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PHYSICO-CHEMICAL AND MICROBIAL STATUS OF MALKHED LAKE AT CHANDUR RAILWAY, DISTRICT: AMRAVATI

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ABSTRACT

An accurate assessment and periodic monitoring on water quality as well as screening for microbiological parameters are necessary to frame a sound public policy and implementation of water quality improvement programmes. It is not only a safeguard against the possible outbreak of disease, but also is a test of efficiency for the treatment plan and the disinfection process. Various physico-chemical parameters of six different sites of Malkhed Lake were measured during 2008 and 2009. The pH of water was slightly alkaline (7.3 to 8.9). Turbidity and electrical conductivity ranged from 3.00 to 5.50 NTU and 329to 359 μmhos/cm respectively. The total dissolved solids, alkalinity, total hardness, chloride were ranged from 342 to 395, 178 to 192, 98 to 143 and 19.50 to 25 mg/L respectively. Cations viz., Ca^{++}, Cu^{++}, K^{+}, Na^{+} and Mg^{++} were ranged between 6.50 to 10.10, 0.01 to 0.07, 0.01 to 0.10, 26.50 to 34.50 and 7.9 to 8.60 mg/L respectively . 4.22 to 7.34 mg/L DO, and 2.03 to 7.10 mg/L BOD recorded. Phosphate, nitrate iron and fluoride were found 0.00 to 0.10, 40 to 55.01, 0.01 to 0.10 and 0.19 to 0.29 mg/L respectively. Lake water did not show any significant pollution during the present study, except nitrates and BOD. The differences in various parameters were statistically significant ($p < 0.05$) when compared with BIS and WHO. These parameters were found to be important for quality of water which showed strong correlation with several other parameters. MPN count varied for *E.coli* from 18/100 mLand 63/ 100 mL which indicate that dam water in study area are less contaminated.

INTRODUCTION

Direct or indirect contact of chemicals or waste water to the sources of drinking water cause the undesirable changes in it which becomes dangerous for all living things. So the Government has made strict laws for preventing the pollution of water and spends a lot of money for filtration, storage, chlorination of water and supplying of it. Some of the natural water resources play significant microbial load through domestic sewage, animal and human excreta and industrial wastes and increased use of chemicals in agriculture. Thus conservation of freshwater environment has got paramount importance and their monitoring of pollution is highly essential (Mohapatra and Rangarajan, 1995). Directly or indirectly the aquatic life is governed by the interaction of a number of physical, chemical and biological conditions and the tolerance of the organisms to variations in one or more of them which determines the water quality (Reid and Wood,1976). Number of studies has been carried out for defining criteria of water quality and assessing the pollution load to check the water sources in different parts of the country from getting further polluted (Hawkins, 1974; Ott, 1978; Lohani, 1981; Tiwari *et al*., 1986; Bharati and Krishnamurthy, 1990; Srivastava and Sinha, 1994; Padmavathy *et al*., 2002, Reshma and Prakasam, 2006, Smitha *et al*., 2007, Tambekar *et al*., 2008, Li *et al*., 2009, Avsan Maruti *et al*. , 2010, Arumugam *et al*., 2013). In the following account, an attempt has been made to correlate select physical and chemical water quality parameters to find out whether the water of Malkhed lake is polluted or require monitoring programme because the water of this lake is being used for drinking and irrigation purposes by people of Chandur Railway city. Today needs : The base line data is essentially required for assessment of any program and this study has tried to produce a base line data because an accurate and periodic assessment on water quality is necessary to shape a sound public policy and implementation of water quality improvement programmes. Not much work has been carried out on this lake, therefore, the present topic is selected for the study with the following objectives-

Physico-chemical parameters

Such as temperature, pH, colour, odor and transparency, conductivity, total dissolved solid, biological oxygen demand, dissolved oxygen, salinity, calcium hardness, phosphates, nitrates and chlorides.

Trace metals: Na^{+}, K^{+}, Mg^{++}, Ca^{++}, Fe^{++}, Cu^{++} and Fluoride.

Microbial study: Bacteria present in water.

