ARTICLE

Water Quality Assessment and Algal Analysis of Two Temple Ponds in the Industrial Area, Kollam District, Kerala

[1] **Sreeja Krishnan and Pooja Pushkaran**

Received on 19-7-2017
Accepted on 12-10-2017

Abstract

Water quality is a measure of the condition of water relative to the requirements of one or more biotic species or to any human need. Water quality assessment and algal analysis are ways for evaluating the water chemistry and the biological characteristics of the water body. The physico-chemical and biological characteristics of all aquatic ecosystems are dynamic, because of the factors like temperature, rainfall, sedimentation, decayed organic materials, location of water body etc. Water pollution has been seriously disturbing the life of man, plants and animals. The whole nature of water bodies is also getting worse due to the contamination of water. Some of the industrial waste water discharges are being released untreated into the environment and causes water pollution. Algae, a vital group of plants in aquatic ecosystems, are an important component of biological monitoring programs for evaluating the water quality. They are suited to water quality assessment because of their nutrient needs, rapid reproductive rate and very short life cycle. In the present study, approximately twenty water quality parameters were studied and sixteen algal species were identified. Site 1 sample is acidic but the iron content was absent but Site 2 sample was highly acidic with high iron content. Chlorophycean members were dominant in Site 1 and there were few algal species in Site 2. The present study briefly explains water quality and algal diversity of two temple ponds in the industrial area of Kollam District, Kerala.

Keywords: Water quality, algal analysis, parameters, temple pond, industrial area.

Introduction

Water have played an important role in the architectural heritage of India from early times. Hydrobiology of fresh water attracted the attention of environmental scientists from the early decades of the 20thcentury. It is the most frequently used reference to a set of standards against which compliance can be assessed. The parameters for water quality are determined by the intended use. Work in the area of water quality tends to be focused on water that is treated for human consumption, industrial use or in the environment. Measurements commonly made on site and in direct contact with the water source in question include temperature, pH, dissolved oxygen, conductivity, turbidity, biological oxygen demand, chemical oxygen demand etc.

Algae are suited for analysing water quality. Microscopic analysis of water samples collected from pond determines the diversity and density of algal species and provides potentially useful early warning signs of deteriorating conditions. Algal species richness is an increasing saturating function of the pond. Aquatic environment can be polluted in many ways which are not produced under natural conditions eg., by powdered wastes, toxic chemicals, hot effluents etc.

Post Graduate Department of Botany,
Sree Narayana College, Cherthala, Kerala, India
[1]Corresponding Author email id: sreevaskrishna@gmail.com

The Kerala Minerals & Metals Ltd (KMML) industrial complex is situated at Sankaramangalam, Chavara in Kollam District. KMML produces titanium dioxide from ilmenite mineral sand collected from the coast. Various toxic gases such as chlorine and ammonia are stored in the plant for various purposes. The occasional leakage of these gases possess serious threat to the lives of nearby inhabitants. The liquid effluent contains ferrous ions which produces a reddish-brown coloured substance on reaction with soil. It possess serious threats to the fresh water quality of this region. The waste water discharged by the company was found accumulating in the environment and polluting natural water bodies before reaching the sea. The area to the north of the factory was filled with pools of brownish yellow, pungent smelling water which is highly acidic and reactive. The colour change of water is noticed in the ponds and wells. The present study is on the water quality and algal analysis of the two temple ponds in this industrial area.

Materials and Methods

The present investigation was carried out in two temple ponds located near KMML industrial area, Sangaramangalam, Chavara, Kollam District.

1. Parimanam temple pond, Neendakara, Chavara, Kollam (Site 1):

Parimanam temple pond is situated 5kms away from KMML in Chavara. It lies at 8º57′0"N latitude and 8 º 57′0′E longitude. This pond is stagnant, annual and

quadrant in shape with 185m depth and was well-constructed. The pond serves as water reservoir for bathing and temple uses.

2. Subramanya swami temple pond, Panmana, Chavara, Kollam (Site 2):

Subramanya swami temple pond is situated 780m away from KMML in Chavara. It lies at 9 ^{o} 0′0"N latitude and 9 ^{o} 0′0"E longitude. This pond is stagnant, perennial and quadrant in shape with about 140m depth.

For the study of physico-chemical analysis, water samples were collected from the pond surface in clean containers from each pond for a period of six months. Water samples were collected in one litre plastic containers. Some of the parameters were recorded at the sampling sites whereas the other were recorded in the lab. The parameters observed were temperature, pH, free CO_2, total alkalinity, acidity, turbidity, electrical conductivity, total hardness, total dissolved solids, calcium, magnesium, chloride, sulphate, phosphate, fluoride, nitrate, iron, dissolved oxygen, biochemical oxygen demand and chemical oxygen demand. These various physico-chemical parameters were analysed by following the standard methods of APHA, 1995.

