INTERNATIONAL JOURNAL OF APPLIED BIOLOGY AND PHARMACEUTICAL TECHNOLOGY

www.ijabpt.com Volume-4, Issue-1, Jan-Mar-2013 Coden : IJABPT Copyrights@2013

ISSN : 0976-4550

Received: 07th Nov-2012 *Revised: 11th Nov-2012* *Accepted: 12th Nov-2012*

Research article

STUDY OF POND WATER QUALITY BY THE ASSESSMENT OF PHYSICOCHEMICAL PARAMETERS AND WATER QUALITY INDEX

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ABSTRACT: Water quality index (WQI) is a dimensionless number that combines multiple water quality factors into a single number by normalizing values to subjective rating curves. Conventionally it has been used for evaluating the quality of water for water resources such as rivers, streams and lakes, etc. The present work is aimed at assessing the Water Quality Index (W.Q.I) of pond water and the impact of human activities on it. Physicochemical parameters were monitored for the calculation of W.Q.I for the rainy, winter and summer seasons. The parameters namely pH, Total hardness, TDS, Calcium, Chloride, Sulphate, Sodium, Potassium, EC and DO values were within the permissible limits on the other hand total alkalinities and magnesium values were exceeding the permissible limits as prescribed by Indian Standards. However, the W.Q.I values in the present investigation were reported to be 83.43, 76.598 and 91.52 for different season indicating that the pond water quality is very poor and not totally safe for human consumption.

Key Words: physicochemical parameters, Water quality standards, Water Quality Index, Drinking water quality

INTRODUCTION

Water is one of the most important factors for every living organism on this planet. Water is mainly used for drinking, bathing, fisheries and other domestic purposes. Ponds are one of the important water resources used in this area. On the other hand, they also provide a habitat for invertebrates, fishes and aquatic birds (Kumar et al 2006). During recent years there has been increasingly greater concern for inland fresh water resources, which are affected in different ways by all kinds of human activities. Therefore scientific study needs to review strategies for conservation and better utilization of ponds. Water quality index (W.Q.I) provides a single number that expresses overall water quality at a certain location and time, based on several water quality parameters(Chauhan et al 2012, Chaterjee et al 2002). The objective of water quality index is to turn complex water quality data into information that is understandable and used by the public. A water quality index based on some very important parameters provides a single indicator of water quality. In general, water quality indices incorporate data from multiple water quality parameters into a mathematical equation that rates the health of a water system with number (Pandey 2002, Ram et al 1996).

Physicochemical properties of water in any aquatic ecosystem are largely governed by the existing meteorological conditions and are essential for determining the structural and functional status of natural water (Parashar et al 2006). The municipal waste water of near by areas of Raipur city are dumped into Burha Talab through various nalas, including municipal and domestic wastes. The present study was under taken to define the various point sources of pollutants in Burha Talab and to assess the quality of water samples with special reference to physicochemical properties to decide its WQI.

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STUDY AREA

Budha Talab literal meaning aged (burha) lake (talab), Burha Talab also known as Vevekanad Sarovar is the largest pond (30.25 ha.) among total 22 ponds present in the Raipur city Figure1. It receives domestic waste and sewage and also used for cloth washing, animal bathing and therefore water quality is fast deteriorating.

