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Prevalence of Coliform Bacteria in Kodaikanal and Yercaud Lake, Tamilnadu, South India

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Abstract: The present study deals with enumeration and seasonal distribution of total and faecal coliform bacteria, the indicators of faecal pollution of two lakes namely Kodaikanal and Yercaud lake, Tamilnadu, India was investigated. Water samples from 4 different sites from the lakes were collected during February 2003 to January 2004 and were analysed for total coliform count, faecal coliform count and faecal streptococci, which is an indicator organism of faecal contamination. The range of MPN 100 mL^{-1} for total coliform was found to be 46-50, 46-60 and 33-40, in Kodaikanal lake water and 94-140, 110-180 and 79-110 in Yercaud lake water in summer, monsoon and winter, respectively. In Kodaikanal lake the faecal coliform was in the range of 27-33 MPN 100 mL^{-1}, 33-46 MPN 100 mL^{-1} and 17-27 MPN 100 mL^{-1} and in Yercaud lake it was 63-94 MPN 100 mL^{-1}, 70-110 MPN 100 mL^{-1} and 63-79 MPN 100 mL^{-1} in summer, monsoon and winter, respectively. The range of faecal streptococci found in Kodaikanal lake water was 7-14 MPN 100 mL^{-1} during summer, 8-17 MPN 100 mL^{-1} during monsoon and 5-14 MPN 100 mL^{-1} during winter and that of Yercaud lake water was 17-46 MPN 100 mL^{-1}, 26-49 MPN 100 mL^{-1} and 9-43 MPN 100 mL^{-1} in summer, monsoon and winter respectively. Bacteriological analysis of the lake waters indicated that water was polluted by faecal contaminants to the extent that they were unpotable for and unsuitable for recreational activity. Hence the lakes needed thorough impoundment.

Key words: Kodaikanal, Yercaud, findicator, faecal coliform

Introduction

Water has played a significant role in the transmission of human disease and indicator micro-organisms have been used to suggest the presence of pathogens (Berg, 1978). Today we understood the possible reasons for the presence or absence of indicator and pathogenic bacteria. In short there is no direct correlation between numbers of any indicator bacteria and enteric pathogens (Grabow, 1996). Human faecal material is generally considered to be greater risk to human health as it is more likely contain human enteric pathogens (Scott *et al*., 2003). Typhoid fever, cholera, infectious hepatitis, bacillary and amoebic dysenteries and many varieties of gastrointestinal disease can all be transmitted by water. The most important aspect of water quality is its freedom from contamination with faecal matter.

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Microorganisms are widely distributed in nature and their abundance and diversity may be used as an indicator for suitability of water (Okpokwasili and Akujobi, 1996). Bacteriological assessment particularly for coliforms, the indicators of contamination by faecal matter is therefore routinely carried out by many public health authorities to ascertain the quality and portability of water to ensure prevention of further dissemination of pathogens through the agency of water. The use of bacteria as water quality indicators can be viewed in two ways, first the presence of such bacteria can be taken as an indication of faecal contamination of the water and thus as a signal to determine why such contamination is present, how serious it is and what steps can be taken to eliminate it; second, their presence can be taken as an indication of the potential danger of health risks that faecal contamination posses (Baghel *et al*., 2005). The ratio between total coliforms and faecal streptococci has been proposed by Geldreich (1976) as a means of distinguishing between human and animal-derived faecal matter. However, this method is no longer recommended (Howell *et al*., 1995) and none of the currently-used bacterial indicators distinguish different sources of faecal matter confidently when used alone (Cabelli *et al*., 1983). The most widely used indicators are the coliform bacteria, which may be the total coliform bacteria that got narrowed down to the faecal coliform and faecal streptococci (Kistemann *et al*., 2002; Pathak and Gopal, 2001; Harwood *et al*., 2001; Vaidya *et al*., 2001). The contamination of lakes and rivers by faecal material increases the risk to the populations due to waterborne diseases.

The present study was undertaken to assess bacteriological quality of lake water in terms of enumeration of coliform bacteria, their periodicity and pattern of distribution in Kodaikanal lake and Yercaud lake of Tamilnadu during February 2003 to January 2004. Also the relationship between total and faecal coliform was established.