MATERIALS AND METHODS

Study area

Malkhed lake is an artificial shallow fresh water ecosystem situated near Sawanga Vithoba village (longitude 77′ and 55′-0 and latitude 20º and 55º) whose water spreading capacity is 260 hectares and storage capacity is 8.962 m^3.

The present study was carried out from September 2008 to February 2009**.** Six sampling sites were chosen for regular15 days monitoring. The samples were collected from active spots and brought to the laboratory in a suitable sterilized plastic

bottle, then mixed in an equal quantity and made a composite sample for the further study.

Various physico-chemical parameters like colour, odor, transparency, pH temperature, turbidity, alkalinity, chlorides, total hardness, dissolved oxygen, biological oxygen demand, fluorides, phosphate, iron, magnesium, sodium, calcium, copper, electrical conductivity, total dissolved solids (TDS), potassium etc. were estimated, according to standard methods (Trivedi and Goel, 1986). The trace elements and metals were studied on Atomic Absorption Spectrophotometer at Sadhna Krushi Vidynan Kendra, Durgapur, the microbial study of the water sample were carried out at District Health Laboratory, Amravati and determined by most probable count (MPN) method using multiple dilution technique (APHA, 1995) for this the samples were collected from margin of lake .The readings of samples were compared with the standard readings recommended by WHO (1984) and BIS (2003) - Bureau of Indian Standards. The data were subjected for statistical analysis, SPSS, 10.0 (Statistical Package for Social Science).

RESULTS

(Table no.1, 2 and 3) The physical parameters viz. temperature, colour, odour, turbidity are found to be acceptable limit for potable purpose, though seasonal variations are there. pH value in sampling areas ranged from 7.3 to 8.9 according to WHO (1984), desirable pH of drinking water between 7 to 8.5. The maximum pH was recorded during post-monsoon 8.9 and minimum during pre-monsoon 7.3. Conductivity ranged from 329 to 359 μmho/cm. All the hundred percent water samples were having electrical conductivity(EC) exceeding the desirable limit *i. e.* 300 μmhos/cm which indicate high concentration of ions than that of the permissible level which are present in the form of NO_3. The water transparency is directly related with that of turbidity, when measured at the spot transparency varies in the range 400 cm to 750 cm. The maximum transparency was recorded in the month of February and minimum in the month of September. Turbidity was found in the range 3.00 to 5.50 NTU and average value 3.94 NTU. Maximum turbidity was recorded in the month of September. 5.50 NTU and minimum in the month of November and February. The total dissolved solids (TDS) vary from 342 to 395 mg/L. The maximum TDS was recorded in the month of January and minimum were recorded in the month of November. Dissolved oxygen concentration varied from 4.22 to 7.34 mg/L. Maximum D.O. was occurred during December while minimum in October. Data indicates that the value of total hardness is ranged from 98 to 143 mg/L. All water samples were having total hardness below the limit *i.e.* 150 mg/L. Chlorides were found in the ranged 19.50 mg/L to 25 mg/L. chloride concentration in almost all the samples observed to be less as compared to its standard value 200 mg/L. Phosphate concentration in all the samples were observed to be less or nil. Phosphate was found in the range 0 to 0.10

Table 1: Physical parameters analysis of water from Malkhed lake

Months	Temperature ºC	pH	Turbidity NTU	Total Disso. Solids	Electrical Conductivityμmhos /cm	Colour	Odour	Transparency (cm)
September-I	25.0	7.5	5.5	378	329	Slightly yellow	Acceptable	400
September-II	25.5	7.5	4.65	395	335	Light yellowish	Acceptable	500
October-I	26.5	7.3	4.5	350	345	Colourless	Acceptable	500
October-II	26.0	7.5	4.25	365	341	Colourless	Acceptable	550
November-I	24.0	7.9	3.0	390	346	Colourless	Acceptable	750
November-II	25.0	7.7	3.3	342	343	Colourless	Acceptable	650
December-I	23.5	8.0	3.9	358	339	Colourless	Acceptable	550
December-II	23.0	8.9	4.0	388	340	Colourless	Acceptable	550
January-I	24.0	8.1	3.5	381	342	Colourless	Acceptable	650
January-II	24.0	7.5	4.61	395	351	Light green	Acceptable	500
February-I	22.0	7.7	3.01	390	355	Light green	Acceptable	750
February-II	24.5	7.5	3.0	393	359	Light green	Acceptable	750