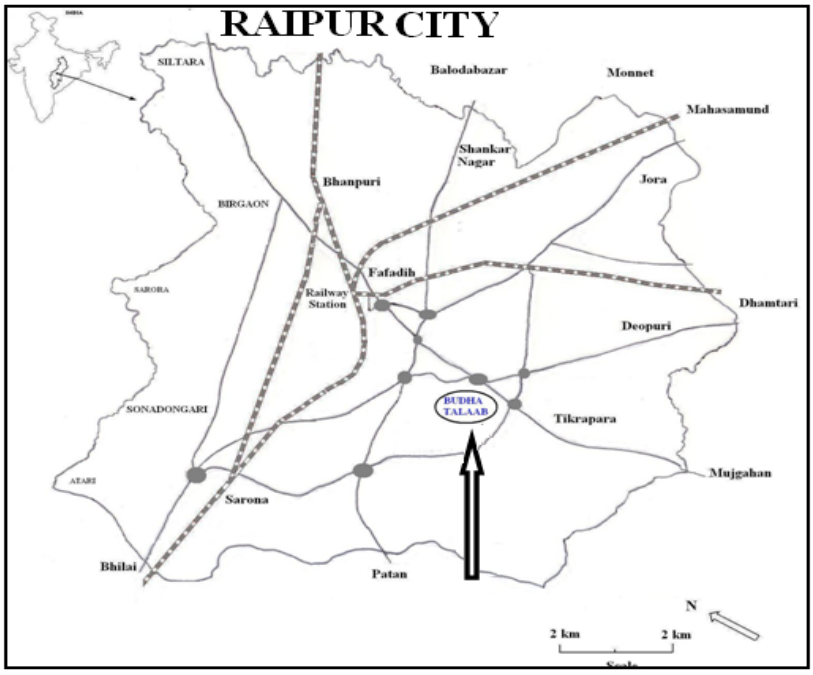

Figure1: Pond Location in Raipur City CG

METHODOLOGY

The water sample from the pond were collected at an interval of 30 days and analyzed for 10 physicochemical parameters by following the established procedures. The parameters pH and dissolved oxygen were monitored at the sampling site and other parameters like total dissolved solids, total alkalinity, total hardness, calcium, magnesium, chloride and sulphate were analyzed in the laboratory as per the standard procedures of APHA (2005).

Table 1 Water Quality Index (W.Q.I.) and status of water quality

Water Quality Index	Water Quality Status
0 – 25	Excellent Water Quality
26 – 50	Good Water Quality
51 – 75	Poor Water Quality
76 – 100	Very Poor Water Quality
> 100	Unfit for drinking

In this study for the calculation of water quality index of 10 important parameters were chosen. The W.Q.I has been calculated by using the standards of drinking water quality recommended by the WHO (1992), BIS (1993) and ICMR (1975). The weighted arithmetic index method has been used for the calculation of W.Q.I of the pond. Further quality rating or sub index (qn) was calculated using the following expression.

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Qn = 100 x [Vn-Vo] / [Sn-Vo]

Where, qn = Quality rating for the nth water quality parameter.
Vn = Estimated value of the nth parameter at a given sampling station.
Sn = Standard permissible value of the nth parameter.
Vo = Ideal value of nth parameter in a pure water.
Unit weight was calculated by a value inversely proportional to the recommended standard values Sn of the corresponding parameters.

$$Wn = K/Sn$$

Where, Wn = Unit weight for the nth parameter.
Sn = Standard value for nth parameter.
K = Constant for proportionality

The overall Water Quality Index (W.Q.I) was calculated by aggregating the quality rating with the unit weight linearly.

WQI = ∑qn Wn /∑Wn

Table 2 Drinking Water standards recommending agencies and unit weight.
(All values except *p*H is in mg/L)

Parameters	Standards	Recommended Agency	Unit weight(Wn)
pH	6.5-8.5	ICMR / BIS	0.2188
Total Alkalinity	120	ICMR	0.0155
Total Hardness	300	ICMR / BIS	0.0062
TDS	500	ICMR / BIS	0.0037
Calcium	75	ICMR / BIS	0.025
Magnesium	30	ICMR / BIS	0.061
Chloride	250	ICMR	0.0074
Sulphate	150	ICMR / BIS	0.0124
DO	5.0	ICMR / BIS	0.3723
Nitrate	45	ICMR / BIS	0.0413
			∑Wn =0.7636

The above water quality is also supported by the variations observed in physicochemical parameters during the different seasons (Figure 2).

RESULTS AND DISCUSSION

Water quality index of the present lake is established from important various physicochemical parameters in different seasons. The values of various physicochemical parameters for calculation of water quality index are presented in Table 3. Season wise water quality index calculations are depicted in the Table 4. The water quality index obtained for the pond water system in different seasons of study period i.e., rainy season, winter season and summer season are 83.43, 76.59 and 91.52, respectively which indicate the very poor quality of water (Chaurasia et al 2007).

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Table 3 Seasonal variations of the physicochemical parameters of the Water body (All values except P is in mg/L)

Parameters	Rainy Season	Winter Season	Summer Season
pH	7.61	7.54	7.86
Total alkalinity	112	145	167
Total hardness	160	210	324
TDS	325	385	487
Calcium	55	43	67
Magnesium	31	26	39
Chloride	52	75	120
Sulphate	16	20	36
DO	5.7	5.2	5.4
Nitrate	21	26	34

Table 4 Calculation of Water Quality Index

	Rainy Season		Winter Season		Summer Season	
	Quality Rating (Qn)	Wn Qn	Quality Rating (Qn)	Wn Qn	Quality Rating (Qn)	Wn Qn
pH	40.6667	8.8979	36	7.8768	57.3333	12.5445
Total alkalinity	93.3333	1.4467	120.8333	1.8729	139.6667	2.1648
Total Hardness	53.3333	0.3307	70	0.4340	108	0.6696
TDS	65	0.2405	23.3333	0.0863	97.4	0.3604
Calcium	73.3333	1.8333	57.3333	1.4333	89.3333	2.2333
Magnesium	103.3333	6.3033	86.6667	5.2867	130	7.9300
Chloride	20.8	0.1539	30	0.2220	48	0.3552
Sulphate	10.6667	0.1323	13.3333	0.1653	24	0.2976
DO	114	42.4422	104	38.7192	108	40.2084
Nitrate	46.6667	1.9273	57.7778	2.3862	75.5556	3.1204
		$\sum WnQn$ =63.7081		$\sum Wn$ Qn= 58.4828		$\sum WnQn$ = 69.8843
	WQI =83.43		WQI =76.59		WQI =91.52	

***p*H**

The average pH value of the lake water was 7.6 during rainy season, 7.5 during winter season and 7.8 during summer season. The pH of water was relatively high in the summer season and low in monsoon and winter season. However, when the average values for three seasons are taken into account the water body was found to be slightly alkaline. In the present investigation pH values were within the ICMR standards.

