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Assessment of physicochemical and microbiological parameters in surface water of Ooty lake, a tourist hot spot in South India

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Abstract

The microbial flora of water plays a key role in defining the quality of water. The present study focused on the physicochemical and microbiological analysis of water sample collected from Ooty Lake, Ooty, Tamil Nadu, India. The organoleptic characters of water sample showed a tolerable value. The physiochemical parameter of the water sample was noted respectively. The heterophillic plate count of bacterial (39×10^3 cfu/ml), fungal (2×10^2 cfu/ml) and actinomycetes (35×10^2 cfu/ml), were checked. The presence of water borne pathogens was isolated and identified by screening and enrichment techniques and also by using specific media. Several pathogens such as *E. coli*, Shigella, *Vibrio parahemolyticus*, *Vibrio cholerae*, and several Salmonella species were detected from water.

Keywords: physicochemical parameters, Salmonella, Shigella, *Vibrio cholerae*, waterborne pathogens.

Introduction

Ooty is one of the most popular tourist destinations in South India. Ooty is otherwise known as Ootacamundor or Udagamandalam, considered as the 'Queen of Hill stations'. Ooty is gifted with unexpected scenic beauty in the heart of Nilgiris and is a popular summer getaway for people all over the country and abroad. Ooty Lake is the main attraction of this hill station to the tourists. Ooty Lake is an artificially constructed lake with attractive natural surroundings. Initially created for the purpose of fishing, the lake has become all but the central visitor landmark in Ooty (Ilavarasan et al., 2016). Ooty Lake has been formed during 1823-24 by the then Collector of Coimbatore district Mr. John Sullivan. The lake originally covers 65 hectares in the year 1823 and it is shrunken to the present status of 23 hectares. The maximum depth of the lake is 12 meters and average depth of 6 meters (Rajamanickam and Nagan 2016). The lake was formed by damming the mountain streams flowing down Ooty valley. The lake is set among groves of Eucalyptus trees with a railway line running along one bank (Sivakumar et al., 2000).

The most important and common factor of lake degradation is the deterioration of water quality due to organic pollution from dumping of domestic and other solid wastes. Eutrophication, i.e. enrichment with nutrients, is another foremost and most wide spread problem in almost all lakes. Enhancement is due to nutrients entering with the excess from the

catchments. Strom water runoff from developed areas brings a variety of toxic substances besides nutrients and particulate matter. Another reason for the shrinkage of the lake is the encroachment and the silt deposition. Siltation due to high sediment load in the runoff caused by erosion. Large reservoirs are affected by silt carried by the rivers from their large catchments whereas in rural lakes much of siltation occurs due to human activities such as agriculture and over grazing in their close neighborhood.

The increased demand of water as consequence of population growth and industrial development has forced environmentalist to determined chemical physical and biological characteristics of natural water resource (Regina and Nabi, 2003). The bacterial pathogens that have been exposed to cause human intestinal disease associated with drinking water are *Salmonella typhi*, and other *Salmonella* species, *Shigella* species, *Vibrio cholerae* and *Escherichia coli*. As water is one of the important source, to sustain life and has long been suspected of being the source of much human illness source, an attempt was made to study the physicochemical and microbiological quality of water from Ooty Lake, Ooty.

Materials and Methods

Sample collection

Water sample was collected from Ooty Lake, Ooty, Tamil Nadu, India during the month of February 2019. Water sample was collected in 1L sterilized bottle and was transported in icebox to the laboratory for further analysis.

Chemicals and media used

Glucose, tryptone, phenolphthalein indicator, hydrochloric acid, methyl orange, eriochrome black T, ethylenediamine tetraacetic acid (EDTA), potato dextrose agar (PDA), starch casein agar, bismuth sulphite (BS) agar, thiosulphate citrate bile salt sucrose (TCBS) agar, brilliant green agar, eosin methylene blue agar (EMB) and KF streptococcal agar were procured from HiMedia Laboratories Pvt. Limited, Mumbai, India.

Organoleptic Analysis of Water Sample

Organoleptic characters such as odour, color and taste of the water sample was analyzed (Dietrich and Burlingame, 2015).

Physical Parameters

The pH of the water sample was determined using pH meter (Systronics 361, India). The temperature was measured using standard mercury filled centigrade thermometer. The electrical conductivity and Total Dissolved Solids (TDS) were measured using pre-calibrated conductivity TDS meter (Systronics 308, India). Salinity and specific gravity of the water sample was estimated using a handheld refractometer (Erma, ERS10, Tokyo, Japan).

Chemical Parameters

Alkalinity and hardness was analyzed using standard methods (APHA, 1992).

