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BOD, Total and Faecal coliforms bacterial status of Lake Pichhola, Udaipur, Rajasthan

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Abstract
The study has been carried out to investigate the impact of organic loadings on water quality in relation to fish and fisheries of Lake Pichhola. The water quality of Lake Pichhola is highly polluted. The bacterial load of lake water is very high and the values of biological oxygen demand (BOD) show its pollution status. Attempt has been made to relate water quality with the observed waste water discharge in this lake.
The overall results from the present investigation indicate that this water body is rapidly under going through process of eutrophication advancement. Therefore, suitable restoration programme should be initiated for the sustained use of this lake, as the lake attracts thousands of tourists from domestic and international level every year.

Keywords: Water quality, eutrophication, BOD, Total Coliforms, Faecal Coliforms

1. Introduction

Rapid development, increase in population of the metro cities and urbanization of their suburbs have resulted in the manifold increase in environmental pollution. The most affected are the water bodies which become highly polluted by addition of foreign materials such as plant and animal matter, and domestic sewage and industrial effluents. Dumping of solid wastes and indiscriminate encroachments also add to the chaos. The diminishing quality of water seriously delimits its use for human consumption and for aquatic life. Therefore, the continuous and periodical monitoring of water quality is necessary so that appropriate preventive and remedial measures can be undertaken. The BOD and Bacteriological characteristics of an aquatic body reflect the type of the water quality and pollution.

The pollution of water is a serious problem today because all water resources have reached to a point of crises due to unplanned urbanization and industrialization (Singh *et al.*, 2002) [30]. It is recognized that mankind, animals and plants, all face a variety of problems arising from various kinds of environmental pollution (Petak, 1980) [23].

As against waste of inorganic character, organic wastes are bio-degradable and are thus easy to manage. Indeed, to some extent nature has very efficient mechanism for self-purification of such wastes in course of time through the process of recycling and biological transformation. Stockholm conference on Human Environment (June, 1972) recommended control and recycling of crop residue and animal waste as fertilizer. Obviously, a heterogeneous assemblage of bacteria, algae and other scavengers play a vital role in the process of bio-degradation of organic wastes. However, unless it is achieved efficiently public health may be put at risk due to many forms of pathogens associated with the wastes of human and animal origins. One gram of human excreta carries as high as 10,00,000 bacteria (Hultan, 1981) [15]. Further, organic wastes being rich in nutrients of vital biological significance, may alter the ecological scenario of the water body receiving such wastes. Thus, disposal of raw organic wastes may accelerate the process of eutrophication.

The increase in faecal pollution among water sources is a major problem in developing countries [American Society for Microbiology (ASM), Colloquium report, 1999] [3]. In India 80% of diseases are water borne *viz*. typhoid, cholera, dysentery, infectious hepatitis etc. which spreads through contaminated water (WHO, 2001) [36]. The faecal pollution of drinking water introduces a variety of intestinal pathogens-bacterial, virus and parasites. Their occurrence is related to microbial diseases and their carriers. Out of the intestinal bacterial pathogens those occurring in the drinking *water are the strains of Salmonella shigella, Enterotoxigenic Escherichia* *coli*, *Vibrio cholerae*, *Yersinia* and *Campylobacter* species. These organisms cause diseases from gastroenteritis to fatal dysentery cholera and typhoid.

2. Materials and Methods

2.1 Sampling Stations

Sampling for estimating BOD as well as bacteriological parameters was conducted at two fixed stations *viz.* A and B of lake Pichhola. Station "A" was located at Gangour gat where excess organic load enters into the lake and Station "B" was located at just opposite side of doodh talai (Dam site) in the main Pichhola Lake where relatively clear and comparatively deeper water was available. At each station 3 surface water samples were randomly collected at fifteen days interval up to 4 months.

2.2 Sample Collection

During the study period, surface water samples were collected using Biochemical Oxygen Demand (BOD) bottles of 250 ml for the analysis of BOD. While, for microbiological analysis of water, samples were collected in pre sterilized glass stoppered bottles of 250 ml. Water samples for BOD and microbial analysis were brought to the laboratory in pre sterilized glass stoppered bottles of 250 ml capacity and analyzed as soon as possible using standard method of APHA(2005) [2] and WHO (2006) [37].

2.3 Review of Literature

Storm water runoff and discharge of sewage into the lakes are two common ways that various nutrients enter the aquatic ecosystems resulting in the death of those systems (Sudhira & Kumar, 2000) [31]. The washing of large amount of clothes and the continued entry of domestic sewage in some areas are posing pollution problems (Benjamin *et al.* 1996) [4]. Studies on water quality of freshwater lakes have been undertaken by a number of scientists (Mohan, 1987 [20], Zutshi and Khan, 1988[38], Vijay Kumar, 1999 [34], Radhika *et al.* 2004 [24]).