Table 2: Chemical parameters analysis of water from Malkhed lake

Months	Alkalinity	Total hardness	D.O.	B. O. D.	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	ClÉ	NO_3	Fe^{++}	PO_4	F	Cu^{++}
September-I	187	104	6.29	3.5	10.1	0.22	8.0	27	22	40.5	0.01	0.02	0.20	0.03
September-II	178	98	6.09	4.06	7.4	0.19	8.1	26.5	20	40	0.05	0.05	0.29	0.03
October-I	185	108	5.18	6.09	8.2	0.2	8.4	27.8	23	43	0.03	0.01	0.26	0.02
October-II	180	117	4.22	3.9	7.1	0.25	7.9	27.2	25	41	0.04	0.01	0.25	0.04
November-I	183	121	5.89	2.13	6.9	0.27	8.5	29.1	22	45.3	0.03	0.03	0.27	0.01
November-II	185	123	4.85	6.07	7.2	0.29	8.3	30.5	20.2	47.5	0.05	Nil	0.24	0.05
December-I	180	130	4.97	2.03	7.4	0.25	8.4	30.3	22.1	49.1	0.03	0.1	0.22	0.07
December-II	182	128	7.34	2.08	6.5	0.3	8.1	32	21.3	50.7	0.04	0.1	0.19	0.05
January-I	188	135	5.15	6.06	6.9	0.27	8.6	34.5	19.5	55.01	0.07	0.03	0.27	0.04
January-II	192	132	5.19	6.17	7.4	0.32	8.1	33.8	22	50.01	0.03	Nil	0.20	0.01
February-I	185	140	5.75	2.03	7.3	0.3	8.1	34	20.5	50	0.06	Nil	0.25	0.06
February-II	180	143	6.6	7.1	7.9	0.33	8.3	34.4	21.1	52	0.1	Nil	0.19	0.05

All the values in mg/L.

Table 3: Observed mean, standard value, P-value and significant of various physico-chemical parameters of Malkhed lake (Units are given in previous tables)

Parameter	Minimum	maximum	Observed Mean	SD	SE ±	Standard Value	P-Value	Significant
Temperature	22.00	26.50	24.42	1.28	0.37	-	-	-
pH	7.30	8.91	7.76	0.43	0.13	7.50	0.00	P < 0.05
Turbidity	3.00	5.50	3.94	0.80	0.23	5.00	0.00	P < 0.05
T.D.S.	342	395	377.08	18.88	5.39	500.00	0.00	P < 0.05
E. C	329	359	343.75	8.31	2.40	40.00	0.00	P < 0.05
Alkalinity	178	192	183.75	4.05	1.17	200.00	0.00	P < 0.05
Total Hardness	98	143	123.25	14.26	4.12	300.00	0.00	P < 0.05
Calcium	6.50	10.10	7.53	0.93	0.27	75.00	0.00	P < 0.05
Magnesium	0.19	0.33	0.27	0.05	0.01	30.00	0.00	P < 0.05
D. O.	4.22	7.34	5.63	0.87	0.25	5.00	0.03	P < 0.05
B. O. D	2.03	7.10	4.27	1.94	0.56	5.00	0.22	Non -Significant
Sodium	7.90	8.60	8.23	0.21	0.06	20.00	0.00	P < 0.05
Potassium	26.50	34.50	30.59	3.09	0.89	10.00	0.00	P < 0.05
Chloride	19.50	25	21.56	1.50	0.43	-	-	-
Fluoride	0.19	0.29	0.24	0.04	0.01	1.00	0.00	P < 0.05
Nitrate	40.00	55.01	47.01	4.97	1.43	45.00	0.19	Non -Significant
Iron	0.01	0.10	0.05	0.02	0.01	0.30	0.00	P < 0.05
Phosphate	0.00	0.10	0.04	0.04	0.01	-	-	-
Copper	0.01	0.07	0.04	0.02	0.01	-	-	-

