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Physicochemical and microbial analysis of pond water at Sundarakkottai, Thiruvarur District, Tamilnadu, India

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Abstract

Water is an elixir of life that governs the evolution and functions of the universe on earth hence water is "the mother of all living world". Industrial sewage and municipal wastes that are discharged to water reservoirs, affect the physicochemical quality of water making them unfit for use of livestock and other organisms. The present investigation has been carried out to assess the physicochemical and microbial profile of pond water samples in Sundarakkottai village, Mannargudi. The results of this study indicated that some of the water quality parameters are high exceeding the permissible limits of World Health Organization (WHO). The bacteriological analysis revealed the presence of bacteria such as *Escherinchia coli, Staphylococcus aureus, Klebsella pneumoniae, Pseudomonas aeroginousa, Proteus vulgaris, Bacillus subtilis, Vibrio cholerae, Clostridium difficile, Shigella dysentriae* and *Salmonella typhimurium* and fungi such as *A. fumigatus, A. niger, P. brevicompactum, Fusarium sp.*, and *A. flavus.* The results clearly indicated that the pond water samples are not satisfying the normal requirement for various applications and it is unsafe for humans without treatment.

Keywords: Pond water, physicochemical characteristics, microbial analysis.

INTRODUCTION

Although water is essential to human life, many people do not have access to clean and safe drinking water and some of them suffer due to waterborne bacterial and viral infections. Pond water gets polluted due to the discharge of effluents from various industries, domestic waste, land and agricultural drainage resulting in the degradation of water quality of these water resources. Water quality assessment generally involves analysis of physicochemical, biological and microbiological parameters that reflect the abiotic and biotic status of the ecosystem. Water pollution is a major global problem. It has been suggested that water pollution is the leading worldwide cause of diseases and deaths and that it accounts for the deaths of more than 14,000 people daily (Goel , 2006). An estimated 580 people in India die of water pollution related illness every day. Some of the limitations of water pollution are listed below:

- Water pollution seriously affects the ecosystem
- Pesticide contamination in the ground water causes reproductive damage in the wildlife ecosystem
- Discharge of polluted water which contains organic material from sewage and agricultural run-off causes eutrophication
- Destroys life in the water based ecosystem which is polluted and in turn disrupts natural food chain
- Aquatic life is destroyed due to the non-bio degradable pesticides and chemicals

Waterborne disease is caused largely due to infection that predominantly gets transmitted through bathing, washing, drinking and the preparation of food or consumption of food. According to the World Health Organization, such diseases account for an estimated 4.1% of the total DALY (Disability-Adjusted Life Year) global burden of disease and cause about 1.8 million human deaths annually. The World Health Organization estimates that 88% of that burden is attributable to unsafe water supply, sanitation and hygiene (WHO, 2014.)

The present article deals with the analysis of water quality in terms of physicochemical parameters and microbial analysis of pond water at Sundarakkottai, Mannargudi, Thiruvarur District of Tamil Nadu.

MATERIALS AND METHODS

Geographical and climate

Sundarakkottai, Mannargudi Taluk, Thiruvarur district in the state, Tamil Nadu in India.

Collection of water samples

Water samples were collected from five ponds located in Sundarakkottai and analyzed for their chemical and biological quality. Physicochemical parameters such as odour, temperature, pH, turbidity, total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), alkalinity, total hardness, BOD, COD, phosphate, chloride, sulfate, dissolved O_2, dissolved CO_2 were analysed by standard methods (APHA, 1985). The bacteriological analysis such as isolation of microorganisms was done by serial dilution method. The pure cultures of the bacterial isolates were subjected

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to various morphological studies as gram's staining and biochemical identification tests. Bacterial isolates were identified using Bergey's Manual of Determinative Bacteriology. The fungi isolated from the water samples were followed by culturing them on potato dextrose agar medium and using standard manuals (Clesceri and Greenberg, 1978).

RESULTS

The results of the analysis of the five pond water samples are tabulated in Tables 1 – 9. Table 1 gives the comparison with respect to the smell, pH, temperature and turbidity. Table 2 gives the results of the chemical analysis namely total solids, total suspended solids, total dissolved solids, total hardness, dissolved oxygen, dissolved carbon dioxide, phosphates, chlorides and sulphate contents in all the five water samples. Table 3 gives the staining characteristics of the bacteria identified. Most of them were rod shaped and motile. These bacteria were further confirmed for their presence in each water sample by suitable biochemical test and the results obtained are tabulated in Tables 4, 5, 6, 7 and 8. Table 9 gives the various fungi identified in the selected locations.