Microbiological Analysis

Heterophillic Plate Count

Heterophillic plate count (HPC) provides an indication of general microbial population in water. Sample to be analyzed for quantitative bacterial analysis, were plated on Glucose Tryptone Agar (GTA) (APHA 1998), fungal analysis were done on PDA and the Actinomycetes count was estimated using Starch Casein Agar (Cappucino and Sherman, 2002). The bacterial plates were incubated at 37^{o}C in an incubator and the fungal and actinomycetes plates were kept for incubation at 28^{o}C and the number of colonies were counted after incubation.

Bacteriological analysis of water sample

Bacteriological analysis was done to detect the presence of water borne pathogens such as *Salmonella* sp., *Shigella* sp., *Vibrio* sp., *E. coli* and faecal streptococci. Specific culture medium was used to detect the presence of these pathogens. For the isolation of *Salmonella* sp., 10 ml of water sample was inoculated into l00 ml of selenite enrichment broth and incubated at 37 ^{o}C for 12-18 hours and swabs from the selenite broth were then streaked on Bismuth Sulphite (BS) agar (Humbert et al., 1997). Water samples suspected to contain *Vibrio* sp. were enriched by adding 50 ml water sample in 100 ml of double strength alkaline peptone water (pH 8.6) and incubated at 37 ^{o}C for 24 hours and swabs from the alkaline peptone water were then streaked on TCBS agar and further incubated at 37 ^{o}C for 24 to 48 hours. Brilliant green agar was used to culture *Salmonella* sp. and *E. coli*, Eosin methylene blue agar for *E. coli* and KF Streptococcal agar for culturing faecal Streptococci.

Results and Discussion

Organoleptic characteristics

The water sample collected from Ooty lake was colorless, tasteless and had an earthy odour.

Physical parameter analysis

The pH of the water sample was 7.34 and temperature was 22 ^{o}C. The electrical conductivity was calculated as 587.8 µS. The results of different parameters are given in **Table 1**.

Table 1: Physical parameters of Ooty Lake water sample

Sl. No.	Parameters	Readings
1	pH	7.34
2	Temperature	22 ^{o}C
3	Electric Conductivity	587.8 µS
4	Salinity	0
5	Specific Gravity	0
6	TDS	292.2 ppm
7	Hardness	120 ppm
8	Alkalinity	130.20 ppm

Alkalinity and hardness of water sample

Alkalinity was found to be 130.20 ppm in water sample collected. Hardness of water sample was 120 ppm respectively.

Heterophillic plate count

The heterophillic bacterial count was 39×10^{3} cfu/mL, the fungal and actinomycetes count are given in **Table 2**.

Table 2: Hetrophillic plate count of microorganisms

Sl No:	Organisms	Number of colonies (cfu/mL)
1	Bacteria	39×10^{3}
2	Fungus	2×10^{2}
3	Actinomycetes	35×10^{2}

Isolation and identification of pathogenic bacteria

Table 3: Presence of pathogenic bacteria in Ooty lake water sample

Sl No:	Selective media	Colony characteristics	Microorganism
1	EMB agar	Purple with black centre and green metallic sheen	*E.coli*
2	TCBS agar	Yellow Bluish green Greenish yellow	*V. cholerae* *V. parahemolyticus* *V. vulnificus*
3	BS agar	Black with metallic sheen Brown	*S.typhi* *Shigella flexneri*
4	Brilliant Green	Pinkish white Yellowish green	*S. typhimurium* *E. coli*
5	KF Streptococal agar	Red- maroon	*Enterococcus faecalis*

The identification of pathogenic bacteria was done by plating the water sample in specific media and the results are given in **Table 3**. The presence of *E. coli* in water samples were confirmed on the basis of colony morphology on EMB and brilliant green agar. The existence of entero pathogenic *Vibrio* sps., *Vibrio parahaemolyticus* and *Vibrio cholerae* were found after plating the enriched water sample in alkaline peptone water in TCBS agar plates **(Fig: 1).**

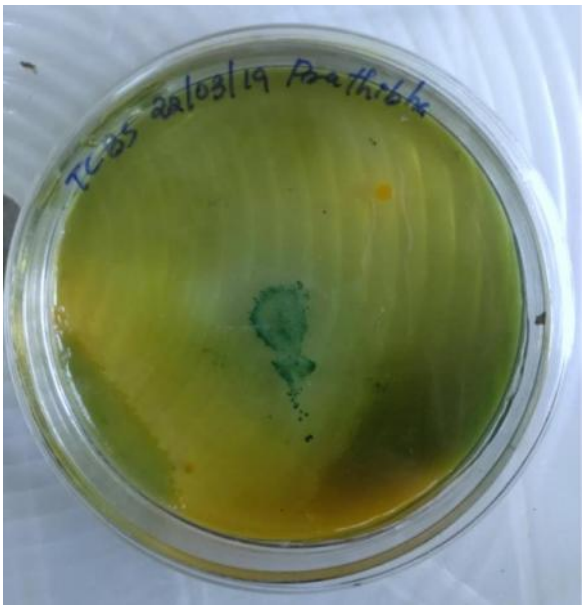

Figure 1: Presence of *Salmonella typhi* in TCBS agar

BS agar is used as the specific medium for the isolation of *Salmonella typhi* **(Fig: 2).** Brilliant green agar is used for the isolation and confirmation of *Salmonellae* other than *Salmonella typhi* in the water sample.