mg/L. The concentration of nitrates is more than the acceptable limit in some samples, acceptable limit for nitrate in water is 45 mg/L. In the present investigation, it is cleared that nitrate concentration varied from 40 to 55.01 mg/L and high concentration of nitrates were observed in the month of January. Very few samples have satisfied value of Biological Oxygen Demand. The average value of B.O.D. was observed 4.27 which is less than the permissible limit while B.O.D was found in the range of 2.03 to 7.10 mg/L. The total alkalinity as $CaCO_3$ from 178 to 192 mg/L indicating lake water sample is alkaline in nature. Water sample has the lowest value of magnesium 0.19 to 0.33 mg/L and lowest value of calcium ranged from 6.5 to 10.1 mg/L. These values of calcium and magnesium are very low than the standard value 75.00 and 30 mg/L respectively. The iron concentration varied from 0.01 to 0.10 mg/L and the average value were observed 0.05.permissible limit of WHO (1.0 ppm) Fluoride concentration varied from 0.19 to 0.20 mg/L. Results indicate that all the water samples were having fluoride content lower than the permissible limit 1.0 to 1.5 mg/L. Copper concentration varied from 0.01 to 0.07 mg/L and the average value were observed 0.04 mg/L. (WHO standard 0.05 mg/L). Sodium ranged from 7.9 to 8.60 mg/L while calcium average value is 7.53 mg/L both values were very low than the permissible limit. Potassium is ranged from 26.50 to34.50mg/L which is exceeded than permissible limit.

The total density of bacteria *E. coli* in composite water sample of Malkhed lake is found highest in the month of September and lowest in the month of January (63/100mL and 18/100mL respectively) which indicated that the dam water in study area are less to moderately contaminated in the month of January and are severe in rainy season when the value are compared with recommended standard, water samples were found in potable form.

DISCUSSION

The water temperature is directly related with that of atmospheric temperature when measured at the spot. Variations in the water temperature have direct or indirect effects on life processes (Welch, 1952). Colour is the visible water quality parameter. pH values in sampling areas ranged from 7.3 to 8.9 and so the water of Malkhed lake is alkaline in nature. According to WHO (1984), desirable pH of drinking water is in between 7 to 8.5. pH has no direct adverse effect on health but at the same time alters the taste of water. Higher pH reduces the germicidal potentiality of chlorine and induces the formation of toxic trihalomethanes(Trivedi and Goel. 1986). Increase in pH during day time is largely due to photosynthetic activity whereas decrease at night is the result of catabolic processes (Trivedi and Goel, 1986; Gupta, *et al.,* 2009). In present study the turbidity fluctuated with the season (Shrivatava and Sinha, 1994) but acceptable. Chloride is considered to be pollution indicating parameter and it is responsible for the salty taste of water .Chloride present in water originates from both natural and anthropogenic sources (Napacho and Manyele, 2010). Conductivity is a very important parameter for determining the water quality for drinking as well as agricultural purposes. Conductivity based on total concentration of various ions. The values of electrical conductivity in the study area ranged from 329 to 359 and average mean 343.75 μmho/cm. All the 100% water samples were having electrical conductivity exceeding the desirable limit *i.e.* 300 μmhos/cm (WHO, 1984).Electrical conductivity signifies the amount of total dissolved solids which indicates the inorganic pollution of water (Hem, 1959). High values of conductivity indicate high concentration of soluble salts present in ground water sources and also reflect the contribution from seepage of domestic, industrial and municipal sewage (Hussain *et al.,* 2002). Dissolved calcium and magnesium ions have been reported as the major contributors to hardness in natural water (Ademoroti, 1996 and Miroslav and Vladimir, 1999). In present study the total hardness of lake water is found in the range between 98mg/Lto143mg/L (Afiukwa *et al.,* 2012). When hardness is in excess of permissible level is undesirable and risky to the health