The water samples for phytoplankton analysis were collected separately in wide mouth bottles with the help of plankton nets of 55µm mesh size with some amount of pond water and immediately preserved in 4% formalin solution. The algal species were identified using standard literature.

Results and Discussion

Now-a-days pollution of surface water has become one of the most important environmental problem. Algae are involved in water pollution in a number of significant ways. They are normal inhabitants of surface water and are encountered in every water supply that is exposed to sunlight. The study on physico-chemical characteristics and algal analysis were conducted in two temple ponds of the industrial area of Kollam District.

1. Physico-chemical characterization

A total of twenty different physico-chemical parameters were analysed. The parameters were measured as water temperature in ^{o}C, turbidity in NTU, conductivity in µs/cm and others in mg/l.

Water temperature is one of the most important factors in aquatic environment (Singh and Mathur, 2005). The surface water temperature was always a little lower than atmospheric temperature. The water temperature of Site 1 water is 30^{o}C and Site 2 is 33^{o}C. According to Zajic (1971) water with temperature above 30^{o}C is unfit for public use. The rise in temperature of the water leads to an increased rate of the chemical reaction. Water temperature in Site 2 sample was slightly above 30^{o}C.

pH is a common index of water body. pH express the intensity of acidity and alkalinity. The value of pH in Site 1 sample is 5.68 and in Site 2 sample is 2.29. These two results are much lower than the recommended limit 7.0-8.5 of WHO (1992). Two sites are highly acidic in nature. This may be due to the release of untreated effluents from KMML factory.

Free Carbon dioxide appears to be an important component of the buffering systems of water bodies. Free carbon dioxide in Site 1 sample was 42mg/l and Site 2 sample was 63mg/l. Higher concentration of free carbon dioxide in Site 2 sample can be attributed to the presence of decomposable organic matter in the bottom as suggested by Unni (1972). Carbon dioxide diffuses mostly into water from atmosphere resulting in carbonic acid, which affects the pH of water. The high saturation levels of oxygen and carbon dioxide found to have toxic effects on aquatic biota.

Total alkalinity is a measure of the concentration of bases. This may be due to the presence of carbonate, bicarbonate and hydroxide in natural waters (Jain *et al*., 1996). The value of total alkalinity for Site 1 was 132mg/l and in Site 2 was below the detectable level. The value of Site 1 exceeded the higher desirable limit given by WHO (1992). But Site 2 sample showed the least concentration of alkalinity. According to Nayak *et al*., (1982) and Ghosh and George (1989), the higher alkalinity indicates pollution. High alkalinity is commonly observed during summer due to decomposition of organic matter in water body.

Acidity means the acid content of water. The acidic range of Site 1 sample was 22.0mg/l but in Site 2 sample was 180mg/l. The water sample from Site 2 sample showed high content of acid. This may be due to the release of untreated effluents from the industry because Site 2 is comparably near to the KMML industry.

Turbidity in the open water zone is commonly caused by organic matter. The value of Site 1 sample was 4.68 NTU and for Site 2 was 3.42 NTU. The desirable limit of turbidity is 5.0NTU. The low turbidity in Site 2 may be due to the settlement of silt, clay and heavy suspended particles.

Electrical conductivity is a measure of how well solution conducts electricity and is correlated with salt content. Higher value of conductivity shows higher concentration of dissolved ions. Electrical conductivity of Site 1 sample was 211µs/cm and Site 2 sample was 482µs/cm.

Total Hardness of water is not a pollution parameter but indicates water quality mainly in terms of Ca^{2+} and Mg^{2+} expressed as $CaCO_3$ (De, A.K, 2006). Hardness of water reflects the higher concentration of many cations. Total Hardness in Site 1 sample was 134mg/l and Site 2 sample was 266mg/l. Hardness levels, above 500mg/l are generally considered to be unacceptable (WHO, 1992). The recorded values were less than this limit. Water hardness upto 60mg/l is considered as soft water, and from 61-120mg/l is considered as moderately hard water, from 121-180mg/l as hard water and above 180mg/l as very hard water (Kannan, 1991).

Total Dissolved Solids include inorganic matters and can affect various uses of water resources. In the present records, Site 1 sample value was 115mg/l and Site 2 value was 355mg/l. The values in the range of 150-250mg/l make the water unfit for any use (Ranu *et al*., 1991).

Calcium level in Site 1 sample was 43.28mg/l and Site 2 sample was 101.80mg/l. Any value above 25mg/l indicates calcium rich water.