Table 1. Physical Characteristics

Sample	Odour	pH	Temperature	Turbidity (NTU)
Sample I	Agreeable	8.27	33.5^{0}C	21.7
Sample II	Disagreeable	8.52	30.2^{0}C	18.6
Sample III	Agreeable	8.07	35.1^{0}C	20.5
Sample IV	Agreeable	8.14	36.7^{0}C	18.5
Sample V	Agreeable	8.18	34.6^{0}C	22.4

NTU = Number of transfer unit

Table 2. Chemical characteristics

Sample	TS (mg/L)	TDS (mg/L)	TSS (mg/L)	Alkalinity (ppm)	Total hardness (ppm)	BOD (mg/L)	COD (mg/L)	DO (mg/L)	DCo_2 (mg/L)	Phosphate (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
Sample I	450	501	51	360	500	228	452	5.58	176	0.08	290	40
Sample II	498	520	22	380	480	232	430	5.64	182	0.09	320	30
Sample III	697	503	194	390	525	245	440	5.75	185	0.10	335	25
Sample IV	642	504	138	350	540	252	445	6.10	196	0.11	340	45
Sample V	507	502	05	340	420	240	428	5.68	198	0.09	355	38

Table 3. Staining and Morphological characteristics

S. No	Bacteria	Gram staining	Observation	Motility test
1	*E.coli*	Negative	Cocci shape	Motile
2	*S.aureus*	Positive	Circular shape	Motile
3	*K.pneumoniae*	Negative	Rod shape	Non Motile
4	*P.aeroginousa*	Negative	Rod shape	Motile
5	*P.vulgaris*	Negative	Rod shape	Motile
6	*B.subtilis*	Positive	Rod shape	Non Motile
7	*V.chlorae*	Negative	Rod shape	Motile
8	*C.difficile*	Positive	Sprindle shape	Motile
9	*S.dysentriae*	Negative	Rod shape	Non Motile
10	*S.typhimorium*	Negative	Rod shape	Motile

Table 4. Biochemical test for the Identification of Bacteria - Sample I

Bacteria	IT	MRT	VPT	CUT	NT	TSI	OT	UT	CT	SHT	GHT
E.coli	+	-	+	-	+	+	+	-	+	+	-
S.aureus	-	-	-	+	-	+	+	+	-	+	-
K.pneumoniae	+	-	-	+	+	-	-	-	+	+	+
P.aeroginousa	-	+	+	-	+	+	-	-	-	+	+
P.vulgaris	-	-	+	-	-	-	+	+	-	+	-
B.subtilis	-	-	+	+	-	-	+	+	+	-	+
V.cholera	+	-	+	-	-	+	+	+	-	-	+
C.difficile	-	+	-	+	+	+	-	-	-	+	-
S.dysentriae	+	+	+	+	+	-	-	+	+	+	-
S.typhimorium	+	+	+	-	+	+	+	+	-	-	+

(+) = Presence; (-) = Absence

Table 5. Biochemical test for the Identification of Bacteria - Sample II

Bacteria	IT	MRT	VPT	CUT	NT	TSI	OT	UT	CT	SHT	GHT
E.coli	+	+	+	+	-	-	+	+	+	-	-
S.aureus	+	-	-	-	+	+	+	-	-	+	+
K.pneumoniae	-	-	-	+	+	+	-	-	+	-	+
P.aeroginousa	+	+	+	-	-	+	+	+	-	-	-
P.vulgaris	+	+	+	-	-	+	-	+	-	+	+
B.subtilis	-	-	+	-	-	+	+	+	+	+	+
V.cholera	+	+	+	-	+	-	-	-	-	+	+
C.difficile	+	+	-	-	-	+	+	+	-	-	+
S.dysentriae	+	+	+	+	-	+	+	+	-	-	-
S.typhimorium	+	-	-	-	-	+	+	+	+	-	+

(+) = Presence; (-) = Absence

Table 6. Biochemical test for the Identification of Bacteria - Sample III

Bacteria	IT	MRT	VPT	CUT	NT	TSI	OT	UT	CT	SHT	GHT
E.coli	-	-	+	+	-	-	+	+	+	+	-
S.aureus	-	+	+	+	-	-	+	-	+	-	+
K.pneumoniae	+	+	+	-	-	-	+	+	+	-	+
P.aeroginousa	-	-	-	-	+	+	+	+	-	-	+
P.vulgaris	+	+	+	+	-	-	-	+	+	-	+
B.subtilis	-	-	-	+	+	-	+	+	-	+	-
V.cholera	+	-	-	+	-	+	-	+	+	+	-
C.difficile	-	-	+	+	+	+	-	-	-	+	+
S.dysentriae	-	+	+	+	-	-	+	+	+	+	-
S.typhimorium	+	-	+	-	+	-	+	-	+	+	+

