26	20.51	28.88
July	2016-17	34658	24.33	31.63	5.87
	2017-18	44568	18.13	52.31	29.26
August	2016-17	47852	2.77	30.87	12.47
	2017-18	39856	35.65	40.64	19.04
November	2016-17	36542	48.98	38.93	18.93
	2017-18	31365	24.86	43.73	36.69
December	2016-17	27846	29.66	31.34	21.11
	2017-18	27526	32.94	22.05	36.58
January	2016-17	31546	36.11	44.66	39.30
	2017-18	19784	16.84	37.59	6.71
May	2016-17	34856	7.74	29.26	33.80
	2017-18	27964	23.15	28.93	20.83

In Upper lake maximum value of standard plate count (47852 /ml) was recorded during monsoon and the minimum (13564 mg/l) in winter. Same trend was revealed in Shahpura lake were minimum total SPC (33652/ml) was recorded during winter and maximum (9584/ml) in monsoon.

The higher bacterial population can thus be related to generation of organic matter from both allochthonous and autochthonous source. Lower values of standard plate counts in winter were probably due to the healthy condition of macrophytes. Similar trends were recorded by Singh and Sharma (2016) in Jaisamand lake Alwar (Rajasthan); Agrawal et al., (2010), in Tehri Dam, Garhwal Himalaya ,India; Chohan (2015) in Jaju sagar Dam ,Neemach (Madhya Pradesh). Concerning faecal indicators and pathogen removal Lopez & Becares (1993) found that *Scirpus lacustris* had higher bacteria removal rates than *Typha angustipholia*, *Iris pseudacorus*, *Phragmites Australis.* It is well known that different plant species have different resource requirements and rates of matter processing. Tanner et al., (1995) and Loveridge et al., (1995) while working on differences between planted and unplanted systems concluded that macrophytes play an active role in the removal of microorganisms from wastewater. The presence of plants increased protozoan abundance, which could be another reason for the higher bacteria removal in planted systems (Chavalparit 1997 and Decamp et al., (1999). Soto et al., (2000) showed that planted tanks were more efficient at removing microbes (up to 99.9 %) than unplanted tanks.

Significant site variation in standard plate count was recorded in Upper lake during both the years (2016-18) which is further confirmed by ANOVA as the calculated values were higher than the tabulated values (2.78) df=4 at 0.05% level of significance with (**Table**-6-7). Similar results were also reported in case of Shahpura lake as tabulated values (3.18) df=3 at 0.05% level of significance **(Table - 8 and 9).** The condition of macrophytes during different season has been found play an important role in controlling the ambient microbial population close to its vicinity. The macrophytes in the growing and there healthy stage reduced the microbial numbers as on the other hand during the degradation stage there was an abrupt rise in microbial population in the surrounding water of macrophytes. Reduction of different macrophytes depicted in **(fig. 1 and table 1,2 and 3)**

Awuah(2006) also reported that healthy macrophytes perform better in the removal of coliforms and other enterobacteria .During rainy season emergent macrophytes played no significant role in reducing bacterial load as is evident from **(Table-3)** in the month of August 2016-17 .

Sequence of efficiency in reducing bacterial load is as;

Submerged > free floating > Emergent macrophytes.

During monsoon months in surface waters which is attributed to healthy growth of macrophytes. Thus the condition of macrophytes during different season has been found to play an important role in controlling the ambient microbial population close to its vaccinating.

Table 3. Percentage of MPN Reduction by Macrophytes in shahpura Lake.

Months	Year	Total coliform	Emergent	Free Floating
June	2016-17	2800	28.57	25.00
	2017-18	1100	0.00	15.45
July	2016-17	2300	8.70	26.09
	2017-18	3600	36.11	22.22
August	2016-17	1400	7.14	14.29
	2017-18	1200	-25.00	8.33
November	2016-17	1200	21.67	30.00
	2017-18	1700	35.29	35.29
December	2016-17	1200	22.50	20.83
	2017-18	950	1.05	2.11
January	2016-17	1100	-9.09	13.64
	2017-18	1300	15.38	46.15
May	2016-17	1800	16.67	38.89
	2017-18	1500	13.33	20.00

Table 4. Variation of MPN in Upper lake (2016-17).

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1622579	4	405644.8	15.30891	3.07E-08	2.55717915
Within Groups	1324865	50	26497.3			
Total	2947444	54				

Table 5. Variation of MPN in Upper lake (2017-18).

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1746992	4	436747.9	12.72794	2.12E-07	2.539689
Within Groups	1887275	55	34314.1			
Total	3634267	59				

Table 6. Variation of SPC in Upper lake (2016-17).

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.38E+09	4	3.45E+08	7.53835	7.82E-05	2.55717915
Within Groups	2.29E+09	50	45736482			
Total	3.67E+09	54				

Table 7. Variation of SPC in Upper lake (2017-18).