Magnesium level in Site 1 sample was 22.04mg/l and Site 2 sample was 39.09mg/l. The desirable limit of magnesium was 30mg/l. In this record, Site 2 sample shows high content of magnesium. High values of magnesium suggest a close affinities between magnesium concentration and inorganic pollution. Zafar (1996) and Munawar (1970) have also found a direct correlation between these two parameters.

Chloride is a highly reactive compound and is used as a disinfectant. Chloride is not generally harmful to human beings, but high chloride is considered as unsafe. In the Site 1 sample, chloride content was 30.0mg/l and Site 2 sample was 520mg/l. According to WHO (1992) the limit for chloride is 250mg/l. Gopal and Durve (1989) observed that high chloride content of water with an annual average of 83.7mg/l is an indication of organic pollution. Site 2 sample indicates organic pollution.

Sulphate is a naturally occurring anion in all kinds of waters. In the present study, the sulphate content in Site 1 sample was 0.34mg/l and Site 2 sample was 0.813mg/l. The range of sulphate content in two samples are too low based on the desirable limit.

Phosphate is one of the vital constituent to monitor the plankton growth. Higher concentration of phosphate indicates the pollution. The phosphate content in Site 1 sample was 0.2mg/l and Site 2 sample was 0.113mg/l. The permissible limit is 0.1mg/l. The phosphate concentration above 0.5mg/l indicates pollution (Jain *et al*., 1996). Higher value may be due to the presence of detergents in sewage waste dumped in the pond.

Fluoride was below the detectable level in both samples. This shows that fluoride content was too low in the present study.

Nitrate content in Site 1 sample was 0.303mg/l and Site 2 sample was 0.127mg/l. The values are lower than 1.0mg/l, the permissible limit.

Iron is considered an essential heavy metal. The permissible level of iron is 1.0mg/l. Iron content in the Site 1 sample was below the detectable level and Site 2 sample was 2.63mg/l.

Dissolved oxygen is an important water quality parameter. Oxygen content of a fresh water body is depleted in numerous ways. DO is an index of physical and biological process going on in the water. The presence of oxygen demanding pollutants like organic wastes causes rapid depletion of DO from water (Jameel, 1998). DO level in Site 1 sample was 3.5mg/l and Site 2 sample was 1.23mg/l. DO level was much lower than the desirable limit. Its depletion is the most critical manifestation of pollution (Shaji *et al*., 2010).

Biological Oxygen Demand determination is a most useful technique to check the level of organic pollution in water. In unpolluted waters BOD is lower while it is higher in the case of polluted ones (Hynes, 1971). Presence of decomposable organic wastes and the organic pollutants cause a BOD raise in proportion to volume of organic materials in waters. The permissible limit of BOD is 5mg/l (WHO, 1992). In the present study, BOD level in Site 1 sample was 3.9mg/l and Site 2 sample become 20.26mg/l. The water from the Site 2 have BOD values much higher than the permissible limit. Higher values indicate that untreated organic wastes are being leached out to the ground water as observed by Adeleye and Adebiyi (2003).

Chemical Oxygen Demand is the total measurement of all chemicals in the water. This test is commonly used to indirectly measure the amount of organic compounds in water. The permissible limit of COD is 10mg/l (WHO, 1992). In the present study, COD level in Site 1 sample was 6.3mg/l and Site 2 sample become 22.6mg/l. The water from the Site 2 sample have higher value than permissible limit. Higher value of COD indicates the presence of oxidizable organic matter (Chandrashekar *et al*., 2003).

From the study on the physico-chemical parameters of the water sample, Site 2 was found to be more polluted as it is near to the industrial area.

2. Algal study

The analysis of water samples from the two temple ponds, Site 1 and Site 2 showed the presence of algal forms. The study of the diversity of algae showed the presence of 16 algal species. In Site 1 sample, ten algal species belonged to four classes were identified- Class Chlorophyceae contains seven algal taxa: *Scenedesmus acuminatus*, *Cosmarium blyttii*, *Staurastrum crenulatum*, *Characium pringsheimii*, *Microspora irregularis*, *Oedogonium echinospermum*, *Mougeotia parvula*; from Class Bacillariophyceae one algal taxa identified was *Navicula cari*; Class Crysophyceae contain one algal taxa: *Chrysopyxis paludosa* and Class Cyanophyceae with one algal taxa: *Aphanocapsa pulchra*. In Site 2 sample, there were six algal species belonged to two classes-from Class Bacillariophyceae four algal taxa: *Navicula cari*, *Pinnularia conica*, *Pinnularia divergens* and *Pinnularia gibba* and from Class Cyanophyceae two algal taxa: *Chroococcus turgidus* and *Spirulina princeps*. In Site 1 Chlorophycean members and in Site 2 Bacillariophycean members were dominant. The dominance of Bacillariophycean members showed that the Site 2 water sample was more polluted.

