



Copyright © 2017 Kumari *et al.*

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/2.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

ORIGINAL RESEARCH

Comparative assessment of physico-chemical and biological parameters of ponds in Saharsa District, Bihar

Simmi KUMARI¹, Raj Kumar SARDAR^{2*}, Shikha CHOUDHURY³

¹Faculty of Biological and Chemical sciences, MATS University, Raipur, C.G, 492 002, India

²Department of Biotechnology, M.L.T. College Saharsa, Bihar, 852 201, India

³Department of Botany, S.N.S.R.K.S. College, Saharsa, Bihar, 852 201, India

*Corresponding Author email: kumar.raaj115@gmail.com

• Received: 18 January 2017 • Revised: 19 February 2017 • Accepted: 07 March 2017 • Published: 15 March 2017 •

ABSTRACT

A study of fresh water ponds at two different sites were made to compare the physico-chemical and biological properties. The seasonal variation in temperature, pH, dissolved oxygen, phosphate and nitrate content and alkalinity of the ponds located in populous city area and village area were compared and analysed. The results showed both the ponds differ in chemical, biochemical and biological content in three seasons including winter, summer and monsoon of the year. Total 19 species of Cyanophyceae were recorded in city pond whereas only 13 species in village pond. The variations in the physico-chemical properties of the ponds may be the reasons of variation in the Cyanophycean species.

KEY WORDS: *Cyanophyceae, Dissolved oxygen, pH, Pond water, Saharsa district*

Introduction

Ponds are one of the sources of fresh water and water is actually very precious for life on our planet. The role of water in nature is unique not only for human; but, also for the numerous organisms living in the water. Limnological investigations has been carried out to assess the current status of ponds located in the leap of rural and urban influence of the saharasa district. So far not any such study is recorded on the physico-chemical and biological characteristics of the said pond. Present study on Cyanophyceae planktonic population in relation to water chemistry will substantiate the basic information of ecology and the present condition of the system. To maintain the aquatic habitat suitable for existence, chemical and physical factors will exercises their influence individually or synergistically, while the nutrient status of water as well as

soil play the most important role in governing the production of plankton organisms (Banerjea, 1967). The pond lies within geographical co-ordinates of 25°87'95.25"N and 86°58'95.19"E of city and 25°87'67.62"N and 86°55'33.86"E in out skirts of city. The pond has a maximum depth of 7.0 meter and minimum depth 3.0 meter. The pond receives water through surface run off during monsoon from surrounding upland. Rain is the main source for fresh water for this pond. The pond is commonly used for, animal bathing, washing of clothes and fish culture by the people besides the idol immersion occasionally.

Saharsa is a district which is spreaded in 1661.30 sq.km area and located in the north Bihar. The majority of the population of the district affected by the flood of Koshi River every year. The average annual temperature and rainfall in Saharsa is 25.2 °C and 1095 mm respectively.

Cyanobacteria also known as “blue green algae” are photosynthetic microorganisms found in different environments comprising oceans, freshwater, bare rock and soil (Whitton, 2012). It have been considered the first oxygenic photosynthetic organisms on Earth and contributed to the generation of oxygen in the Earth’s atmosphere over 3 billion years ago (Rasmussen *et al.*, 2008). They can exist as solitary, free-living cells or as colonies or filaments. These are usually microscopic but populations of them can be visible, for example, as benthic mats, crusts, large gelatinous colonies or blooms. We compared physico-chemical properties and Cyanophyceae planktons of pond water located in two different areas.

Materials and Methods

The studies were conducted on seasonal basis constituted of summer (March-June), Monsoon (July - October) and winter (November-February) of year 2015-2016. Two man made ponds located in different residential area of Saharsa district were selected for the studies. One pond from city 25°87’95.25’’N and 86°58’95.19’’E (City pond SHC) possess cemented embankment and another 4 km away from city was village 25°87’67.62’’N and 86°55’33.86’’E (village pond SHC) which possess the earthen embankment.