Materials and Methods

Study Area

Kodaikanal Lake

Kodaikanal is situated in Tamilnadu, India between 11°13'50" N and 77°28'07"E, at an altitude of about 2113 m and it covers an area of 21.45 km^2. It is located amidst the folds of the verdant Palani hills of the most popular serene hill stations in India. With the wooded slopes, mighty rocks, waterfalls and a beautiful lake, Kodaikanal is a charming hill station of South India. Kodaikanal lake is a magnificent man made lake which spreads out in a star shape over 24 ha. It is very attractive as it is get amidst the greenery and is a tourist area.

Yercaud Lake

Yercaud is situated in Tamilnadu, India between 11°46'N and 78°13'60 E at an altitude of 1,500 m, stand in the Servaroyan (Shevaroy) Hills above the city of Salem in Tamil Nadu, is considered as a Jewel of the South. It is a hill station visited by tourists throughout the year. The Servaroyan Hills as a whole provide many beautiful vistas and panoramic views. Yercaud itself is a pretty hill station with a pleasant cool climate. Yercaud's temperature never rises above 30°C or falls below 13°C. The Yercaud Lake, a picturesque pool surrounded by gardens and well-wooded areas, offers a cool respite from the stifling heat of the plains.

Samples were collected form four sampling sites, outlet (K I), boat house (K II), sewage inlet (K III) and animal rearing area (K IV) of Kodaikanal lake. Sampling sites of Yercaud lake are pumping station (Y I), sewage inlet (Y II), center of the lake (Y III) and boat house (Y IV). The samples were in pre-sterilized stopper glass bottles and transported to the laboratory in ice box and processed within 6 to 8 h of collection. Water samples were collected once a month from February 2003 to January 2004 for a period of one year. The water quality was determined by Most Probable Number (MPN) method. Coliforms were detected by inoculation of samples into tubes of Lactose Lauryl Tryptose

Broth (LLTB) and incubation at 37±1°C for 48 h. The positive tubes were subcultured into Brilliant Green Bile Broth (BGBB) and were incubated at 44.5±1°C. Gas production in BGBB at 44.5±1°C was used for the detection of faecal coliform after 48 h incubation. Faecal streptococci were detected by inoculation of water samples in Azide Dextrose Broth and incubated at 37±1°C for 24-48h (APHA, 1998). All the culture media were obtained from Hi-Media Pvt. Ltd., Bombay, India.

Results and Discussion

As per the present study the seasons were divided into three, summer running from February to May, monsoon from June to September and winter from October to January. Counts of coliforms (total, faecal coliform and faecal streptococci) varied from site to site and also showed seasonal variation in both Kodaikanal and Yercaud lake water.

Total Coliforms, Faecal Coliforms and Faecal Streptococci in Kodaikanal Lake Water

Total coliform (TC) of Kodaikanal lake was found in the range of 46-50 MPN 100 mL^{-1} in summer, 46-60 MPN 100 mL^{-1} in monsoon and 33-40 MPN 100 mL^{-1} in winter season. The counts of faecal coliform observed during summer, monsoon and winter was in the range of 27-33 MPN 100 mL^{-1}, 33-46 MPN 100 mL^{-1} and 17-27 MPN 100 mL^{-1}, respectively. Faecal streptococci were in the range of 7-14 MPN 100 mL^{-1} in summer, 8-17 MPN 100 mL^{-1} in monsoon and 5-14 MPN 100 mL^{-1} in winter (Table 1).

