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Bacteriological status of Udaipur lakes in relation to public health

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Abstract
An attempt has been made to work out the comparative study of microbiological water quality of the lakes Pichola, Fateh Sagar, Swaroop Sagar and Rang Sagar. In order to ascertain the drinking water quality because the main source of drinking water for the public of Udaipur city. The study was conducted during the months of Feb. to April, The main focus of the study was on bacterial load of the lake water especially for Total coliform and faecal coliform bacteria. The results revealed that the values of MPN were found to cross the standard limits in water samples suggested by WHO (2006) [28]. The bacteriological study has given the information regarding the suitability of the water for various uses like drinking and other domestic applications. Conclusions revealed that large number of drains of Udaipur city and industrial discharge is mainly responsible for pollution in lakes.

Keywords: Lakes Pichola, Father Sagar, Swoop Sagar, Rang Sagar, Total coliforms, faecal coliforms Bacterial load, water quality

1. Introduction

Udaipur is truly famous for its beautiful lakes and watercourses. The city is popularly known by the phrase of the “City of Lakes”. All the lakes from a chain in the saucer shaped Udaipur valley. The lake-system arising out of the river Breach and its tributaries is an integral component of the upper Bearch basin Udaipur lake system comprises of the lake Pichola, Fateh Sagar, Swaroop Sagar and Rang Sagar (Sharma *et al*., 2009) [22]. These are an important source of potable water supply for the Udaipur City.

The key to increase human productivity and long life is good quality water (Urbansky *et al*., 2002) [23]. The provision of good quality household drinking water is often regarded as an important means of improving health (Moyo *et al*., 2004) [13]. According to World Health Organization (WHO, 1996) [25], there were estimated 4 billion cases of diarrhoea and 2.2 million deaths annually. The consumption of unsafe water has been implicated as one of the major causes of this disease. Most gradual deterioration of water quality was resulted by the increase in human populations and Urbanization (Ho and Hui, 2001) [4]. As water pollution is getting serious, houses especially in the urban area started to equip with a water filter system. People are concern with the presence of pollutants such as heavy metals and toxic chemical in their daily drinking water. Filtered water is the main source of safe and reliable drinking water. Public health problems such as vector borne and waterborne diseases arise as result of water impoundment. Water borne diseases arise due to the percolation of reservoir and other water into the drinking water. Water from inadequately maintained or polluted sources can carry a number of pathogens that cause diarrhoea, hepatitis, typhoid fever or parasitosis (Listori *et al*., 2001) [10]. Rajendran *et al.* (2006) [16] studied the bacteriological analysis of water samples from tsunami affected area. They found entry of harmful bacteria in the drinking water. At present, public health concerns remain focused on waterborne diseases, with incidence data in both developed and developing countries making gastroenteritis highly important. A diversity of enteric bacteria and viruses has been associated with outbreaks of waterborne gastroenteritis (Liang *et al*., 2006) [9].

Most coliforms are present in large numbers among intestinal flora of humans and other warm-blooded animals, and are thus found in faecal wastes (Dorothy and Philip, 1998) [3]. As a consequence, coliforms, detected in higher concentrations than pathogenic bacteria, are used as an index of the potential presence of entero-pathogens in water environments (Rompre *et al*., 2002) [19]. Coliforms are also routinely found in diversified natural environments, as some of them are of telluric origin, but drinking water is not a natural environment for them.

As a result, their presence in drinking water must be considered as harm to human health. Positive presence of coliforms in treated water which is usually coliform-free may indicate treatment ineffectiveness.

Water quality is an index of health and well-being of a society. Pollution of water bodies is one of the areas of major concern to environmentalists. Industrialization, urbanization and modern agriculture practices have direct impact on the water resources. These factors influence the water resources quantitatively as well as qualitatively. The city sewage and industrial effluent drains into the lakes and pollutes the water quality. Assessment of indicator bacteria namely coliform bacteria is a convenient way to evaluate sanitary condition of any water body.

The most common and widespread health risks associated in drinking water in developing countries are of biological origin (as coliforms). The coliforms refers to any rod shaped, non-spore forming, gram negative bacteria capable to ferment lactose at 37 ºc ± 0.5 ºc with the production of acid, gas and aldehyde within 24 to 48 hrs are total coliforms, where with same properties at a temperature of 44 ºc ± 0.5 ºc are considered as faecal (thermo tolerant) coliform organisms. It is well known that the quality and safety of the drinking water continues to be an important public health issue (Hrudey and Hrudey, 2007) [7], (Reynolds *et al*., 2007) [18], because its contamination has been frequently described as responsible for the transmission of infectious diseases that have caused serious illnesses and associated mortality worldwide (Marshall *et al*., 2006) [11], (Peace, 2007) [15]. Clearly, point-of-use water quality is a critical public health indicator (Reynolds *et al*., 2007) [18]. Therefore, the microbiological examination was carries out in the lakes of Udaipur.