Figure 2: Brilliant Green Agar plate showing *Salmonella* sp.

KF Streptococcal agar is used for selective isolation and enumeration of faecal *Streptococci* **(Fig: 3).** Faecal Streptococcal colonies were red-maroon and round shaped.

Figure 3: Faecal *Streptococci* in KF Streptococcal agar

Discussion

Water is the most common liquid on earth. Our mother Earth will not exist without water. The current study focused on the physicochemical and microbiological analysis of water sample collected from Ooty Lake, Tamil Nadu district, India. However, human activities on lakes have increased quickly in recent days. Major changes have occurred in the land where natural vegetation is cleared, agricultural, urban and industrial activities are exaggerated (Neelakandan, 2007). These activities like deforestation, agriculture, urban settlements and industries have accelerated the aging process as enlarged amounts of sediments, nutrients and other toxic substances that enter into lake and runoff. Most lakes are in the edge of depletion in various ways, through eutrophication, toxic pollution or habitat loss. In addition to this catchment based activities have been convoyed by impingement on lake-shores by recovering shallow lake margins, sewage disposal, water abstraction, and broadening of in lake recreational activities. All these activities directly cause rapid degradation of lakes (CPCB, Water Quality Status of Lakes and Reservoirs in Delhi, 2001).

The organoleptic characteristics of water sample was analysed to distinguish the acceptability of water sample. The pH, temperature, electrical conductivity, total dissolved solids, salinity and specific gravity of the water was also analysed and the results were obtained. The chemical parameters such as alkalinity, hardness were compared on the basis of values recognised by BIS, 1991. In 2016, Rajamanickam and Nagan studied on the Water Quality Status of Major Lakes in Tamil Nadu from 2001-2015 and found that each of the physicochemical characters has a drastic change in every year. The pH observed in 2014 was 8.11 and now it was 7.34. The electric conductivity, TDS and hardness of the water was found to be higher than that of the investigational value. The HPC of the water sample revealed that sample had more number of bacterial colonies on culture media and less number of fungal colonies. The CFU value of HPC of the water sample also shows highest value of actinomycetes colonies. HPC can provide an indication of the level of the general population in the system and is considered as a good general indicator of overall water quality (Chandran et al., 2011). A group of bacteria commonly referred as faecal coliform act as indicator for faecal contamination of water (Gopinath et al., 2012; Jyothilekshmi et al., 2019). The isolation and identification of pathogens were done on the basis of biochemical test and morphological analysis on the specific agar surface.

The presence of *E. coli, S.typhi, V. cholerae, Shigella* sp. etc. pose a threat to the aquatic life and also confirms that the water was unfit for use. *E. coli* and coliforms presence in the surface water sources points out the possibility of contamination by other pathogenic microorganisms that further renders such water unsafe for drinking and food processing (Anyamene and Ojiagu, 2014). The presence of *E. coli*, *Salmonella* spp. or *V. cholerae* in drinking water is a threat to human health.

These bacteria can cause haemorrhagic colitis (Kerr et al., 1999), diarrhea, nausea, abdominal cramps, fever, and vomiting (Ocepek et al., 2011) and cholera (Shanan et al., 2011), respectively. Several studies have been reported a statistically significant increase in gastrointestinal illness in populations that drink contaminated water with different types of coliform bacteria (Payment et al., 1997).

Conclusion

The present study reveals that the Ooty lake water was heavily polluted with pathogenic microorganisms. The anthropogenic pressures depletes the quality of water makes it unfit for every purpose especially for drinking and also faces the risk for the aquatic life. The improvement of the quality of lake is important and can be restored by the *in situ* measures of lake cleaning such as de-silting, de-weeding, bioremediation, aeration, bio-manipulation, nutrient reduction, withdrawal of anoxic hypolimnion, and catchment area treatment which includes aforestation, storm water drainage, silt traps etc., strengthening of bund, lake fencing, shoreline development, Lake front eco-development including public interface, Prevention of pollution from non-point source by providing low cost sanitation, public awareness and public participation.

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