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Original Research Paper

A Laboratory Study on the Physico-Chemical Characteristics of Various Surface Water Bodies in Coimbatore City, Tamil Nadu

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ABSTRACT

The main objective of the study is focused on water quality assessment of various surface water bodies in the Coimbatore city during winter (January 2011) and summer (April 2011). About 75% of the population in the area selected depends on the lake water for domestic purposes, agriculture and industrial purposes. Water samples were collected from four lakes in and around Coimbatore having the same source. The physical and chemical parameters like pH, turbidity, total dissolved solids, electrical conductivity, hardness, concentration of calcium, magnesium, iron, free ammonia, nitrate, nitrite, chloride, fluoride, sulphate and phosphate were analysed and compared with standard techniques. The data were analysed by comparing the values with BIS standards. The studies revealed that water in all the four surface water bodies are to be pre-treated suitably and could be employed for drinking, agriculture and industrial purposes.

INTRODUCTION

Water is vital for the existence of all life forms and is essential for all activities of human beings. Among different sources of water, freshwater bodies like lakes and ponds are found throughout the world. An indisputable bond exists between freshwater bodies and human beings. These are the prime sources of water used for drinking and domestic purposes, irrigation, industrial usage, and also aid in ground water recharge. Since the lake and pond waters are used for drinking and domestic purposes, their quality is to be maintained and should be monitored periodically, because the quality of drinking water plays an important role in maintaining sound health. Several studies were carried out on the quality of freshwater bodies and their physico-chemical characteristics were analysed.

The aim of the present study is to focus on the water quality of four lakes situated in the centre of Coimbatore city. These lakes are the prime water sources of the city and also they have same origin. For this study, the physico-chemical characteristics of the lake water were analysed during winter season (January) and summer season (April) 2011.

MATERIALS AND METHODS

The details of the four freshwater samples collected for analysis are given in Table 1. Water samples were collected in high grade plastic bottles of one litre capacity after rinsing them with distilled water followed by sample water at least three times as suggested by Chanakaya & Jeevan Rao (2010).

Water samples were immediately brought to the laboratory for physico-chemical analysis. Certain parameters like turbidity, colour, pH, electrical conductivity and total dissolved solids of water samples were measured immediately. Others parameters like nitrate, phosphate, chloride, fluoride, calcium, magnesium, alkalinity, etc. were measured within 24 hours. The procedures describe by APHA (1995) and Trivedy & Goel (1986) were applied for analysis of water.

RESULTS AND DISCUSSION

The physico-chemical characteristics of all the four water samples in the winter season are presented in Table 2 and summer season in Table 3. A comparative graphical representation of the various parameters are shown in Figs. 1a, 1b, 2a and 2b for both the seasons.

Turbidity: The turbidity may be caused by a wide variety of suspended particles that range in size from colloidal to coarse dispersions, depending upon the degree of turbulence. In both winter and summer seasons, the turbidity value is more than the standard limit. This clearly shows that more amount of sewage water mix continuously to the four lakes from Coimbatore city. Karne & Kulkarni (2009) and Hujare (2008) have reported about the turbidity which supports the findings of this study.

Total dissolved solids (TDS): Total dissolved solids were found to be maximum during summer and minimum during winter. It may be due to low water flow into the water bodies and high evaporation rate as reported by Karne & Kulkarni

Table 1: Fresh water bodies in Coimbatore City.

Freshwater Bodies	Area	Sample Code	Source type
Lake 1	Valankulam, Kottaimedu	S1	Surface water
Lake 2	Periakulam, Ukkadam	S2	Surface water
Lake 3	KurichiKulam, Kurichi	S3	Surface water
Lake 4	Chittanankulam, Perur	S4	Surface water

(2009). The S3 lake water samples crossed the limits of TDS in both the seasons. It was observed that addition of waste to the S3 lake water was more than in other water bodies. The results indicated that water in all lake bodies is not suitable for drinking.