1.1 Material and Methods

All selected lakes such as Pichola, Fathe Sagar, Swaroop Sagar, and Rang Sagar are situated in densely populated area of Udaipur city. Water of these lakes affected the population on a large scale in Udaipur due to enormous changes in the environment. Eight water samples are subjected to biological study has given the information regarding the suitability of the water for various uses like drinking and other domestic applications.

During the study, water sample were collected at weekly interval, using clean, pre sterilized 250 ml BOD glass bottles for analysis of water in the laboratory from randomly selected station in all the four lakes. Microbiological analysis was carried out within 6 hrs of sample collection using standard methods outlined in WHO (2006) [28], APHA (1989) [1].

2. Results and Discussion

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. Clark and Pogel (1977) [2] considered coliforms as a reliable indicator of contamination of water. Total coliforms indicate degree of pollution and their higher density shows the difference between clean and polluted water. Faecal coliforms have long been used as indicator of pollution in water due to the potential for introduction of pathogens and other pollutants along with these bacteria (Mc Math *et al*., 1999) [12]. 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. (Sharma *et al*., 2008) [20]. Several previous studies have also demonstrated higher concentration of faecal coliforms in water and sediments during summer (Howell *et al*., 1996) [6], (Whitman *et al*., 1999) [24].

2.1 Pichola Lake

The bacteriological status of the lake Pichola under investigation in general follows the trends shown that the higher levels of total coliforms were evident from the values which varied between 345 to ≥2400 MPN/100ml.Whereas, the range of faecal coliforms were in Pichola lake 18-175 MPN/100 ml (Table 1.2).

Table 1.2: Average value of total and faecal coliforms in lake pichola.

S. N.	Total Coliforms (MPN/100ml)	Faecal Coliforms (MPN/100ml)
1st day	1609	18
8th day	189	93
15th day	≥2400**	19
22nd day	1609	22
29th day	≥2400	34
36th day	≥2400	93
43rd day	≥2400	29
50th day	124	175

** shows higher values

2.2 Fateh Sagar

In Fateh Sagar total coliforms numbers fluctuated from a minimum 124 to ≥2400 MPN/100 ml. whereas, faecal coliforms ranged from 9 to 28 MPN/100ml (Table 1.3).

Table 1.3: Average value of total and faecal coliforms in lake fateh sagar.

S. N.	Total Coliforms (MPN/100ml)	Faecal Coliforms (MPN/100ml)
1st day	1609	18
8th day	189	9
15th day	≥2400**	19
22nd day	1609	22
29th day	≥2400	9
36th day	≥2400	19
43rd day	≥2400	16
50th day	124	28

** shows higher values

2.3 Swaroop Sagar

Table1.4: Average value of Total and Faecal coliforms in Lake Swaroop Sagar.

S. N.	Total Coliforms (MPN/100ml)	Faecal Coliforms (MPN/100ml)
1st day	1609	22
8th day	189	18
15th day	≥2400**	27
22nd day	≥2400	26
29th day	109	19
36th day	≥2400	221
43rd day	1609	26
50th day	167	221

** shows higher values

The results of microbiological status of Swaroop Sagar in respect to total coliforms were shows range from 167 to ≥2400 MPN/100 ml Herein the Faecal coliforms varied from 18 to 221MPN/100 ml (Table 1.4).

2.4 Rang Sagar

In Rang Sagar total coliforms varied from 60 to ≥2400 MPN/100 ml. whereas, faecal coliforms varied from 22 to 278 MPN/100 ml (Table 1.5).

Morphometric features and results of microbiological study of selected lakes are summarized in Table 1.1 to 1.5. Values of total and faecal coliforms of four lakes showed a higher range of total coliform count (348 to ≥ 2400 MPN/ 100ml) in Pichola. On other hand in Rang Sagar showed lower range of total coliform (60 to ≥2400 MPN/ 100ml) as compared to other. The variations in faecal coliforms were 9 to 278 MPN/100 ml. The highest faecal coliforms (278 MPN/100ml) count was detected from Rangsagar followed by Swaroop Sagar (221MPN/100ml) > Pichola lake (175MPN/100ml) > Fathe Sagar (28 MPN/100 ml). The total and faecal coliforms were found above the WHO limits in all lakes which are used for supply drinking water (WHO, 2001) [27], (WHO, 2002) [29].

