Journal of Advanced Scientific Research

Available online through https://sciensage.info

ISSN

0976-9595

Research Article

Physicochemical and Biological Water Quality Assessment of Local Ponds of Tumakuru, Karnataka, India

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Received: 18-08-2024; Accepted: 14-09-2024; Published: 30-10-2024

https://doi.org/10.55218/JASR.2024151003

ABSTRACT

Water is an essential component of life. The developments, urbanization and load of the various pollutant sources lead to the deterioration of the ponds. Therefore, the study was conducted to assess the physicochemical and biological characteristics of water from the regional ponds of Tumakuru, Karnataka, India. The water samples from six ponds were taken for the study. The physicochemical parameters showed that the pH of the ponds was found to be 7.35, 6.90, 7.21, 7.91, 7.16 and 8.10, respectively. EC was found to be 0.60, 0.19, 0.42, 0.22, 1.43 and 1.0, respectively. The high value of pH and EC shows its nutrient-rich and alkaline nature. Cl was found to be 4.0, 3.0, 4.4, 2.6, 2.4 and 6.8, respectively. Calcium hardness was observed as 1.9, 2.58, 2.34, 1.15, 1.11 and 12.19, respectively. The Biological oxygen demand (BOD) of the samples was found to be 0.1, 1.6, 0.8, 3.3, 1.2 and 0.4 mg/lit, respectively. Qualitative analysis through most probable number (MPN) method was employed. MPN index of water samples which tested satisfactory was < 2 per 100 mL and MPN index of water sample no. WS1, WS3 and WS5 respectively whereas unsatisfactory ranged from 38 to > 1600 per 100 mL of water sample no. WS2, WS4 and WS6, respectively showed that the water was not suitable for domestic uses having s high value of bacterial load. In order to stop the spread of intestinal illnesses, drinking water sources should undergo routine assessment of physicochemical and microbiological quality tests.

Keywords: Physicochemical parameters, Electrical conductivity, BOD, MPN index, Microbiological quality.

INTRODUCTION

Safe water quality is a major concern with reference to public health importance.[1,2] All life on earth depends on water. Water is involved in every biological function, either directly or indirectly. Because water is essential to every cell in the human body, humans cannot exist without it for very long. However, in rural areas now, pond water is becoming polluted mainly due to the discharge of wastewater from houses, effluent from septic tanks etc., as most villages lack improved sanitation practices and have no provision for wastewater treatment systems.[3,4] The WHO estimates that water factors are responsible for around 80% of human diseases.[5] Pollution of surface and groundwater is a major problem due to rapid urbanization and industrialization. The physicochemical contaminants that adversely affect the quality of groundwater are likely to arise from various sources, such as land application of agricultural chemicals, disposal of organic wastes, infiltration of irrigation water, septic tanks, infiltration of effluent from landfills, pits, lagoons and ponds used for wastewater discharge, that are significantly altering the water quality.[6] A pond is referred to as a man-made or natural water body that holds water for four months of the year or more and is normally used as a groundwater recharge source.[7-10] Since ponds play an important role in groundwater recharge therefore, it is necessary to assess the water quality of the pond and to see the impact of percolation of contaminants on the surrounding aquifer. So that strategic management of these resources can be done.[11-14] Village ponds used to be a lifeline for people in rural areas. Rainwater and runoff water are normally stored in ponds for the drinking and bathing of animals. Over the period of time, wastewater from households and septic tanks is also finding its way into the village ponds.[15-19] Therefore, the present study aims to evaluate the physicochemical and biological parameters of six local ponds of the Tumkuru region for their potability and domestic purposes without any risk.

MATERIAL AND METHODS

Study Area

Tumkur District, which has a population of 5,16,661, is spread across an area of 1043 sq. km and is situated in the southeast of Karnataka state between 13° 06'30" and 13° 31' North latitude and 76° 59' to 77° 19' East longitude (Fig. 1). Agriculture, horticulture, and animal husbandry employ about 80% of the workforce and are the main sources of employment.[20]

Sample collection

Total six water samples were collected using pre-sterilized plastic bottles from six different ponds located in Tumakuru district

Fig. 1: Map indicating the study area

especially at morning hours during the month of August to December, 2023 (Table 1). Collected samples were transferred in an ice box to the laboratory for further analysis.

Physicochemical Parameters

Pond water samples were analyzed for physicochemical parameters such as pH, electrical conductivity, total hardness, bicarbonate, carbonate, chloride, sulfate, calcium, magnesium, sodium, and SAR using standard procedures recommended by APHA 1994.