(+) = Presence; (-) = Absence

Table 7. Biochemical test for the Identification of Bacteria - Sample IV

Bacteria	IT	MRT	VPT	CUT	NT	TSI	OT	UT	CT	SHT	GHT
E.coli	+	+	+	-	-	-	-	+	+	+	+
S.aureus	+	-	-	-	+	+	+	-	-	-	+
K.pneumoniae	+	-	-	-	+	+	-	+	+	-	-
P.aeroginousa	+	-	-	+	+	+	+	-	-	-	+
P.vulgaris	-	+	+	+	-	-	-	+	+	+	-
B.subtilis	+	-	-	+	+	-	-	+	+	+	-
V.cholera	-	+	+	+	-	-	-	+	+	-	-
C.difficile	-	+	+	-	-	+	+	-	-	+	-
S.dysentriae	-	-	+	+	-	+	+	-	+	+	+

(+) = Presence; (-) = Absence

Table 8. Biochemical test for the Identification of Bacteria - Sample V

Bacteria	IT	MRT	VPT	CUT	NT	TSI	OT	UT	CT	SHT	GHT
E.coli	+	-	+	-	+	+	-	-	-	+	+
S.aureus	+	+	-	-	-	+	+	-	-	-	+
K.pneumoniae	-	-	+	+	+	-	+	-	+	-	+
P.aeroginousa	-	-	+	+	+	-	-	+	+	-	+
P.vulgaris	+	-	+	-	+	+	-	-	+	-	-
B.subtilis	+	-	-	+	+	-	+	+	-	-	-
V.cholera	+	+	-	+	-	-	+	+	+	-	+
C.difficile	-	-	+	+	+	-	-	+	+	+	-
S.dysentriae	+	-	+	+	-	-	+	-	-	+	+
S.typhimorium	+	-	-	+	+	-	+	-	+	+	-

(+) = Presence; (-) = Absence

- IT = Indole Test
- MRT = Methyl Red Test
- VPT = Voges Proskauer Test
- CUT = Citrate Utilization Test
- NT = Nitrate Test
- TSI = Triple Sugar Iron
- OT = Oxidase Test
- UT= Urease Test
- CT = Catalase Test
- SHT = Starch Hydrolysis Test
- GHT = Gelatin Hydrolysis Test

Table 9: Identification of fungi

S. No	Sample	Name of the fungus
1	Sample I	*Aspergillus niger*
2	Sample II	*Aspergillus fumigatus*
3	Sample III	*Aspergillus flavus*
4	Sample IV	*Pencillium brevicompactum*
5	Sample V	*Fusarium oxysporum*

DISCUSSION

Discharge of domestic, agricultural and industrial wastes have markedly increased the chemical content of the water bodies, which considerably alter their physicochemical characteristics.

Odour of the water indicates the quality of water. The odour can be either agreeable or disagreeable. In the present study, out of the five samples of water analyzed, sample 2 had disagreeable odour, revealing the extent of pollution.

pH is an important parameter that decides the corrosive nature of water. Lower the pH value, higher is the corrosive nature of water. pH was positively correlated with electrical conductance and total alkalinity (Gupta, 2009). The reduced rate of photosynthetic activity, the assimilation of carbon dioxide and bicarbonates, are responsible for the increase in pH. The low oxygen content may be due to the rise in temperatures above normal. In the present study, the pH of the pond water samples was found to be in the range 8.07-8.52. The deviation from the neutral 7.0 may be due to the bicarbonate/ carbon dioxide/ carbonate equilibrium.

Temperature is one of the most important factors deciding the aquatic environment (Singh and Mathur, 2005). It plays a crucial role in physicochemical and biological behavior of aquatic system. In an established system, the water temperature controls the rate of all chemical reactions and affects the growth of fisheries, their reproduction and immunity. The analysis reveals the temperature of the water samples from the selected ponds were found to be in the ranges of 30.2^{0}C-36.7^{0}C.

The results also reveal the turbidity level to be in the range between 18.5-22.4 NTU. Two of the water samples are found to be within the normal range whereas the other samples exceeded the normal limits. Turbidity may be due to the presence of suspended solids.

However, too much of dissolved solids in water can affect human beings by inducing a laxative effect and giving the water a mineral taste. Increased total solids have a similar effect to that of turbidity in that water. The clarity can get reduced, water temperature can rise, oxygen levels can fall (as a result of less photosynthesis) and solids can bind to toxic compounds and heavy metals. In our study, TS of ponds water was ranging between 450-697.

The quantity of total dissolved solids differed between the samples analyzed. Maximum permissible limit of TDS in potable water was 20-500 mg/L. The TDS level in the pond water samples were identified to be between 501-508 mg/dL which was closer to the allowed limit.