Total coliform count was high in sampling site KIV during all the seasons i.e., 50 MPN 100 mL^{-1}, 60 MPN 100 mL^{-1} and 40 MPN 100 mL^{-1} during summer, monsoon and winter, respectively. The highest faecal coliform count of Kodaikanal lake water was 38 MPN 100 mL^{-1}, 46 MPN 100 mL^{-1} and 27 MPN 100 mL^{-1} in sampling site K IV during summer, monsoon and winter, respectively (Table 1) (Fig. 1A). Monsoon season showed high faecal coliform counts in all the sampling sites i.e., 40 MPN 100 mL^{-1}, 33 MPN 100 mL^{-1}, 40 MPN 100 $mL^{-1}$and 46 MPN 100 mL^{-1}in sampling site K I, K II, K III and K IV, respectively (Fig. 1B). The faecal streptococcus count was higher in sampling site II than the other sampling sites. During monsoon faecal streptococcus was 9 MPN 100 mL^{-1}, 17 MPN 100 mL^{-1}, 8 MPN 100 mL^{-1} and 12 MPN 100 mL^{-1} in S1, S II, S III and S IV, respectively (Fig. 1C).

Total Coliforms, Faecal Coliform and Faecal Streptococci in Yercaud Lake Water:

Counts of total coliforms of Yercaud lake water ranged from 94-140 MPN 100 mL^{-1}, 110-180 MPN 100 mL^{-1} and 79-110 MPN 100 mL^{-1} during summer, monsoon and winter, respectively. The range of faecal coliform and faecal streptococci observed in Yercaud lake water were 63-94 MPN 100 mL^{-1}, 70-110 MPN 100 mL^{-1} and 63-79 MPN 100 mL^{-1}, 17-46 MPN 100 mL^{-1}, 26-49 MPN 100 mL^{-1} and 9-43 MPN 100 mL^{-1} in summer, monsoon and winter respectively (Table 1). Counts of total coliform were high during monsoon of all the four sampling sites (Fig. 2A). It is clear from our result that high count of total coliform i.e., 140 MPN 100 mL^{-1},

Table 1: Range of total coliform, faecal coliform and faecal streptococci of Kodaikanal and Yercaud lake water during different seasons

Kodaikanal lake	Summer	Monsoon	Winter
Indicator organisms (MPN 100 mL^{-1})			
Total coliform	46-50	46-60	33-40
Faecal coliform	27-33	33-46	17-27
Faecal streptococci	7-140	8-17	5-14
Faecal coliform (FC)/Faecal streptococci (FS)	1:3.48	1: 3.80	1: 2.99
Yercaud lake			
Total coliform	94-140	110-180	79-110
Faecal coliform	63-94	70-11	63-79
Faecal streptococci	17-46	26-49	9-430
Faecal coliform (FC)/Faecal streptococci (FS)	1: 2.66	1: 2.450	1: 2.61

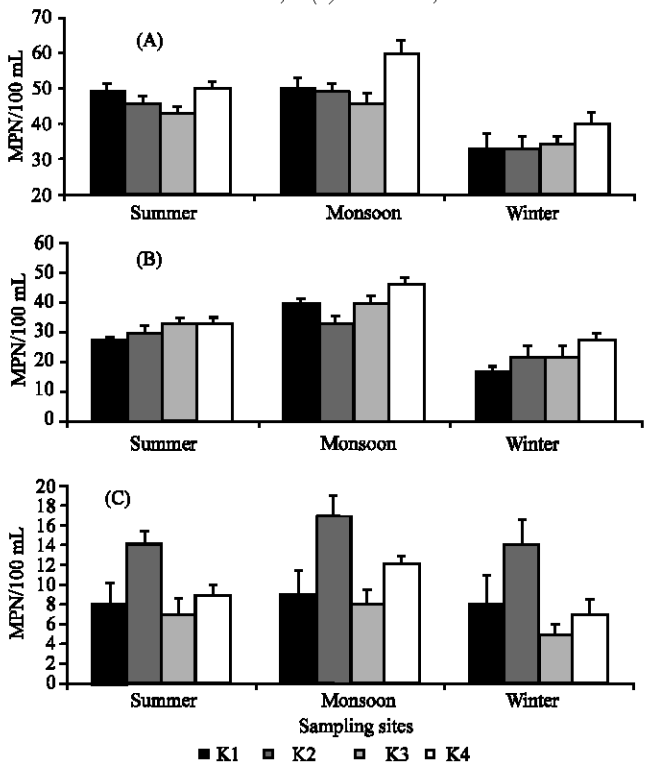

Fig. 1: Indicator organisms of various sites of kodaikanal lake water. (A) Totals coliform, (B) Face coliform and (c) Facal sterptococci