Table 4: Correlation coefficient among the various parameters of the study site of Malkhed lake(units are given in previous table)

	Temp	pH	Turbidity	TDS	EC	ALK	Total hardness	Ca^{++}	Mg^{++}	D.O.	B.O.D.	Na^{+}	K^{+}	Cl^{-}	F^{-}	NO_3	Fe^{++}	PO_4	Cu++
TEMP	1.00																		
pH	-0.60*	1.00																	
TURB	0.48	-0.26	1.00																
TDS	-0.45	0.16	-0.06	1.00															
EC	-0.34	-0.15	-0.69*	0.26	1.00														
ALK	-0.16	-0.10	0.18	0.04	0.12	1.00													
TH	-0.70*	0.33	-0.71**	0.22	0.75**	0.19	1.00												
Ca^{++}	0.36	-0.54	0.61**	-0.11	-0.33	0.21	-0.43	1.00											
Mg^{++}	-0.62*	0.32	-0.60**	0.31	0.72**	0.28	0.88**	-0.39	1.00										
D. O.	-0.37	0.45	-0.01	0.60*	0.02	-0.17	0.05	0.12	0.18	1.00									
BOD	0.50	-0.48	0.02	-0.16	0.33	0.33	0.10	0.15	0.15	-0.23	1.00								
Na^{+}	-0.09	0.17	-0.51	-0.19	0.20	0.10	0.28	-0.26	0.04	-0.10	0.22	1.00							
K +	-0.69*	0.33	-0.58*	0.35	0.71**	0.39	0.93**	-0.38	0.85**	0.17	0.25	0.30	1.00						
ClÉ	0.43	-0.27	0.34	-0.29	-0.09	-0.14	-0.25	0.16	-0.20	-0.37	-0.14	-0.38	-0.47	1.00					
F	0.30	-0.25	-0.15	-0.09	-0.14	-0.16	-0.39	-0.27	-0.54	-0.38	-0.03	0.29	-0.35	-0.15	1.00				
NO_3	-0.67*	0.50	-0.61*	0.21	0.57	0.31	0.90**	-0.46	0.77**	0.15	0.19	0.48	0.95**	-0.49	-0.33	1.00			
Fe^{++}	-0.18	0.01	-0.66*	0.27	0.64*	-0.25	0.60	-0.34	0.49	0.16	0.45	0.25	0.62*	-0.47	0.03	0.57	1.00		
PO_4	-0.02	0.53	0.18	-0.10	-0.49	-0.56	-0.15	-0.34	-0.24	-0.02	-0.56	-0.21	-0.33	0.40	-0.07	-0.16	-0.26	1.00	
Cu^{++}	-0.44	0.36	-0.36	-0.25	0.07	-0.42	0.45	-0.17	0.23	0.03	-0.26	-0.03	0.30	-0.22	-0.27	0.38	0.39	0.34	1.00

* Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed)

(Austin, 1984).Biological Oxygen Demand is less than the permissible limit. From this observation, it is very clear that there may be an infiltration of sewages from the living area to that of the dam. The low value of D.O. due to its increased amount of decomposition of organic matter and high value of B.O.D. is due to the effluent of sewage (Singh *et al.*, 1999; Singh *et al.*, 2010). Results indicate that all the water samples were having fluoride content lower than the permissible limit. The values of iron is within the permissible limit of WHO (1.0 ppm) though iron concentration varied from 0.01 to 0.10 and the average value was observed 0.05. High amount of iron content water interferes infiltration process in the human body (Jameel *et al.*, 1998) and also influence the presence of bacteria (iron-reducing) in water (Tyrell and Housewam, 1997).Copper is an essential element and good for health in very small quantities but excessive dose is toxic. In the present study, the copper content of the water sample is within the permissible limit of WHO (1 ppm) but slightly higher than BIS (0.05 ppm) in one water sample. The source of copper is the industrial and domestic wastes or addition of salts during water treatment for algal control also contributes to copper level in water (Sharma *et al.*, 2007).