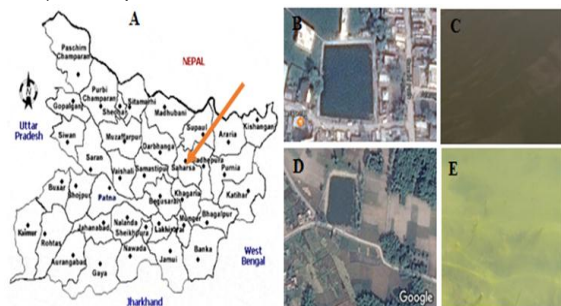


Figure 1: A) Location map of Saharsa District B) Satellite image of City Pond C) Water of City Pond D) Satellite image of Village Pond E) Water of Village Pond. (Image Source: A. NIDM Bihar, B & D. Google satellite image, C & E. Respective ponds)

The samples from these two ponds were collected at different season at the certain time interval. The physico-chemical analyses of the water samples were done according to APHA (1998). The temperature and pH of samples were recorded at on the site by their respective probes. Chemical parameters such as Dissolved Oxygen (DO), alkalinity, phosphate (Stannous chloride method) and nitrate (phenol – di sulphonic acid colorimetric test)

concentration measurements were conducted in the laboratory.

Sample collected for Cyanophyceae plankton analysis was also carried out. Plankton samples were collected, filtered, concentrated and preserved in 100 ml vials containing 1ml of Lugol’s solution. The concentrated samples were analysed under the inverted microscope and identification of plankton was done following the taxonomic references of Adoni (1985), Desikacharya (1958), Edmondson (1992), Needham and Needham (1962), Prescott (1973) and Sinha and Naik (1997).

Statistical Analysis

All values of various parameters of physico-chemical analysis were taken in triplicate and mean value and standard deviation were calculated according to seasons using Excel 2013.

Results and Discussion

Morphological study

The morphological characteristics of these two selected ponds studied in present investigation are shown in Table-1.

Table 1: Morphological studies of ponds

| Sl. No | Features | City pond SHC | Village pond SHC |
|--------|----------------------------|---------------|------------------|
| 1. | Shape | Square | Square |
| 2. | Embankment | Cemented | Earthen |
| 3. | Water covered area (acres) | 0.35 | 0.32 |
| 4. | Mean depth (meters) | 6 | 7 |
| 5. | Bottom | Muddy | Muddy |
| 6. | Macrophyte infestation | Scanty | Scanty |

These ponds are situated in city and village area of Saharsa district namely, city pond located at Gandhipath, Near Surya Clinic, and at the distance of 4 Km Village pond is located at Rahuamani near Sardar tola. City pond possess cemented embankments while village pond possess earthen embankments where marginal weeds have infested the pond considerably. City pond are perennial, non-drainable, utilized for bathing, washing clothes and household wastes are regularly disposed, from the nearby peoples. The village pond are also perennial, non-drainable, but utilized for

Table 2: Details of the physico-chemical parameters of the ponds

| S.N. | Parameters | City Pond | | | Village Pond | | |
|------|---------------------------------------|-----------|--------|---------|--------------|--------|---------|
| | | Winter | Summer | Monsoon | Winter | Summer | Monsoon |
| 1. | Temperature(T ⁰ C) | 20.3 | 32.1 | 30.6 | 20.0 | 32.2 | 31.1 |
| 2. | pH | 7.4 | 8.5 | 8.2 | 7.1 | 8.3 | 7.8 |
| 3. | D.O (mg/L) | 9.2 | 5.5 | 6.0 | 12.5 | 7.3 | 9.1 |
| 4. | Phosphate (PO ₄ -P) (mg/L) | 0.921 | 0.580 | 0.667 | 0.519 | 0.592 | 0.638 |
| 5. | Nitrate (NO ₃ -N) (mg/L) | 1.315 | 1.558 | 0.810 | 0.732 | 0.420 | 0.598 |
| 6. | Alkalinity (mg/L) | 210 | 195 | 270 | 230 | 180 | 285 |

bathing, washing clothes and household wastes are regularly disposed, from the nearby peoples. The village pond are also perennial, non-drainable, but utilized for bathing, washing clothes and cattle. The physico-chemical analysis made in various seasons in these ponds have been shown in the Table 2.

Physico-chemical characteristics of fresh water aquatic system

The physical, chemical and biological properties of two ponds selected for the studies are listed below in table 2.

Temperature

Temperature plays an important role and influences the chemical and biological characteristics of aquatic environment and also considered as an important factor in controlling the functioning of aquatic ecosystem. (Wetzel, 1975; Dwivedi and Pandey, 2002; Singh and Mathura, 2005). The present investigation observed that the surface temperature of water of both the ponds varied very slightly throughout the studies. The maximum temperature of the city and village pods were recorded 32 °C while minimum were 20 °C.

pH

Because most of the chemical and biochemical reaction are influenced by the pH it is of great practical importance. pH is a limiting factor and works as an index of general environmental condition. The pH reading of city pond was found higher than the village pond. It is evident from the data of the both ponds water that the pH declines during the monsoon season and increases during summer. Additionally the higher pH indicated in city pond may causes of washing of the cloths which was noticed a common practice and respectively lower pH value in village pond may imparted by disposing of cattle waste. But overall pH range of both the

ponds waters lies between 7.1-8.5 which is best suited for growth of aquatic Cyanophceae planktons.