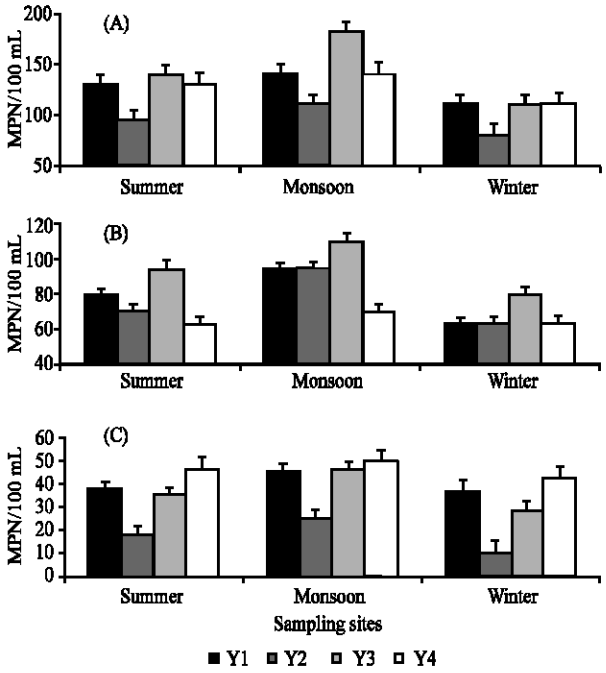

Fig. 2: Indicator organisms of various sites of Yercaud lake water (A) Totals coliform, (B) Face coliform and (c) Face sterptococci

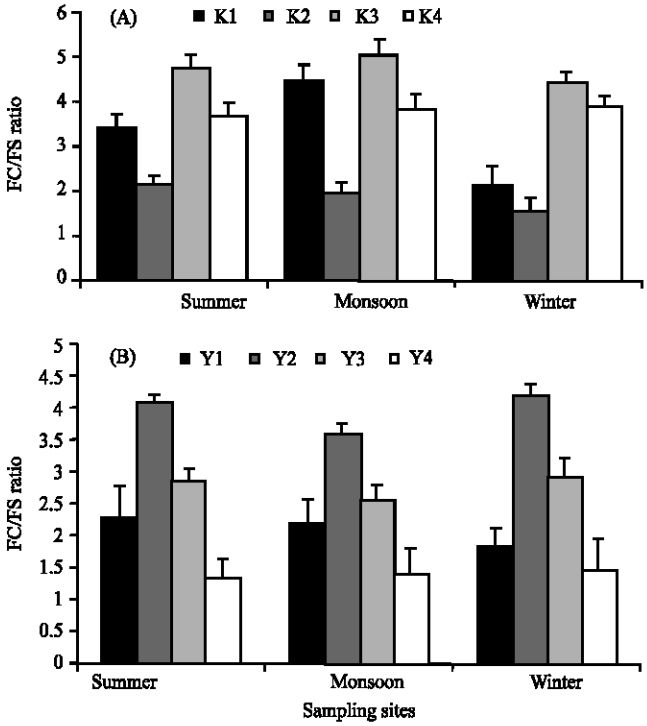

Fig. 3: Faecal coliform (FC)/Faecal streptococci (FS) count of the various sites of A. Kodaikanal lake; B. Yercaud lake

result that high count of total coliform i.e., 140 MPN 100 mL^{-1}, 180 MPN 100 $mL^{-1}$and 110 MPN 100 mL^{-1} in summer, monsoon and winter respectively was found in sampling site Y III. It was observed from the results that high count of faecal coliform was in Y III during all the seasons. The counts of faecal coliform were 94 MPN 100 mL^{-1}, 110 MPN 100 mL^{-1} and 79 MPN 100 mL^{-1} in summer, monsoon and winter respectively (Fig. 2B). High count of faecal streptococci i.e. 43 MPN 100 mL^{-1} in Y I, 26 MPN 100 mL^{-1} in Y II, 43 MPN 100 mL^{-1} in Y III and 49 MPN 100 mL^{-1} in Y IV during monsoon season. Among the sampling station Y IV showed higher count of faecal streptococci followed by Y III, Y I and Y II (Fig. 2C).