Mathivanan *et al*. (2004) [18] studied the assessment of water quality of river Cauvery at Mettur, Salem district, Tamil Nadu in relation to population. Namitha Rath (2007) [21] has suggested that if oxygen requirement is more, the BOD value becomes higher and the water is considered to be more polluted.

Bacteriological aspects for lakes were investigated by many workers. Henrici (1938) [10] was probably the first to investigate lake bacteria. Since then the discipline of limnobacteriology came in to existence. Geldreich (1972) [8] reported that *Salmonella*, *Shigella*, *Leptospira*, *Escherichia coli*, *Vibrio* and *M ycobacterium* are the potential agents for health problems. Olah (1970) [22] and Jones (1971[16], 1972) [17] observed that depth of water affect bacterial numbers. Trivedi (1984) [32] reported that faecal coliforms and total coliforms were more on surface during monsoon. Schroder (1975) [29] and Allen *et al*. (1979) [1] reported inverse relationship between bacterial population and pH value. Hepher and Schroder (1977) [11] and Ray and Hill (1978) [26] reported that bacterial population is higher in eutrophic waters. Saxena *et al*. (1992) [28] studied the impact of water hyacinth on density of coliforms bacteria.

3. Results and Discussions

3.1 Biological Oxygen Demand

BOD is a measure of quantity of oxygen required by bacteria and other micro-organisms under aerobic condition in order to biochemically degrade and transform organic matter present in the water body. High BOD is considered as a limiting factor for the living organisms. It is an indicator of organic pollution. In the present study a wide fluctuation was found in BOD values 2.9 to 7.1 mg/l (Table 1.1 and Fig.1.1).

In general, the water of stations A and B exhibited overall mean value of Biological Oxygen Demand 4.9 mg/l (Table 1.2). When the data of both stations (A and B) were arranged for t-Test, it showed the t-value 1.90 which indicated that biochemical oxygen demand of water was non- significant.

3.2 Bacteriological Status of Lake Pichhola

Coliform bacteria are described and grouped, based on their common origin or characteristics such as *Escherichia coli (E. coli*), as well as other types of coliforms bacteria that are naturally found in polluted water. Coliforms organisms are used as indicators of water pollution. The presence of faecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the faecal material of man or other animals. Total coliforms indicate degree of pollution and their higher density shows the difference between clean and polluted waters (Ray and Hill, 1978) [26]. Faecal coliforms have long been used as indicator of pollution in water (McMath *et al.* 1999) [19], due to the potential for introduction of pathogens and other pollutants along with these bacteria (Ricca and Cooney, 1999) [27]. High level of nutrients can also increase the growth rate of bacteria. Further, a higher coliforms count confirms various anthropogenic factors namely, release of sewage in to the water body, cattle and pet wastes etc. (Gearheart, 1999) [7]. Several previous studies have also demonstrated higher concentration of faecal coliforms in water and sediments during summer (Byappanahialli *et al* 2006 [5]; and Hyland *et al.* 2003 [14]).

In the present study results showed that the lake Pichhola is polluted due to organic loadings. This might be due to low volume of water in the lake and entrance of domestic sewage besides internal loadings from sediments. Since the lake has attained very high bacterial load as such the water is unacceptable for human consumption (WHO, 1967 [35]; EEC, 1975 [6]) without proper treatment. Geldreich and Kenner (1969) [9] and Hodgkiss (1994) [12] categorized such types of water as polluted and grossly polluted.

Further, it is clear that station A is the main source of contamination in Lake Pichhola which receives high loading of domestic sewage and solid wastes from surrounding densely populated area. Tzannetis and Vassilopoulos-Kaclas (1993) [33], Rao *et al*. (1994) [25] reported that number of total and faecal coliform bacteria is indirectly proportional to the distance of obvious source of contamination.

Thus, the bacterial population is found to be invariably higher in nutrient rich or eutrophic waters. The incidence of high bacterial load in nutrient rich waters has also been reported earlier by Hepher and Schroeder (1977) [11] and Rao *et al.* (1994) [25].

3.3 Total coliforms

The bacteriological status of the lake Pichhola under investigation in general follows the trends shown by that of limno-chemistry. Herein, the higher levels of total coliforms were evident from the values which varied between 918 to ≥2400 MPN/100ml at station A. Station B maintained comparatively lower values of total coliforms which varied from 918 to ≥2400 MPN/100 ml. Station A maintained comparatively higher mean values of total coliforms 2116

MPN/100 ml and at station B it was observed 1803 MPN/100 ml (Table 1.1 and Fig. 1.2)

In general, the water of stations A and B exhibited overall mean value of total coliforms 1959 MPN/100ml (Table 1.2). When the data of both stations (A and B) were arranged for t-Test, it showed the t-value 1.81 which indicated that total coliforms of water was non- significant.