In an aquatic ecosystem, nitrates are formed on biological oxidation of organic nitrogenous matter received from raw domestic sewage, agricultural runoff and industrial waste containing organic waste matter, metabolic waste, excretory products and decaying organic matter further add organic nitrogen. Such organic nitrogen is mainly oxidized by nitrifying bacteria **(**Thomas *et al.*, 1980**).** Nitrate can be converted to much more toxic nitrite and ultimately even to a carcinogenic nitrosamine (Lehninger, 1984). Anthropogenic activities increases the nitrate level in the water body and thus nitrate acts as a significant polluting agent which leads to euptrophication of water body (Desai, 1982; Hickey and Smith, 1996). According to BIS (2003), acceptable limit for nitrate in water is 45 mg/L. In the present investigation, nitrate concentration varied from 40.00mg/L to 55.01mg/L. Results indicate that the concentration of nitrates is more than the acceptable limit.

In water bodies, phosphorus occurs both in its inorganic and organic forms. Phosphorus as orthophosphate plays dynamic role by acting as the limiting nutrient. Data indicated that the values of phosphate ranged from 0.00 to 0.10 mg/L and decreased phosphate value is due to its utilization of phytoplankton (Reid and Wood, 1976).

Next to calcium, other dominant cations in natural water are magnesium added to the ecosystem by leaching of rocks in the catchments, it is the vital component of chlorophyll (Munshi Dutta and Dutta Munshi, 1995).Very high concentration of magnesium imparts an unpleasant taste to the potable water. In the present investigation, magnesium concentration varied from 0.19mg/L to 0.33 mg/L. Results indicate that the concentration of magnesium is lower than the permissible limit. According to BIS (2003), acceptable limit for magnesium in water is 30 mg/L. Sodium is one of the most important parameter in water quality like calcium. Both play an important role in maintaining electrolyte balance and their concentrations observed during the study were very low than the permissible *i.e.* 20.0 mg/L- 75.0mg/L respectively. The

value of potassium ranged from 26.50 mg/L to 34.50 mg/L and the average mean 30.59 mg/L. The concentration of potassium is very higher than the standard value 10.00 mg/L. Potassium plays critical role in various metabolic and physiological activities in plants and animals (Lewis, 1997) its intoxication is rare as it is rapidly excreted in absence of pre existing kidney damage (Gosselin *et al.,* 1984 and Gennari, 2002).

Freedom from contamination with faecal matter to drinking water is essential aspect for human health as it contains human enteric pathogens (Scott *et al.,* 2003). Seasonal variations of MPN was measured in water of Malkhed lake. Total coliform population depend upon many factors such as physical, chemical and environmental factors, including rainfall temperature, oxygen profile etc. (Akpata *et al.,* 1993). In this study, the values derived from the MPN count varied from 18/ 100 mL and 63/100 mL, which indicated that dam water in study area are less to moderately contaminated. Frequent monitoring of quality of drinking water is an important step in the public health programme(Jensen *et al.,* 2002, Abdul *et al*., 2011, Edberg *et al*., 2012). Microbes serve major contributors in biological remediation of aquatic system and function as a base of trophic interaction for various groups of animals. The chlorides play a significant role in the production of microorganisms and chlorides increased due to the various anthropogenic treatments. The presence of high concentration of chlorides is directly proportional to that of microbial fauna (Hickey and Smith, 1996). The member of the family - Enterobacteriaceae reduces the nitrates into nitrites and contribute free source of nitrogen for many biological systems (Godkar and Godkar, 2003). Enterobacteriaceae being indigenous family of Malkhed lake but it is less in count.

The study concluded that lake water did not show any significant pollution except nitrates and BOD and its MPN count is also low at bank sides. The differences in various parameters were statistically significant ($p < 0.05$) when compared with BIS and WHO (Table no. 3). Water standard values up to the six months, water temperature, transparency, colour, turbidity, TDS, pH, alkalinity, total hardness, calcium, magnesium, chloride, BOD, DO, phosphate, nitrates and trace metals and elements were found to be important parameters which showed strong correlation with several other parameters (Table no.4) but as the precautionary measures there is need to monitor the water quality of Malkhed lake because it is used for potable purpose.

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