Dissolved Oxygen

Temperature plays an important role in determining DO in an aquatic body. Oxygen content is an important for direct needs of many organisms and affects the solubility of many nutrients and therefore the periodicity of aquatic ecosystem (Wetzel, 1983). The result of the present study indicated that the dissolve oxygen recorded in village pond shows lesser in comparison with city pond. The reason behind this could be pollution load in city pond due to anthropogenic activity. Secondly recorded lower DO values during summer in both the ponds may be attributed to the high temperature and its consumption due to high growth and activities of microorganism previously described by Jhingran (1982).

Alkalinity

Alkalinity or acid combining value of a natural aquatic system depends on the geography and season. It constitute an important parameter in determining the quality of water. The total alkalinity of both the pond fluctuates widely according to recorded data in table 2 . The results shows that the alkalinity value increases during monsoon season where as it were lower in summer. The variation may be due to input of water and dissolution of calcium carbonate ion in the pond water (Padma and Periakali, 1999). Organic waste and plant and another organism degraded in water reservoir might also be one of the reason for the increase in carbonate and bicarbonate thereby the alkalinity (Jain *et al.*, 1997; Chaurasia and Pandey, 2007).

Phosphate

Phosphate is an important element contributed as plant nutrient and plays a role of limiting factor among all other

Table 4: List of Cyanophyceae planktons in the ponds

| Cyanophyceae planktons | | | | | |
|-------------------------------|--------------------------|-------------------|-------------|-------------------------|-------------------|
| S.N. | City Pond | Occurrence | S.N. | Village pond | Occurrence |
| 1. | <i>Anacystis</i> sp. | W, S,M | 1. | <i>Anacystis</i> sp. | W, S,M |
| 2. | <i>Anabaena</i> sp. | W,S,M | 2. | <i>Anabaena</i> sp. | W,S |
| 3. | <i>Aphanocapsa</i> sp. | W,S,M | 3. | <i>Aphanocapsa</i> sp. | S,M |
| 4. | <i>Aphanothece</i> sp. | W,S | 4. | <i>Aphanothece</i> sp. | W,S,M |
| 5. | <i>Aphanizomenon</i> sp. | W,S,M | 5. | <i>Chroococcus</i> sp. | W,S |
| 6. | <i>Chroococcus</i> sp. | S,M | 6. | <i>Merismopedia</i> sp. | W,S,M |
| 7. | <i>Gloeocapsa</i> sp. | W,S,M | 7. | <i>Microcystis</i> sp. | W,S,M |
| 8. | <i>Lyngbya</i> sp. | W,S | 8. | <i>Oscillatoria</i> sp. | S,M |
| 9. | <i>Merismopedia</i> sp. | W,S | 9. | <i>Acroceptic</i> sp. | W,S,M |
| 10. | <i>Microcystis</i> sp. | W, S,M | 10. | <i>Spirulina</i> sp. | W,S,M |
| 11. | <i>Oscillatoria</i> sp. | W,S | 11. | <i>Rivilaria</i> sp. | W,S,M |
| 12. | <i>Thornidium</i> sp. | W,S,M | 12. | <i>Nostoc</i> sp. | W,S,M |
| 13. | <i>Acroceptic</i> sp. | W,S,M | 13. | <i>Merisopoedia</i> sp. | W,S,M |
| 14. | <i>Spirulina</i> sp. | W,S | | | |
| 15. | <i>Rivilaria</i> sp. | W,S,M | | | |
| 16. | <i>Nostoc</i> sp. | W,S,M | | | |
| 17. | <i>Merisopoedia</i> sp. | W,S,M | | | |
| 18. | <i>Planktothrix</i> sp. | W,S,M | | | |
| 19. | <i>Synechococcus</i> sp. | W,S,M | | | |

W = winter, S = summer, M = monsoon

plant nutrient so its determination is useful. Results reveal that the value of phosphate varies from minimum of 0.580 mg/L to maximum of 0.921mg/L at city pond. Similarly significantly lesser quantity of phosphate ranging from 0.51-0.63 mg/L was recorded in village pond. Phosphate was expected to be release in water from the bottom mud.

