

International Journal of Applied Sciences and Biotechnology

A Rapid Publishing Journal

ISSN 2091-2609



Available online at:

<http://www.ijasbt.org>

&

<http://www.nepjol.info/index.php/IJASBT/index>

Indexing and Abstracting

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CODEN (Chemical Abstract Services, USA): IJASKD

Vol-2(2) June, 2014

IC Value: 4.37





Research Article

PHYSICO-CHEMICAL AND BIOLOGICAL PARAMETERS OF THE THREE RURAL PONDS OF SASARAM OF BIHAR

Jyoti Choudhary¹, S.N.Singh^{1*} and Sunita Singh²

¹Department of Zoology, Jawaharlal Nehru College, Rohtas, Bihar, India

²Department of Zoology, Tribhuvan University, Thakur Ram Multiple Campus, Birganj, Nepal

*Corresponding author email: aksingh@bauranchi.org

Abstract

The present paper deals with the seasonal variations in some important Physico-chemical parameters and biological analyses of the three rural pond of Sasaram, Bihar using selected standard classical methods with an objective to investigate present condition for its better utilization. The data collected in various seasons (summer, winter and rainy) study revealed that those analyzed parameters were within permissible limit for fish culture and the stocking should be done as per the productivity of the water. Whereas statistical analysis of the results demonstrate significant environmental improvements associated with physico-chemical conditions of those ponds. Our study gives emphasis of involvement and educate the local people for safe disposal of effluents is essential. Our analysis for BOD of the ponds falls under moderately polluted category which should be solved in future for better productivity.

Key words: Physico-chemical; rural pond; Sasaram

Introduction

Agricultural, industrial, household, recreational, environmental activities use fresh water resources for healthy development of human civilization. Fresh water resources are actually very precious for the life on our planet. The number of dams, reservoirs, tanks, etc. has significantly increased in last few years. The development of fisheries in these fresh water resources is the present need using scientific techniques. Limnological investigations on water bodies were generally analyzed to determine the pollution level of the water bodies time to time. The abiotic and biotic factors of the water influence the quality and quantity of aquatic life surviving there. The role of water in nature is unique not only for human; but, also for the numerous organisms living in the water. The physical and chemical properties of fresh water bodies are characterized by the climatic, geochemical, geo morphological and pollution condition. In order to utilize fresh water bodies successfully for fish production, it is very important to study the Physico-Chemical factors influencing the biological productivity in the water bodies (Sahni and Yadav, 2012). The quality of aquatic life surviving in the pond is totally dependent on the water quality of the pond. In the recent years several studies have been made in this field (Yadav *et al.*, 2013) not much information is available on Physico-Chemical and biological parameters of the present water bodies.

Physicochemical parameters and aspects pertaining to these ponds used for culture of fish are not available. Hence the present work is an attempt to study the detailed information on some important Physico-Chemical and

biological parameters of the rural ponds of Sasaram of Bihar.

Material and methods

Three ponds situated in different residential area of Sasaram namely, Pond 1 (Amra Talab), pond 2 (Shershah Tomb pond) possess cemented embankments and Pond 3 (Salim Khan Tank) possess earthen embankments were selected for the study. Monthly sampling was done from June 2011 to May 2012 in all the three ponds for finding out the various abiotic (temperature, transparency, pH, dissolve oxygen, free CO₂, total alkalinity, BOD) and biotic parameters. The physico-chemical analyses of the water samples were done according to APHA (1998).

For estimation of planktonic population, samples were collected with the aid of a mug of one litre capacity. 50 litres of water was collected through the plankton net made of bolting silk no. 25 (0.064 mm mesh size) to obtain the plankton sample and was preserved by adding 2-4% of formalin for further study.

The data collected was grouped in three categories i.e. summer (February-May), Rainy (June-September) and winter (October –January) for comparison of seasonal variations.

Results and Discussion

The morphological characteristics of three ponds studied in present investigation are shown in Table-1. These ponds are situated in different residential area of Sasaram namely,

pond 1 (Amra Talab), pond 2 (Shershah Tomb pond) and pond 3 (Salim Khan Tank). Pond 1 and 2 possess cemented embankments while pond 3 (Salim Khan Tank) possess earthen embankments where marginal weeds have infested the pond considerably. All the three ponds are perennial, non-drainable, utilized for bathing, washing clothes and utensils. In ponds 2 and 3 considerable amounts of dairy wastes are regularly disposed, from the nearby cowsheds. The physico-chemical analysis made in various seasons in these ponds have been shown in the Table 2.