Electrical conductivity: Electrical conductivity is a measure of the ability of water to conduct electrical current and measures the amount of ions in a solution. The more the ions in the solution, the higher is the conductivity. EC is an indirect measure of the total dissolved solids content of water and there is usually an approximately linear relationship between TDS and conductivity. Maximum EC was seen in sample 3 because TDS level was maximum in that sample. In other samples EC values were within the limit for summer and winter seasons.

pH: pH is method of expressing hydrogen ion concentration. It determines whether the water is acidic or alkaline. The permissible pH limit for freshwater is 6.5-9.2. All the samples were found to have pH values within the permissible limit and they were towards slightly alkaline as discussed in the study of Murugesan et al. (2006).

Total hardness: Hardness is caused by multivalent metallic cations. Such ions are capable of reacting with soap to form precipitates and with certain anions present in the water to form scale. The principle hardness causing cations are the divalent calcium, magnesium, strontium, ferrous and manganous ions. The hardness of water reflects the nature of the geological formation with which it has been in contact. The hardness level should be within 200 mg/L for drinking purpose. The lake S3 shows the higher total hardness than the other water bodies. The total hardness exceeding 300 mg/L is generally not recommended for drinking as reported by Srinivasa Rao & Nageswara Rao (2010). Due to more evaporation and low inflow of water in summer season, the total hardness was found to be more in summer than winter.

Calcium and magnesium: The presence of calcium in water supplies results from deposits of limestone, dolomite and gypsum. It contributes to the total hardness. The calcium level should be within 75-200 mg/L. In all the water samples, the calcium level was well below the lower acceptable limit. Similar analysis of calcium was done by Harinath (2009) and was reported to have higher levels of calcium.

Magnesium is a common constituent of natural water and an important contributor to the hardness of water. It forms scales in boiler when water containing magnesium is heated. It should be within the limit of 30-150 mg/L. It was observed that all the four samples exhibit magnesium level below the acceptable limit as per BIS (1991). Also during summer, it shows that the values of calcium and magnesium were slightly higher than in winter due to the evaporation of water.

Iron: Iron is a micronutrient present in water bodies. The presence of iron in water can be attributed to the dissolution of the rocks and minerals, landfill leachates, sewage and industrial effluents. According to the study by Ayers & Westcot (1976), the limit of iron should be within 5.0 mg/L. In both the seasons, the amount of iron present in all the lakes was acceptable. So it will not disturb the property of water.

Nitrite and nitrate: Nitrates and nitrites are the most abundant forms of dissolved nitrogen in groundwater and surface water due to agricultural and domestic activities as discussed by Zutshi & Khan (1998). High concentration of nitrates can stimulate the growth of aquatic plants and may be a health hazard to juvenile mammals. In present study, the nitrite content was within the permissible limit for all the four samples in winter and slightly increased in the summer. But the values were below the maximum acceptance level. Low nitrate concentration may be due to biological destruction of self-purification properties of water bodies.

Chloride: Chlorides were minimum during winter and maximum during summer. Decrease in the water level of these bodies during summer may be the reason for increase in chloride concentration.

Fluoride: Fluoride ion is one of the inorganic anions in water which leads to teeth problems when present above the acceptable limit. Present study has established that all the four water samples have their fluoride content below acceptable limit in both winter and summer seasons.

Sulphate: Sulphate may be present naturally in water bodies and due to bathing and washing of clothes as revealed by Jain et al. (1996). The limit for sulphate content is 200-400 mg/L. All the water samples were found to contain sulphate levels below the lower limit during winter and summer seasons.

Phosphate: Phosphate may be due to the high rate of decomposition of waste materials or due to surface run-off from the surrounding crop fields, evaporation of water and low water level during summer. The phosphate content during winter was higher and lower in summer.

Phytoplankton: In all the four lakes, the outer surface of the water is mostly covered by water hyacinth plants. It is

Table 2: Physico-chemical characteristics of surface water bodies during winter season 2011.