In the present study results showed that the lake Rang Sagar is most polluted as compared to Swaroop Sagar, Pichola and Fathe Sagar. This might be due to low volume of water in the lake and entrance of domestic sewage and located in densely populated area besides internal loadings from sediments. Since the lake has attained very high bacterial load as such the water is unacceptable for human consumption without proper treatment (WHO, 1967) [26], such types of water categorized as polluted and grossly polluted (Hodgkiss, 1994) [5].

Further, it is clear that the main source of contamination in lakes water channel, which receives high loading of domestic sewage and solid wastes from surrounding densely populated area. Number of total and faecal coliform bacteria is indirectly proportional to the distance of obvious source of contamination (Rao *et al*., 1994) [17], (Sharma *et al*., 1991) [21]. In order to protect public health, lakes should be clean, avoid dumping sewage, industrial waste in to the lake.

This study highlighted the poor hygienic conditions of the water quality standards in this area of investigation. The related endemic health problems can be checked by taking appropriate preventive measures to forestall the major outbreak in the future.

Table 1.1: Morphometric features of Lake Pichola, Fateh Sagar, Swaroop Sagar and Rang Sagar.

S. No.	Morpho metric features	Lake Pichola	Lake Fateh Sagar	Lake Swaroop Sagar	Lake Rang Sagar
1.	Longitude	73°40'E	73°42'E	73°40'E	73º40'E
2.	Latitude	24°34'N	24°55'N	20°34'N	--
3.	Altitude	582.17m (ASL)	587m (ASL)	582.17m (ASL)	582.17m (ASL)
4.	Average rainfall	62.5cm	62.5cm	62.5cm	62.5cm
5.	Surface area of lake	6.96 km^2	4.0 km^2	0.583 km^2	273m^2
6.	Catchment area	12700 ha	53.66 km^2	--	--
7.	Maximum depth	8 m	13.4 m	6.98 m	7m
8.	Average depth	4.5 m	--	--	--
9.	Maximum length	3.6 km	2.6 km	0.583 km	0.245km
10.	Maximum width	2.61 km	1.8 km	0.291 km	--
11.	Mean width	1.93 km	--	--	--
12.	Type of Dam	Masonry	Masonry	Masonry	Masonry

Table 1.5: Average value of Total and Faecal coliforms in Lake Rang Sagar.

S. N.	Total Coliforms (MPN/100ml)	Faecal Coliforms (MPN/100ml)
1st day	≥2400	34
8th day	60	27
15th day	≥2400	51
22nd day	542	22
29th day	1609	34
36th day	≥2400**	35
43rd day	345	278
50th day	167	278

** shows higher values

Table 1.6: Comparison of bacteriological status of different lakes.

S. N.	Pichola lake		Fateh Sagar		Swaroop Sagar		Rang Sagar	
	Total Coliforms (MPN/100ml)	Faecal Coliforms (MPN/100ml)	Total Coliforms (MPN/100ml)	Faecal Coliforms (MPN/100ml)	Total Coliforms (MPN/100ml)	Faecal Coliforms (MPN/100ml)	Total Coliforms (MPN/100ml)	Faecal Coliforms (MPN/100ml)
1st day	1609	18	1609	18	1609	22	≥2400	34
8th day	189	93	189	9	189	18	60	27
15th day	≥2400**	19	≥2400**	19	≥2400**	27	≥2400	51
22nd day	1609	22	1609	22	≥2400	26	542	22
29th day	≥2400	34	≥2400	9	109	19	1609	34
36th day	≥2400	93	≥2400	19	≥2400	221	≥2400**	35
43rd day	≥2400	29	≥2400	16	1609	26	345	278
50th day	124	175	124	28	167	221	167	278

Table 1.7: Minimum and maximum values of Total and Faecal coliform in all four lakes.

Name of Lake	Total coliforms (MPN/100ml)	Faecal coliforms (MPN/100ml)
Pichola Lake	345 – 2400	18 – 175
Fateh Sagar	124 – 2400	9 – 28
Swaroop Sagar	167 – 2400	18 – 221
Rang Sagar	60 – 2400	22 – 278

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