Conclusion

In the present study on the Water quality assessment and Algal analysis of two temple ponds in the industrial area of Kollam District Kerala, Site 1 sample was approximately acidic with low range of turbidity, free carbon dioxide, electrical conductivity, less amount of chloride, fluoride, nitrate, iron and also have permissible range of BOD and COD. But some variations such as low level of dissolved oxygen, high concentration of phosphate and pH values indicates some unfavourable fluctuations in the Site 1 sample. Site 2 sample was highly acidic with high range of turbidity, free CO_2, electrical conductivity, TDS, high contents of chloride, BOD, COD and also low level of DO. This results showed that the Site 2 is highly polluted. The diversity of algal taxa was rich in Site 1 as compared to Site 2. So it can be concluded that Site 1 is mesotrophic in nature and Site 2 is eutrophic and is leading towards pollution.

Acknowledgements

The authors acknowledge the University Grant's Commision, New Delhi, India for granting the Teacher Fellowship under XII Plan, the Principal of Sree Narayana College, Cherthala and Kerala Water

Authority- Quality Control District Laboratory, Alappuzha for providing necessary facilities for conducting this study. They also acknowledge Dr. M.V.N Panikkar, Rtd. Director of Research, Sree Narayana College, Kollam for the valuable help rendered during the period of study.

Reference

Adeleye, I.A and A.A Adebiyi (2003).Physico-chemical and Micro-biological assessment of Oko-oba- A Nigerian Abattoir. J. Environ. Biol. 24: 309-313.

APHA (1995).Standard methods for the examination of water and wastewater, 19th edition. American Public Health Association, New York.

Chandrashekar, J.S, L. Lenin Babu and R.K Somashekar (2003). Impact of Urbanization on Bellandar lake, Bangalore- A Case Study. J. Environ. Biol. 24: 223-227.

De, A.K (2006).Environmental chemistry (6th edn.) New Delhi, India: New Age International Publishers (232).

Ghosh, A and George, J.P (1989). Studies on the Abiotic factors and Zooplankton in a Polluted Urban Reservoir Hussain Sagar, Hyderabad: Impact on Water quality and Embryonic Development of Fishes. Indian J. Environ. Hlth. 31(1): 49-59.

Gopal, R.N and Durve, V.S (1989). Cultured Eutrophication of the lake Rangasagar, Udaipur, Rajasthan, Indian. J. Environ. Biol. 10(2): 127-134.

Hynes, H.B,N (1971). The Biology of Polluted Water. University of Toronoto Press, Canada. P.202.

Jain, S.M, Sharma, M and Thakur, R. (1996). Seasonal Variation in Physico-chemical parameters of Halai reservoir of Vidisha District, India, J. Eco. Biol. Vol. 8(3): 181-188.

Jameel, A (1998). Physico-chemical studies in Vytakondan Channel Water of Cauvery, J. Poll. Res. 17(2): 111-114.

Kannan, K (1991). Fundamentals of Environmental Pollution. S. Chand and Co. Ltd. Publ., New Delhi. P 126

Munawar, M. (1970). Limnological Studies of Freshwater Ponds of Hyderabad, India I. The biotope. Hydrobiologia. 35: 127-162.

Nayak, T.R, S.J. Ikyer and S.C. Jaish.(1982). Seasonal Variations of Rotifiers and certain Physico-chemical factors of Matyatal, Punna, M.P., India. Comp. Phy. Ecol., 7.165-169.

Ranu, G, O.U. Singh, S.N. Tandon and Mathur, R.P (1991). A Study of Water Quality and Metal Speciation of Yamuna river. Asia Env. 13: 3-10.

Shaji, C, Suma, B.S., and Bindhu, L.(2010).Physico-chemical and Biological Characterization of Effluent from KMML. TiO2 Industry, Chavara, Kollam District, Kerala, J. Phytol Res. 23(1): 87-90.

Singh, R.P. and Mathur, P. (2005). Investigation of Variations in Physico-chemical Characteristics of Fresh water reservoir of Ajmer City, Rajasthan, Ind.J. Env. 9: 57-61.

Unni, K. S. (1972). An Ecological Study of the Microphytic Vegetation of Doodhadhari Lake, Raipur(MP) Hydrobiologia 40: 25-26.

WHO (1992).Guidelines for Drinking Water Quality- 2nd Ed. 1-188.

Zafar, A.R (1996). Limnology of the HussainSagarlake, Hyderabad, India. Phykos. 5(1&2): 115-126.

Zajic, J.C. (1971). Water Pollution Disposal and Re-use Vol. I, Marel Dekkar Inc., New York.