Temperature

Temperature plays an important role in aquatic environment and considered as an important factor in controlling the functioning of aquatic ecosystem. (Wetzel, 1975; Dwivedi and Pandey, 2002; Singh and Mathura, 2005). In the present study seasonal variability of atmospheric and water temperature have been observed. The air temperature varied from 25°C to 31°C whereas the water temperature range 23.0°C to 27.0°C. It was maximum during summer comparatively less during monsoon and minimum during winter. Kannan and Job (1980) also found similar results as observed in the present study

Table 1: Morphology of the pond

Pond No.	Shape	Embankment	Water spread area (ha)	Bottom	Mean depth (m)	Macrophyte infestation
1.	Sqaure	Cemented	1.0	Muddy	4	Nil
2.	Square	Cemented	13.0	Muddy	6	Scanty
3.	Rectangular	Earthen	8.5	Muddy	3	50% area

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

S.N.	Parameters	Pond 1			Pond 2			Pond 3		
		Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy	Winter
1	Air Temperature (°C)	31.47±2.0	27.3±2.1	25.2±2.1	31.47±2.0	27.3±2.1	25.2±2.1	31.47±2.0	27.3±2.1	25.2±2.1
2	Water Temperature (°C)	27.4±0.8	24.4±1.5	22.95±1.5	27.4±0.8	24.4±1.5	22.95±1.5	27.4±0.8	24.4±1.5	22.95±1.5
3	pH	8.5±0.4	8.0±0.3	7.85±0.25	8.5±0.4	8.0±0.3	7.85±0.25	8.5±0.4	8.0±0.3	7.85±0.25
4	Dissolved oxygen (ppm)	8.7±0.4	9.6±0.3	9.5±0.2	8.7±0.4	9.6±0.3	9.5±0.2	8.7±0.4	9.6±0.3	9.5±0.2
5	Free Carbon dioxide(ppm)	16±2.0	18±3	20±3	16±2.0	18±3	20±3	16±2.0	18±3	20±3
6	Alkalinity(ppm)	190±5	220±3	202±3	190±5	220±3	202±3	190±5	220±3	202±3
7	Secchi disc transparency (cm)	28.5±1.5	36±3.0	29.5±2.0	28.5±1.5	36±3.0	29.5±2.0	28.5±1.5	36±3.0	29.5±2.0
8	Hardness(ppm)	118±3	90±5	103±2.5	118±3	90±5	103±2.5	118±3	90±5	103±2.5
9	Conductivity	2.64±0.5	2.83±0.5	2.42±0.6	2.64±0.5	2.83±0.5	2.42±0.6	2.64±0.5	2.83±0.5	2.42±0.6
10	Total Dissolved solids(ppm)	165±10	172±8.0	154±6.0	165±10	172±8.0	154±6.0	165±10	172±8.0	154±6.0
11	Biological oxygen demand (ppm)	2.81±0.4	2.82±0.5	2.21±0.6	2.81±0.4	2.82±0.5	2.21±0.6	2.81±0.4	2.82±0.5	2.21±0.6
12	Plankton (ml/50 l)	0.3	0.25	0.3	0.3	0.25	0.3	0.3	0.25	0.3

Data shown is the mean of three readings along with S.D.

There was no variation in temperature in all the three ponds. The temperature ranges indicate the suitability for fish culture (Jhingran, 1982) even though the minimum temperature recorded in the month of December (16°C) is also within the permissible limit of the fish culture. Due to large size of the water bodies there are no significant changes in the water temperature. In the peak summer season there was very minor variation in pond 1 in comparison to Pond 2 & 3, may be due cemented embankment and comparatively smaller in size.

pH

pH is a limiting factor and works as an index of general environmental condition. The pH value of the pond showed alkaline trend. The maximum pH value were in the month of April i.e. 8.5 and minimum in the month of October i.e. 7.85. It is evident from the data that the pH declines during the rainy season and increases during summer. pH status in the aquatic environment on important chemical parameters which predicts about the suitability for the fish culture. The alkaline pH is suitable for fish culture (Jhingran, 1982). The pH was more in where there is washing of the cloths and less where the cattle waste are disposed, but overall the pH was same and was little alkaline which is most suitable for the fish culture.

Transparency

Water transparency is an important factor that controls the energy relationship at different trophic levels. The results of transparency ranged between 28cm to 36 cm, during the study period. It was low during the summer and higher during the winter season. The transparency was lower in the summer season due to high planktonic population, while it was low in the rainy season because of increase in the suspended matter brought in through surface run off. The maximum transparency was recorded in winter season attributed to the sedimentation of suspended matter (Chaurasia and Adoni, 1985; Sinha *et al.*, 2002; Kadam *et al.*, 2007; Shah and Pandit, 2012). Transparency plays vital role in nutrient transformation and also gives an indication of productivity of the water. The availability of the plankton influences the transparency of the water. The water was more transparent in the rainy season in comparison to the winter and summer season may be due to poor diluted plankton in the rainy season.

Dissolve oxygen

Oxygen content is important for direct needs of many organisms and affects the solubility of many nutrients and therefore the periodicity of aquatic ecosystem (Wetzel, 1983). Jhingran (1982) stated that the oxygen contents in tropical water would be low considering their high temperature. The results of the present study showed that highest peak value of dissolved oxygen was recorded during the winter season i.e. 9.5 ppm least in rainy season i.e. 8.5 ppm. The minimum dissolved oxygen has been noticed in

summer may be due to excessive temperature which reduces the solubility of oxygen. The higher temperature also increases the decomposition rate and the lowers the oxygen. Results of the present study are similar to other workers (Prasad *et al.*, 1985; Ramulu and Benarjee, 2013).