3.4 Faecal coliforms

In Pichhola lake faecal coliform numbers fluctuated from a minimum 109 to 240 MPN/100 ml at station A. Station B showed the value between 43 to 172 MPN/100ml of water. Station, A maintained comparatively higher mean values of faecal coliforms (153 MPN/100 ml) and at station B it was observed 105 MPN/100 ml (Table 1.1 and Fig. 1.3)

In general, the water of stations A and B exhibited overall mean value of 129 MPN/100ml faecal coliforms (Table 1.2). When the data of both stations (A and B) were arranged for t-Test, it showed the t-value 3.78 which indicated that faecal coliforms of water was highly significant.

Table 1: Minimum-Maximum range, mean values and statistical standard deviation of BOD, Total and Faecal Coliforms in surface water of Lake Pichhola, Udaipur

S. No.	Parameters	Minimum-Maximum range	Mean Value		S D +		t Value
			A	B	A	B	
1	BOD (mg/l)	2.9 – 7.1	5.20	4.55	1.32	1.06	1.90 NS
2	Total Coliforms (MPN/100ml)	918 - ≥2400	2116	1803	532.77	657.65	1.81 NS
3	Faecal Coliforms (MPN/100ml)	43 - 240	153	105	47.47	40.87	3.78**

NS - Non Significant * - Significant at 5% level of significance
** - Significant at 1% level of significance

Table 2: Mean values of BOD, Total and Faecal Coliforms of surface water of Lake Pichhola, Udaipur

S. No.	Parameters	Mean value
1	BOD (mg/l)	4.9
2	Total Coliforms (MPN/100ml)	1959
3	Faecal Coliforms (MPN/100ml)	129

Table 3: Comparative values of BOD, Total and Faecal Coliforms with WHO guideline values and earlier work done during 1994 of Lake Pichhola, Udaipur

S. No.	Parameters	Lake Pichhola 2010	Lake Pichhola 1994	WHO
1	BOD (mg/l)	2.9 – 7.1	NA	NG
2	Total Coliforms (MPN/100ml)	918 - ≥2400	≥2400	10
3	Faecal Coliforms (MPN/100ml)	43 - 240	26 - 172	00

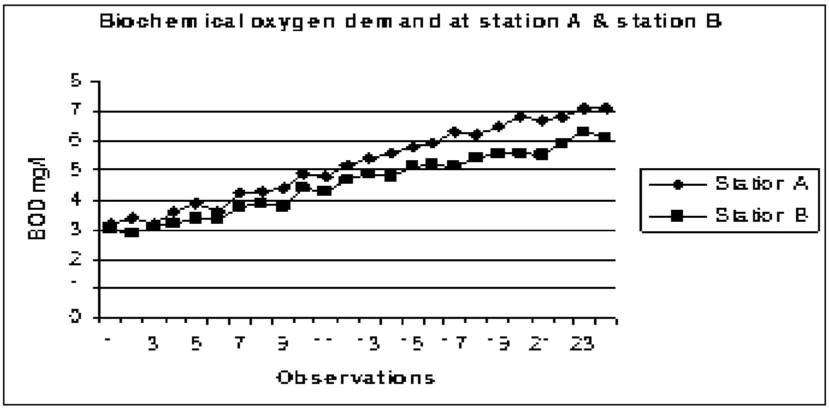

Fig. 1

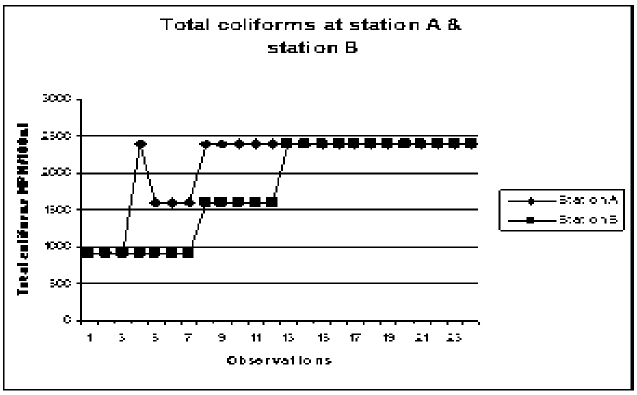

Fig. 2

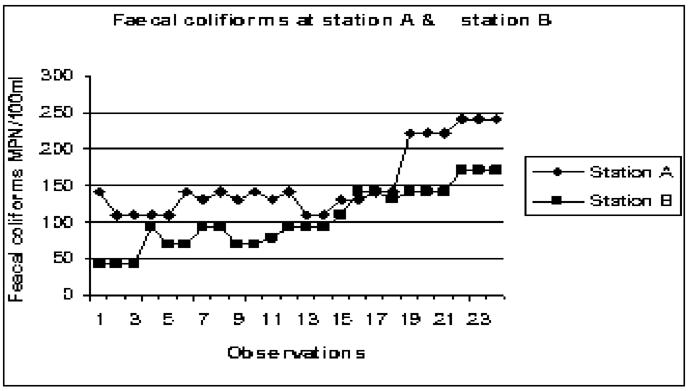

Fig. 3

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