Parameters	S1	S2	S3	S4
Odour	Objectionable			
Colour	Green	Pale green	Green	Green
Electrical conductivity (μmho/cm)	496	652	906	665
Total dissolved solids (mg/L)	347	456	634	466
Total hardness (mg/L)	180	230	190	110
COD (mg/L)	112.5	156.2	148.1	151.1
Turbidity (NTU)	60	20	10	16
Chloride (mg/L)	50	41	137	87
Calcium hardness (mg/L)	48	60	52	36
Magnesium hardness (mg/L)	14	19	14	10
pH	7.32	7.25	7.84	7.35
BOD (mg/L)	4.81	6.40	5.22	5.15
Dissolved oxygen (mg/L)	3.4	2.6	3.8	3.3
Nitrate (mg/L)	2	1	32	6
Iron (mg/L)	1	0.5	0.1	0.1
Fluoride (mg/L)	0.4	0.4	0.4	0.4
Nitrite (mg/L)	0.2	0.2	0.2	0.2
Sulphate (mg/L)	16	55	87	104
Phosphate (mg/L)	1.5	1	2	2

Table 3: Physico-chemical characteristics of surface water bodies during summer season 2011.

Parameters	S1	S2	S3	S4
Odour	Objectionable			
Colour	Green	Pale green	Green	Green
Electrical conductivity (μmho/cm)	598	732	1092	785
Total dissolved solids (mg/L)	512	492	662	592
Total hardness (mg/L)	195	282	202	132
COD (mg/L)	135.8	200.1	158.2	162.1
Turbidity (NTU)	72.5	25.6	12.4	19.8
Calcium hardness (mg/L)	62	72	58	49
Chloride (mg/L)	52	48	146	98
Sulphate (mg/L)	28	98	135	142
Magnesium hardness (mg/L)	21	32	18	19
pH	7.42	7.15	7.92	7.46
BOD (mg/L)	6.70	6.82	7.20	6.10
Nitrate (mg/L)	3	2	34	8
Dissolved oxygen (mg/L)	1.8	1.6	2.1	1.3
Phosphate (mg/L)	1.3	1.2	1.8	1.7
Iron (mg/L)	1.2	0.6	0.1	0.4
Fluoride (mg/L)	0.5	0.4	0.4	0.5
Nitrite (mg/L)	0.3	0.2	0.3	0.2

the indicator of pollution. Due to the presence of nitrogen and phosphorus in water, the overgrowth of phytoplankton on surface of the water was observed. This process is called eutrophication. Eutrophication escalates rapidly however, when abnormally high amounts of nutrients from fertilizers, domestic and industrial wastes, urban drainage, detergents, animal waste and sediments enter water bodies.

Eutrophication causes several physical, chemical and biological changes, which considerably deteriorate the water quality. Algal blooms release toxic chemicals which kill fish, birds and other aquatic animals causing the water to stink. Decomposition of algal blooms leads to oxygen depletion in water. Many pathogenic microbes, viruses, protozoa and bacteria etc., grow on sewage products under anaerobic conditions. It results into spread of fatal waterborne diseases such as polio, dysentery, diarrhoea, typhoid and viral hepatitis.

DO, BOD and COD: Dissolved oxygen is an important parameter of water quality. Deficiency of DO gives bad odour due to anaerobic decomposition of organic matter (Sallae 1974). In the present study, the dissolved oxygen is very low in all the lakes for both the seasons. Since oxygen is a poorly soluble gas, its solubility varies directly with the atmospheric pressure at any given temperature. Because rates of biological oxidation increase with temperature and oxygen demand increases accordingly, high temperature condition where DO is least soluble, can be of concern during the summer months when temperatures are high and solubility of oxygen is low.