Carbon dioxide

The normal water receive carbon dioxide from various sources i.e. (1) The atmosphere. (2) Respiration of plants and animals. (3) Bacterial decomposition of organic matter. (4) Inflowing ground water. The carbon dioxide bears a correlation with pH. The increase in carbon dioxide decreases pH (acidic). The CO₂ varied from 16 to 20 ppm. Maximum free CO₂ in was observed in summer season and minimum in the rainy season. The free carbon dioxide concentration depends on the respiration of organism (plants and animals) and photosynthesis rate. In case of more photosynthesis more carbon dioxide will be utilized.

Alkalinity

Alkalinity is a function of bicarbonate and carbonates. These salts get hydrolyzed in solution and produced hydroxyl ion. It is also used as a measure of productivity of water (Jhingran, 1982; Hulyal and Kaliwal, 2011). Natural water bodies in tropics usually show wide range of fluctuations in their total alkalinity value depending upon the geography and season. In the present study the total alkalinity ranged between 190 ppm to 224 ppm. It is gradually decreased from July to September and then increased in the month of October. Seasonally highest value was recorded during rainy and lowest during the summer season. Increases in total alkalinity during rainy season were due to input of water and dissolution of calcium carbonate ion in the water column (Padma and Periakali, 1999). The degradation of plants and other organism and organic waste 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).

Hardness

Hardness in water is due to salts of Ca⁺⁺ and Mg⁺⁺ mainly in the form of carbonates and sulphates (Wadia, 1961). In the present study the total hardness of water ranged from 90-120 ppm seasonally, highest value was recorded during summer and lowest during the rainy season. Similar observations were found by various workers (Kumar, 1995; Naik and Purohit, 1996; Kaur *et al.*, 2000; Nair, 2002). Hulyal and Kaliwal (2011) found that higher value in summer and lower in winter season. They attributed it to decreases in water volume and increases in rate of evaporation at high temperature. The water can be categorized according to degree of hardness as soft (0-75 mg/l) moderately (75-150 mg/l) hard (150-300 mg/l) and above 300 mg/l as very hard. On the basis of the observation, the water of the present pond appears to be hard.

Electrical conductivity

Electrical conductivity of the water depends on the nature and concentration of salts in high ionic concentration, pollution status, trophic levels, some domestic effluents and other organic matter in water (Ahluwalia, 1999). The range of electrical conductivity in the present study was between 2.4 mScm⁻¹ to 2.9mScm⁻¹. The values of electrical conductivity showed marked seasonal variation being maximum during rainy and minimum during winter season. Similar results were observed by various workers (Hulyal and Kaliwal, 2011; Ramulu and Benarjee, 2013).

Total dissolve solids

Water is a universal solvent and have a large number of salts dissolved in it which largely govern the physico-chemical properties. The maximum value of total dissolved solids was recorded in rainy season 172 ppm and minimum were recorded in winter season 154 ppm. The high value of TDS during rainy may be due to addition of domestic waste water, garbage and sewage etc. in the natural surface water body.

Biological oxygen demand

BOD is dissolved oxygen required by microorganism for aerobic decomposition of organic matter present in water. Jain and Dhaniya (2000) have considered BOD as an important parameter in aquatic ecosystem to establish the status of pollution. The observation of present study showed that highest value of BOD value during rainy season 3.2ppm and lowers during winter season 2.21ppm. There was variation in pond 1 and pond 2 & 3 may be due to the waste matter flowing in the pond from the catchment. Seasonally, the BOD was highest during late summer /early rainy season. High BOD during late summer / early rainy season may be due to the presence of several microbes in water bodies which accelerate their metabolic activities with the increase in concentration of organic matter in the form of municipal and domestic waste pouring into the pond with run off. Prasanna Kumari et al., (2003) also stated that the higher values of BOD during rainy was also due to input of organic wastes and enhanced bacterial activity. High temperatures do play an important role by increasing rate of oxidation. The BOD of unpolluted water is less than 1.00 ppm moderately polluted water 2.00-9.00 ppm while heavily polluted water have BOD more than 10.00 ppm. The BOD in different season in the present study indicates pond as moderately polluted.

Plankton

The plankton concentration varied from 0.1 to 0.3 ml/25 l of water. It was more in winter season and low in summer season. The concentration is low for commercial fish culture (Jhingran, 1982)

Statistical Analysis

All readings of various parameters of physico-chemical analysis was done in triplicate per month and mean value and standard deviation were calculated according to seasons using Excel 2013.

Conclusion

The observation of the different parameters revealed that the physico-chemical and biological parameters of all the three ponds are within the permissible limit for fish culture except the concentration of plankton. It may be due to over stocking or more organisms feeding on plankton. It may be recommended that the stocking of the pond should be done on the basis of the natural productivity of the water or supplementary feeding (if possible) to have better production. Our study gives emphasis of involvement and educate the local people for safe disposal of effluents is essential. Our analysis for BOD of the ponds falls under moderately polluted category which should be solved in future for better productivity.

Acknowledgement

The author is thankful to The Principal, Jawaharlal Nehru College, Rohtas and the faculties of Department of Zoology for their kind support to conduct the study.

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