Biological parameters

Biological oxygen demand (BOD

The pond water samples were analyzed for BOD to detect the pollution total coliform count for fecal contamination and also bacteriological assessment of water samples was carried out. Biological oxygen demand (BOD) is a very important parameter of water quality and is an index of the physical and biochemical processes that occurs in water. The oxygen used in the biological processes that decompose organic matter in water is measured by this method. It's applied in ecology, environmental science, and the management and evaluation of water quality.

Detection of Coliforms by MPN method

A multiple tube fermentation test was used to determine the presumed or total coliform count which entailed dilutions of the sample in varying strengths of the medium (Lactose broth). After 48 hours of incubation, the sample's color changed due to the formation of gas and acid, indicating the presence of total coliforms.

Bacteriological assessment

The water samples were assessed by serial dilution and pour plate method for the other bacterial flora present in the water samples.

Identification of bacteria

The identification of bacteria was done by gram staining. Further confirmation was done by biochemical methods.

Biochemical tests

The bacteria were identified and confirmed by performing IMViC tests, catalase, oxidase and sugar fermentation tests.

Table 1: Sampling area

S. No.	*Sample No.*	*Location of the pond*
1	Water sample 1	Devarayapattana
2	Water sample 2	Devaranadurga
3	Water sample 3	Belagumba-1
4	Water sample 4	Belagumba-2
5	Water sample 5	Oordigere cross
6	Water sample 6	Koratagere

RESULTS AND DISCUSSION

pH

The pH plays a role in the growth of flora and fauna of aquatic ecosystems. Thus, measurement of pH is important because most of the biological processes and biochemical reactions are pH dependent. The pH value ranged from a minimum of 6.80 to a maximum of 8.10 somewhat alkaline in nature. In the present study higher value of pH was observed in the water sample 6 (Fig. 2). According to BIS specification, the desirable limit is 6.5 and the permissible limit is 8.5.

EC

The electrical conductivity of water is a direct function of its total dissolved salts.[21] Hence it is an index to represent the total concentration of soluble salts in water.[22] In the present study, the EC values were in the range of a minimum of 0.19 dSml to a maximum of 1.43 dSml (Table 5). According to[20] the electrical conductivity of the groundwater samples varied between 130 to 3000 µS/cm during pre-monsoon period.

Calcium and magnesium

TDS are contributed by carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium, manganese, organic matter salt and other particles in water.[23] Calcium and magnesium are both essential minerals for living organism. Both minerals are found in all kinds of natural water with magnesium concentration generally lower than calcium. In the present study, the calcium content of water ranged from minimum of 1.11 mg/L to maximum of 12.19 mg/L (Fig. 2). Similarly, magnesium content ranged from a minimum of 0.59 mg/L to a maximum of 8.83 mg/L (Fig. 2). High hardness in water samples indicates the addition of extra salts of calcium and magnesium from anthropogenic sources also. Drinking water in excess of $CaCo_3$ above 200 mg/l have not been considered as suitable for drinking purpose.[24]

Chloride

Elevated levels of chlorides have an impact on plant growth and make metals more corrosive. More than 100 mg/l of chloride gives a solution a salty taste and can harm the body. High chloride concentration water typically tastes bad and can be unsuitable for use in several agricultural applications. Water treated with chlorine becomes permanently hard. The chloride content ranged from a minimum of 2.4 mg/L to a maximum of 4.8 mg/L (Fig. 2). The chloride content in a rural part of Tumkur taluk was found to be well within the permissible levels.

Table 2: BOD of the water samples

S.No.	*Sample no.*	*BOD (mg/L)*
1	01	0.1
2	02	1.6
3	03	0.8
4	04	3.3
5	05	1.2
6	06	0.4

Table 3: Classification of water based upon Coliform count

Class	Grading	Coliform count (No./100ml) (MPN)	% of samples
Class 1	Excellent	0	--
Class 2	Satisfactory	1-3	Sample no, WS1, WS3 and WS5
Class 3	Suspicious	4-9	--
Class 4	Unsatisfactory	10 or more	Sample no. WS2, WS4 and WS6

Sulphate

Sulphate concentration in pond water ranged from a minimum of 0.12 mg/L to a maximum of 2.62 mg/L. Fig. 2 shows the sulfate values for all the groundwater samples are well within the permissible limit 200 mg/l of WHO/BIS for drinking purposes.

Sodium

Sodium is a naturally occurring element in groundwater. The possible source of sodium concentration in surface water is a result of the dissolution of rock salts and the weathering of sodium-bearing minerals. Sodium ion concentration in pond water ranged from a minimum of 0.19 mg/L to a maximum of 0.44 mg/L (Fig. 2). According to the WHO (2006) guideline, the maximum admissible limit is 200 mg/L.

Biochemical oxygen demand

Fig. 3 refers to the BOD of the water sample. BOD is the oxygen used by the microorganism in the aerobic oxidation of organic matter.