BOD and COD are measures of the organic matter present in water. Values of BOD and COD were found to be within the permissible limits in all the samples. These values were higher in both summer and winter season. So the demand for oxygen in all the lakes is more. This results from the addition of sewage to the lake waters at all the times.

CONCLUSION

The physico-chemical analysis of surface freshwater bodies shows that they are suitable for drinking. In all the four water bodies, most of the parameters are within the limits. It is found that TDS and EC are higher than the acceptable limits. Water in all water bodies has to be pre-treated for removing turbidity, and reducing TDS. The DO value is low in all the seasons because of high input of organic load to the lakes. Also the COD and BOD values are more in both seasons. This reveals that excess organic load in the form of sewage is added to water. It brings the harmful bacteria and other microorganisms to all the four lakes. This shows that the water in all the four lakes are to be pre-treated before using them for drinking and other domestic purposes.

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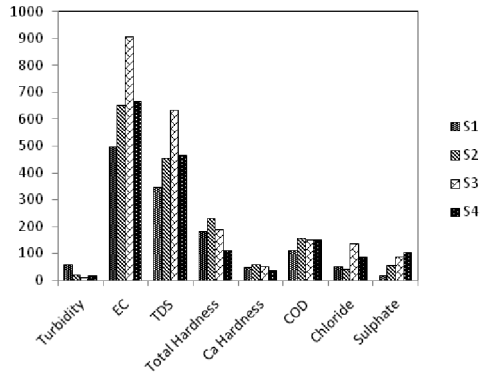

Fig. 1a: Physico-chemical characteristics of surface water bodies during winter season 2011.

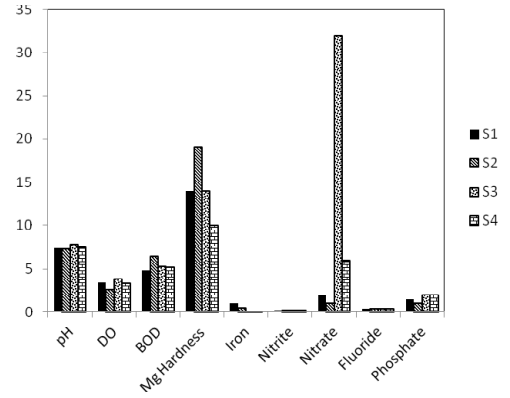

Fig.: 1b Physico-Chemical characteristics of surface water bodies during winter season 2011.

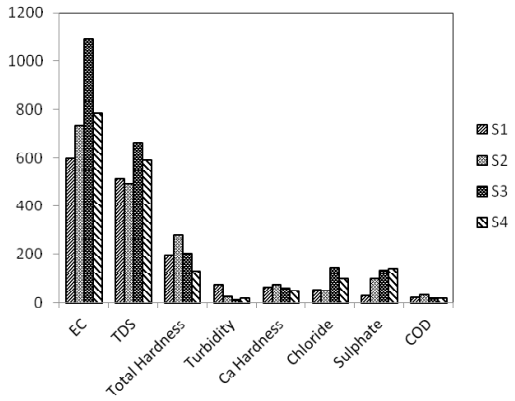

Fig. 2a: Physico-chemical characteristics of surface water bodies during summer season 2011.

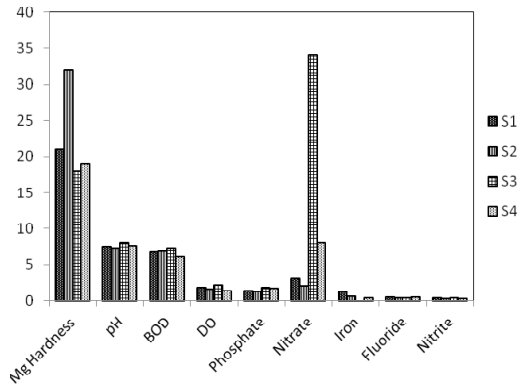

Fig. 2b: Physico-chemical characteristics of surface water bodies during summer season 2011.

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