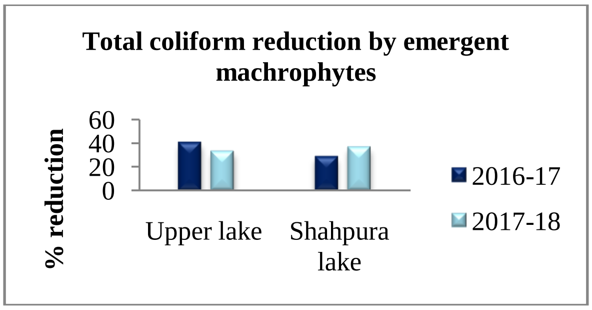
Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	7.43E+08	4	1.86E+08	6.098386	0.00039	2.539689
Within Groups	1.68E+09	55	30469462			
Total	2.42E+09	59				

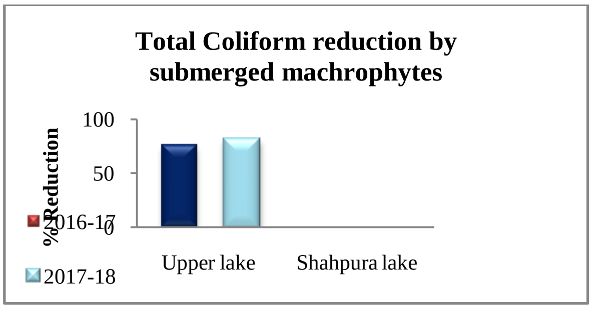
Table 8. Variation of SPC in Shahpura lake (2016-17).

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.55E+09	3	5.16E+08	5.011921	0.004818	2.838745
Within Groups	4.12E+09	40	1.03E+08			
Total	5.66E+09	43				

Table 9. Variation of SPC in Shahpura lake (2017-18).

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	3.07E+09	3	1.02E+09	10.21155	4.01E-05	2.838745
Within Groups	4.01E+09	40	1E+08			
Total	7.08E+09	43				





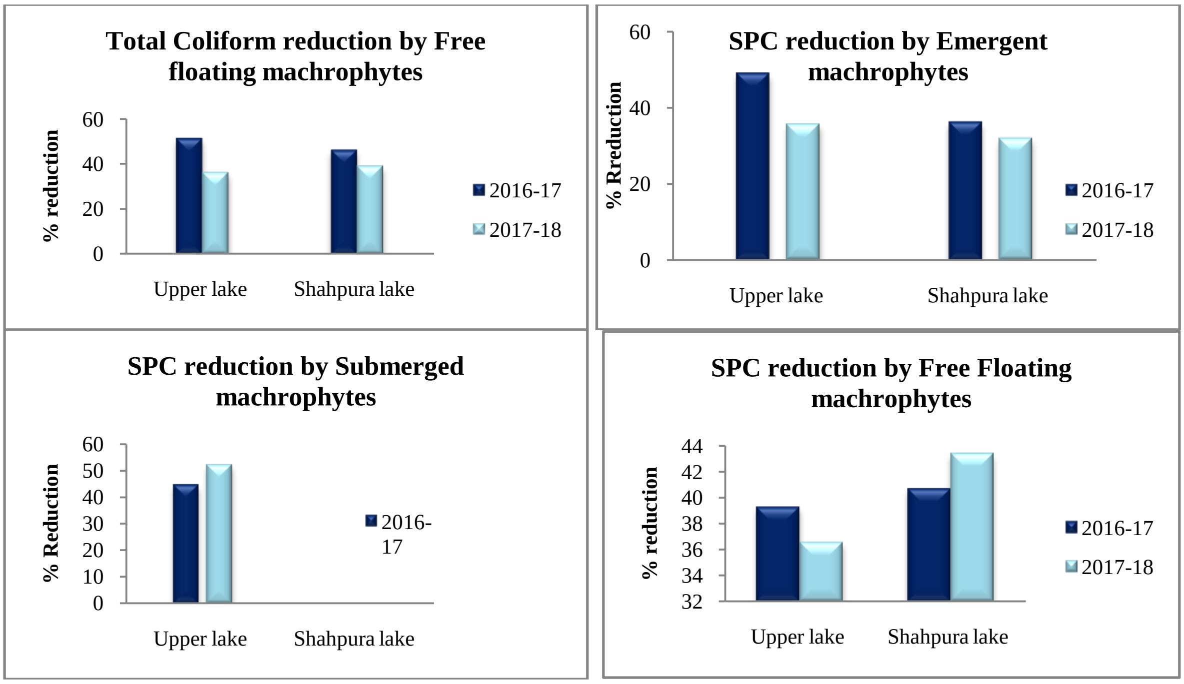


Figure 1. Bacterial reduction (%) by macrophytes at different sites of Upper lake and Shahpura lake.

CONCLUSION

Macrophytes in healthy/growing condition have been found to reduce the bacterial population considerably. This quality (eco-friendly technique) of macrophytes needs lot of attention in preserving the potable quality of water. However, attention is further invited towards the removal of unhealthy/decomposing macrophytes at the beginning stage of their decomposition.

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