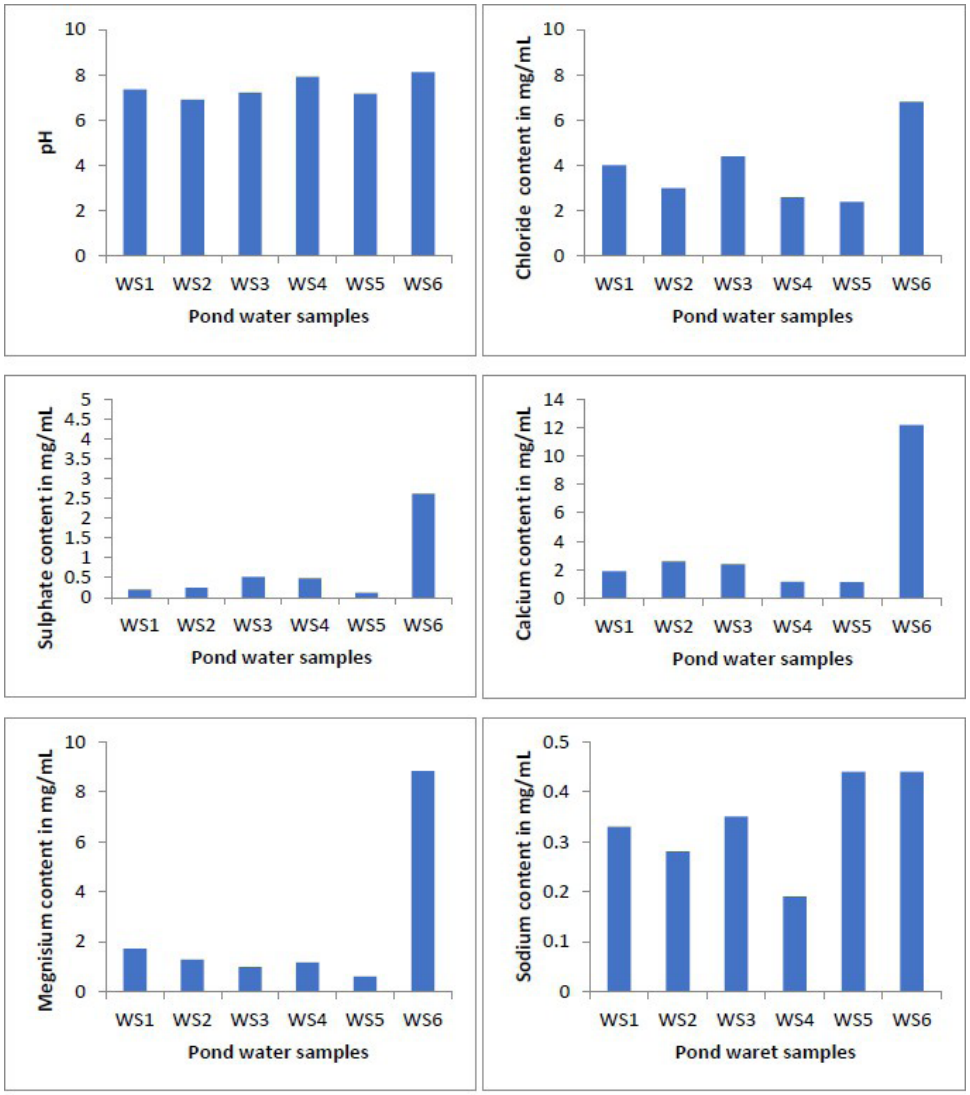

Fig. 2: Physicochemical parameters

Table 4: Morphological and biochemical characteristics of Bacterial isolates from water samples

Bacterial isolates	*Gram stain*	*Shape*	*Indole test*	*MR*	*VP*	*Citrate*	*Catalase*	*Oxidase*	*Sugar fermentation*	
									Lactose	*Glucose*
Staphylococcus spp.	+ve	Cocci	-ve	+ve	+ve	+ve	+ve	-ve	A	-ve
Pseudomonas spp.	-ve	Bacilli	-ve	-ve	-ve	+ve	+ve	+ve	+ve	-ve
Serratia spp.	-ve	Bacilli	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve
Bacillus spp.	+ve	Bacilli	-ve	-ve	+ve	+ve	+ve	-ve	-ve	+ve
E.coli	-ve	Bacilli	+ve	+ve	-ve	-ve	+ve	-ve	AG	-ve
Klebisella spp.	-ve	Bacilli	-ve	-ve	+ve	+ve	+ve	-ve	AG	-ve
Streptrococcus spp.	+ve	Cocci	-ve	+ve	-ve	-ve	-ve	-ve	A	- ve