Nitrate

The concentration of Nitrate depends on the nitrification and denitrification activities of micro-organism. Nitrate is of the most important nutrient for the plant in aquatic ecosystem. The obtained results reveals that the presence of high amounts of nitrates in city pond water in comparison of village pond are indicative of pollution. The nitrate concentration of city pond water lies in the range of 0.81-1.31 mg/l whereas the village pond contains 0.420-0.732mg/l. Higher content of nitrate in the city pond present in sewage, municipal wastes, chemical fertilizers, decayed vegetables, animal feed lots, leachates from refuse dumps, septic tank effluent, etc. disposed off was the most important

sources of biological oxidation and contribute nitrate. In contrary, the village pond was showed low nitrate content because of less pollutants. Our findings also support to the observations of several research done earlier by Hussainy, 1967.

Cyanophyceae

Blue-green algae (or cyanobacteria) are small single-celled prokaryotic (having no nucleus or organelles) microorganisms, usually found in freshwater and are most common in areas with high levels of nutrients. The targeted Cyanophyceae study of the ponds were reveals that the city pond was harbouring total 19 species whereas village pond contains total 13 spp. listed in Table 3. Variations in the numbers of species might be influenced by the physicochemical properties, nutrients and presence of organic solutes water. The Cyanophyceae spp. also varies in different seasons in both the pond.

Conclusion

Both ponds fresh waters were found differing in physic-

chemical characteristics throughout the year of study. Due to the anthropogenic activity, the pond water was found more polluted and contained high amount of nitrate and phosphate. The Cyanophyceae species were also recorded higher in comparison with village pond. So, the increasing level of pollutants in the pond water might lead to eutrophication and create algal bloom. To protect the aquatic species for the maintenance of a healthy ecosystem for fish culture, pollutant disposal must be stopped.

Acknowledgements

The authors thank Dr K. P. Yadav, Principal, M. L.T College Saharsa for the encouragement and support during work. Our sincere appreciation goes to Dr. Ashok Jha, Head of the Department of Biotechnology for providing necessary laboratory facilities.

References

- Adoni, A. D., Joshi, G., Ghosh, K., Chourasia, S. K., Vaishya, A. K., & Yadav, M. (1985). *Work book on Limnology*, Department of Botany, Dr. Harisingh Gour Vishwavidyalaya Sagar, India.
- American Public Health Association, American Water Works Association, Water Pollution Control Federation, & Water Environment Federation. (1915). *Standard methods for the examination of water and wastewater* (Vol. 2). American Public Health Association.
- Banerjee, S. M. (1967). Water quality and soil condition of fish ponds in some states of India in relation to fish production. *Indian Journal of Fisheries*, 14(1 & 2), 115-144.
- Chaurasia, M., & Pandey, G. C. (2007). Study of physico-chemical characteristics of some water ponds of Ayodhya-Faizabad. *Indian Journal of Environmental Protection*, 27(11), 1019.
- Desikacharya, T. V. (1958). *Book of Cyanophyta*. ICAR, New Delhi, Publication.
- Edmondson W.T. (1992): *Fresh Water Biology*, International Books and Periodicals Supply Services, New Delhi.
- Jain, C. K., Bhatia, K. K. S., & Vijay, T. (1997). Ground water quality in a coastal region of Andhra Pradesh. *Indian Journal of Environmental Health*, 39(3), 182-192.
- Jhingran, V. G. (1982). *Fish and Fisheries*.
- Hussainy, S. U. (1967). Studies on the limnology and primary production of a tropical lake. *Hydrobiologia*, 30(3), 335-352.
- Needham J.G. and Needham P.R. (1962): *A guide to the study of fresh water biology*. Publishers-Holden-Day, Inc., San Francisco, U.S.A. pp: 107.
- Padma S and Periakali (1999) Physicochemical and geochemical studies in Pulicat lake, east coast of India, *Indian J. Mar.Sci.* 28: 434-437.
- Prescott G.W. (1973): *The Fresh Water Algae*. Brown Company Publishers, Dubuque, Iowa.
- Rasmussen, B., Fletcher, I.R., Brocks, J.J., Kilburn, R.R., (2008) Reassessing the first appearance of eukaryotes and cyanobacteria. *Nature* 455, 1101e1104.
- Sinha S. and Naik M.L. (1997): *Phytoplankton and Macrophytes in the ponds of Raipur city area, M.P.* Pt. Ravishanker Shukla University, Raipur, M.P. pp-164.
- Wetzel, R. G. (1983). Recommendations for future research on periphyton. In *Periphyton of freshwater ecosystems* (pp. 339-346). Springer Netherlands.
- Whitton, B. A. (2012). *Ecology of cyanobacteria II*. Springer Netherlands.
-