TDS

The total dissolved solids in water pond was 325 mg/L during rainy season, 385 mg/L during winter season and 487 mg/L during summer season. The concentration is high which may be due to addition of solids from run off water, sewage, municipal effluents and other domestic effluents directly to the pond (Jain et al 1996).

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Total alkalinity

The observed average value of total alkalinity was 112 mg/L during rainy season, 145 mg/L during winter season and 167 mg/L in summer season. Total alkalinity values in our observations indicated that the water was hard. Higher values of alkalinity registered during summer might be due to the presence of excess of free CO2 product as a result of decomposition process coupled with the mixing of sewage and domestic waste. The low alkalinity during rainy season may be due to dilution (Yerel 2009).

Total hardness

Hardness below 300 mg/L is considered potable but beyond this limit produces gastrointestinal irritation (Chaurasia et al 2007). The observed average total hardness value was 160 mg/L during rainy season, 210 mg/L during winter season and 324mg/L during summer season, Higher values of hardness during summer can be attributed to low water level and high rate of evaporation of water and addition of calcium and magnesium salts (Rao et al 2010).

Calcium & Magnesium

The observed average value of calcium was 55 mg/L during rainy season, 43 mg/L during winter season and 67 mg/L during summer season. While the observed average value of magnesium was 31 mg/L during rainy season, 26 mg/L during winter season and 39 mg/L during summer season. Magnesium hardness particularly associated with the sulphate ion has laxative effect on persons unaccustomed to it (Parveen et al 2012).

Chloride

Chloride occurs in all types of natural waters. The high concentration of chloride is considered to be an indication of pollution due to high organic waste of animal origin (Trivedi et al 2009). Chloride value obtained in the study was 52 mg/L during rainy season, 75 mg/L during winter season and 120 mg/L in summer season. The chloride in water was found within the acceptable limit.

Nitrate

Nitrate is the most important nutrient in an ecosystem. Generally water bodies polluted by organic matter exhibit higher values of nitrate. Nitrate value obtained in the study was 21 mg/L during rainy season, 26 mg/L during winter season and 34 mg/L during summer season. In the present study water samples of all the seasons showed low concentration of nitrate well below permissible limits (1, 2, 6).

Sulphate

Sulphate ion does not affect the taste of water if present in low concentration. The sulphate ion concentration in 16 mg/L during rainy season, 20 mg/L during winter season and 36 mg/L during summer season. The observed value of sulphate is very low compared to standard value (1, 2, 6).

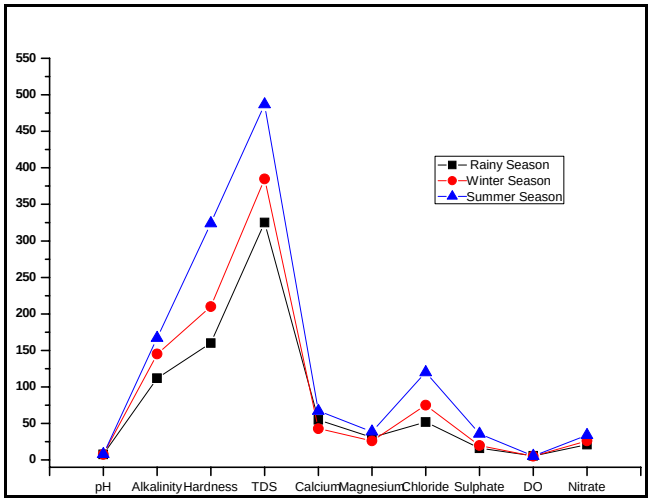

Figure 2 Variations of parameters in different season

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CONCLUSION

The observation in this study indicates the higher values of some parameters of the pond water. They minimize the suitability of the water for drinking purpose without prior treatment. Higher values of WQI clearly show that the status of water body is entropic and not totally safe for human drinking purpose. It is also observed that the pollution load is relatively higher during summer season when compared to the winter and rainy season. People depend on this water are often prone to health hazards due to polluted drinking water. Therefore some effective measures are required to enhance the drinking water quality by delineating and effective water quality management plan for the region.

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