Table 5: Physico-chemical parameters

Location of the pond	*Sample ID*	*pH*	*EC*	*Cl*	*S*	*BCO_3*	*Ca*	*Mg*	*Na*	*SAR*
Devarayapattana	12776	7.35	0.60	4.0	0.2	0.6	1.9	1.71	0.33	0.24
Devaranadurga	12777	6.90	0.19	3.0	0.24	0.9	2.58	1.27	0.28	0.28
Belagumba-1	12778	7.21	0.42	4.4	0.52	0.8	2.39	0.97	0.35	0.23
Belagumba-2	12779	7.91	0.22	2.6	0.49	0.4	1.15	1.16	0.19	0.17
Oordigere cross	12780	7.16	1.43	2.4	0.12	0.5	1.11	0.59	0.44	0.28
Koratagere	12781	8.10	1.0	6.8	2.62	0.0	12.19	8.83	0.44	0.13

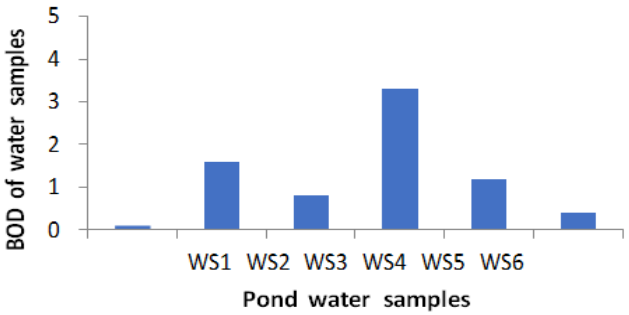

Table 3: Classification of water based upon coliform count

Therefore, with the increase in the amount of organic matter in the water, the BOD increases. High BOD indicates higher consumption of oxygen and higher pollution in water. BOD values ranged from a minimum 0.1 mg/L to a maximum of 3.3 mg/L (Table 2). As BOD increases then DO will also decrease.[25]

Total coliform count

All the pond water samples were analyzed for microbial contamination. Some pond waters were contaminated with fecal coliforms. For the estimation of total coliform count, the most probable number (MPN) method was used, which involved inoculating the sample to several dilutions in a medium (Lactose broth) of different strengths. The samples were incubated for 48 hours and the presence of total coliforms was observed by the color change due to the production of acid and gas. Based on the number of coliforms, water samples can be categorized into four main classes, as shown in Table 3. Total coliforms should ideally not be found in drinking water, as their presence renders it unfit for human consumption. The presence of coliforms indicates contamination of water due to organic material. In the present study WS1, WS3 and WS5 shows satisfactory whereas WS2, WS4 and WS6 shows unsatisfactory results (Table 3). A high number of total coliforms possibly arises from industrial activities as well as residential inhabitants

Microbiological analysis

The primary cause of the low quality of water bodies was the bacteriological load (Table 4). According to this study, these surface waters require adequate treatment before being consumed. These ponds must be shielded from industrial and residential pollution.

CONCLUSION

The water quality of ponds around Tumakuru region has been conducted to assess its suitability for drinking /domestic purposes and the pond's impact on the drinking water quality of a nearby area. A total six pond water samples were analyzed during the months of August to December 2023 for physicochemical and microbiological parameters. During the study period, some of the physicochemical parameters were found (Table 5). The biological oxygen demand (BOD) of the was recorded in the permissible limit. Hence, the water can be used for agriculture and in this period, the tank water is used for drinking purpose only after the treatment. Total coliform count by most probable number (MPN) method was employed. MPN index of water samples which tested satisfactory was < 2 per 100 ml and MPN index of water sample no. WS1, WS3 and WS5, respectively whereas, unsatisfactory, ranged from 38 to > 1600 per 100 mL of water sample no. WS2, WS44 and WS6, respectively showed that the water was not suitable for domestic uses and high value of bacterial load. The bacteria isolated from water samples were *Staphylococcus* spp. *Pseudomonas* spp. *Serratia* spp., *Bacillus* spp., *E. coli, Klebsiella* spp. and *Streptococcus spp*. Chlorinating drinking water before supplying it to households is the Municipality or Grampanchayat should make a recommendation. But, maintaining already-installed community filter plants requires public awareness and involvement.

ACKNOWLEDGMENT

The authors are thankful to the Department of Microbiology, University College of Science, Tumkur University, Tumkur, for providing laboratory facilities to carry out the project work.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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HOW TO CITE THIS ARTICLE: Hosamani R, Mahanthesh V. Physicochemical and Biological Water Quality Assessment of Local Ponds of Tumakuru, Karnataka, India. *J Adv Sci Res*. 2024;15(10): 15-19 **DOI:** 10.55218/JASR.2024151003