The higher amount of total solids in comparison to TP and LCP was perhaps due to runoff from many bathing ghats and municipality solid garbage dump. The amount of total suspended solids is another index to express the extent of pollution. Suspended solids can reduce light penetration. This reduces the ability of algae to produce food and oxygen. When the water slows down, as and when it enters a reservoir, the suspended sediment settles down and it may change the quality of water in the bottom. Indirectly, the suspended solids affect other parameters such as temperature and dissolved oxygen (Gupta and Sunia Saharan, 2009). In present study, TSS of pond water samples was found to be between 5-194 mg/dL.

The reason for the alkalinity is due the minerals that dissolve in water from the soil. The various ionic species that contribute to alkalinity include carbonate, bicarbonate, hydroxide, phosphate, borate and organic acids. The alkalinity of pond water samples should be within the desirable limit of 300 ppm given by WHO (Allen Burton and Robert Pitt, 2001). In the present study, the alkalinity of pond water samples was in between 340-390 ppm which is not much away from the normal levels.

In the present study, the hardness of water samples from ponds was in the range between 420-525ppm, which was within the permissible limits.BOD (biological oxygen demand) test is a widely used test procedure that determines the strength of pollution for domestic and industrial wastes in terms of the oxygen that is required to oxidize the impurities completely (Aswathi and Tiwari, 2004). BOD levels in the pond water samples were ranged in between 228-252 mg/dL.

COD (chemical oxygen demand) level of the pond water samples were in between 428-452 mg/L. Taking the BOD/COD values as standards for evaluating the water quality, the water from the selected locations may be classified as highly biodegradable.

DO (dissolved oxygen) is one of the most important parameters of the water quality, directly affecting the survival and distribution of flora and fauna in an ecosystem. In the present study dissolved oxygen value ranges from 5.58-6.10 mg/L. When water is polluted with large amount of organic matter, a lot of dissolved oxygen would be rapidly consumed in the biological aerobic decay which would affect the water quality. However the decreased dissolved oxygen in water would affect the aquatic lives (Michael Hogan, 2010).

Carbon dioxide in water is the byproduct of metabolism. More than a particulate level, CO_2 in water is toxic to the life in water. In the present study, the value of CO_2 was between 176-198 mg/L.

Phosphates are considered to be one of the most important nutrients in natural water. Although several other nutrients (e.g. Carbon, nitrogen, sulfur, potassium, calcium and magnesium) are required to facilitate the growth of plant material particularly algae, the phosphorus content is critical in determining the level of algal growth that the water will support(Sleema and Ramesh babu, 2007). In the present study, the amount of phosphate was between 0.0 and 0.11 mg/dL.

Chloride may get into surface water from several sources including: wastewater from industries and municipalities; effluent wastewater from water softening; road salting; agricultural runoff and produced from oil and gas wells (Richard Wachman, 2007). In the present study, the chloride values were from 290 to 355 mg/L.

Sulfate is a common compound found in water as a result of the dissolution of minerals and rocks (Norris and Ribbon, 1972). Typical levels are between 0-100 mg/L. In the present study, sulfate is found in the samples were ranging between 25-40 mg/dL.

Health and well being of the human race is closely tied up with the quality of water used. Bacteriological measurements have been used to monitor water quality for a very long time (Geldrich, 1970). Analysis of bacterial population in an aquatic system is of primary importance for evaluating its tropic conditions. High organic contents in water bodies provide suitable substrate for the growth of bacterial contamination. These possess a threat to humans in most of the areas.

In the present study, bacterial studies were carried out on pond water samples and the results are (Table). *Escherinchia coli, Staphylococcus aureus, Klebsella pneumonia, Pseudomonas aeroginousa, Proteus vulgaris, Bacillus subtilis, Vibrio chlorae, Clostridium difficile, Shigella dysentriae, Salmonella typhimorium*are present in the pond water sample. These bacteria produce harmful effects such as skin infection, dysentery, diarrhea and typhoid fever etc.

Fungi such as *Aspergillus niger*, *Aspergillus flavus*, *Aspergillus fumigatus, Fusarium sp., Pencilium brevicompactum* were identified from pond water samples.

The results of the present study indicate that some of the water quality parameters are high and exceeding the permissible limits of World Health Organization (WHO). It is concluded that pond water is not satisfying the requirement for various purposes and it is unsafe for human health. Proper management of water resources has become the need of the hour as this would ultimately lead to a cleaner and healthier environment. In order to prevent the spread of waterborne infectious disease such as cholera, dysentery and typhoid, people should take adequate precaution to periodically check the water bodies and take necessary steps to remove the inorganic impurities as well as disinfect it.

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