Ratio of Faecal Coliform (Fc)/Faecal Streptococci (Fs) in Kodaikanal and Yercaud Lake

The average ratio of Faecal coliform and faecal streptococci of Kodaikanal lake water were 1: 3.48, 1: 3.80 and 1:2.99 and of Yercaud lake water were 1: 2.66, 1: 2.45 and 1: 2.61 in summer, monsoon and winter respectively (Table 1). The ratio of FC/FS of various sites of Kodaikanal and Yercaud lake water was shown in Fig. 3A and B.

Discussion

Population of aquatic microbiota is influenced by many environmental parameters and it varies with time and location of sampling sites. The study reported the variation in bacterial counts with season and the time of collection and the sampling place which was in agreement to other similar studies (Badge and Varma, 1982; 1991; Badge and Rangari, 1999). The bacterial analysis revealed that all the samples collected from 4 different sites of Kodaikanal and Yercaud lake were contaminated with

coliforms and faecal coliforms and faecal streptococci. The coliform bacterial population was lowest in the winter and highest in the monsoon, the pattern which was reported in earlier studies (Badge and Varma, 1982: Badge and Rangari, 1999). The increase in coliform population in monsoon months may be due to the rain water that drained into the lake, as it was the major source of bacterial population in the lake water (Quereshi and Dutka, 1979). High population of coliform bacteria during summer may be due to less available dilution (Badge and Varma, 1982). Lowest count during winter may be explained on the basis of lower multiplication and poor growth of bacteria due to low temperature during winter. The fluctuations in the number of coliforms in different water samples can be attributed mainly to the intensity and age of pollution in addition to the temperature and runoff waters (Badge and Varma, 1982). McLellan *et al*. (2001) stated that faecal pollution indicator organisms can be used to a number of conditions related to the health of aquatic ecosystems and to the potential for health effects among individuals using aquatic environments. The presence of such indicator organisms may provide indication of water-borne problems and is a direct threat to human and animal health. The variation in bacterial counts for both total coliform, faecal coliform and faecal streptococci in different samples collected from the lake at the same time clearly indicated the presence of various populations of coliform bacteria at different stations of the lake water at the time of sampling. It was observed that total coliform, faecal coliform and faecal streptococci count were found to be higher in Yercaud lake water that in Kodaikanal lake water. This indicates that Yercaud lake receives a high load of faecal matter. It is clear from the results that faecal streptococci were found to be maximum during monsoon followed by summer and winter in Kodaikanal lake water and during summer and winter followed by monsoon in Yercaud lake water, which may be due to runoff of water having excreta of the animals. Kistemann *et al*. (2002) observed that in the case of rainfall, the microbial loads of runoff water may suddenly increase and reach the lakes very quickly. Faecal coliform and faecal streptococci ratio of all the sampling sites showed more than one and four may have contamination by animal and human faecal matter (Araujo *et al*., 1989). McLellan *et al*. (2001) stated that faecal pollution indicator organisms can be used to a number of conditions related to the health of aquatic ecosystems and to the potential for health effects among individuals using aquatic environments.

Conclusions

Bacterial population of both total and faecal coliform of Kodaikanal and Yercaud lake water were influenced by various environmental parameters and hence definite variations were observed in the counts of coliform bacteria. In both the lake water sample highest counts of bacteria were reported in monsoon, moderate in summer and lowest in winter. Overall bacteriological analysis of both the lake water revealed that lake water was polluted by faecal contaminants that they are not suitable for drinking and for recreational purposes. The presence of such indicator organisms may provide indication of water borne problems and its direct threat to human and animal health. Our studies on microbial ecology in lake waters in relation to pollution have clearly revealed that there is significant presence of bacterial indicators of faecal pollution. Hence the lakes needed thorough impoundment. Effective measures could be adopted to prevent spread of diseases through the agency of water and to save the water body from deterioration or ultimate extinction.

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