

PHYSICO-CHEMICAL STATUS OF RURAL POND OF SASARAM OF BIHAR IN RESPECT OF FISH CULTURE

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Abstract: The study of Physico-chemical parameters in earthen fish ponds in three of sasaram was conducted to determine the quality of water for pond fish culture from June to October, 2005. Water samples were collected from the ponds and analyzed using standard laboratory methods and procedures. The results showed variation in the observed parameters at the different sampling stations. The Physico chemical parameters i.e temperature, pH, dissolved oxygen, Total alkalinity, Free carbondioxide, transparency, Hardness, total dissolved solids, Conductivity and biological oxygen demand has been studied and correlated with ideal condition for fish culture.

Keywords: Physico-chemical; Rural pond; Sasaram, Fish culture.

Introduction

Water is the living media for fish and its quality is one of the most over looked aspect of pond management until it affects fish production. Water quality generally means the component of water which must be present for optimum growth of aquatic organisms [6,23]. Water quality is made up of physical, chemical and biological factors which influence the use of water for fish culture purposes. These factors include temperature, pH, dissolved oxygen, Total alkalinity, Free carbon dioxide, transparency, Hardness, total dissolved solids, Conductivity and biological oxygen demand. The biological oxygen demand and chemical oxygen demand indicate the pollution level of a given water body [6]. Productivity depends on the Physico-chemical characteristics of the water body [7]. In recent years, the inland waters and the terrestrial life in the state have been subjected to alteration ecologically. This is partly due to the human activities, population growth, oil exploitation and exploration which resulted in the pollution of the environment. The components of the pollution contribute to greater oxygen demand and nutrient loading of the water bodies, promoting toxic algal blooms and leading to destabilized aquatic ecosystem [16]. Water of such poor quality may be acidic, rich in nutrients and organic matter, high in suspended solids or polluted with industrial or agricultural chemicals. Such deterioration in water quality can result in fish being stressed and vulnerable to disease [9]. Fish ponds in the State play vital

role in fisheries to supply the much needed animal protein to the people inhabiting such areas. It is therefore important to know about water quality parameters and their management which have influence on growth and survival of aquatic organisms. The purpose of the present investigation was to provide data on water chemistry and biological characteristics of fish ponds in selected freshwater areas of the State. 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 [23]. 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 [30] not much information is available on Physico- Chemical and biological parameters of the present water bodies. The present study will give an idea to increase the conducive condition to fish culture and increase the fish production.

Materials 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 [2]. 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. [29,5,24]. 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. Similar results have been observed by other workers [13].

Table 1: Morphology of the pond

Pond No.	Shape	Embankment	Water spread area (ha)	Bottom	Mean depth (m)	Macrophyte infestation
1	Square	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

Sl. No.	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

There was no variation in temperature in all the three ponds. The temperature ranges indicate the suitability for fish culture [11] 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 to 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 an alkaline trend. The maximum pH value was 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 [11]. The pH was more in areas 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 an increase in the suspended matter brought in through surface runoff. The maximum transparency was recorded in the winter season attributed to the sedimentation of suspended matter [3,25,12,22]. Transparency plays a 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 poorly 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 [29]. 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 [20,21].

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. Inflowing ground water. The carbon dioxide bears a co-relation 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 [11,8]. 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 [19]. 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 [10,4].

Hardness

Hardness in water is due to salts of Ca^{++} and Mg^{++} mainly in the form of carbonates and sulphates [26]. 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 [15,17,14,18,8] other workers has also found [8] found that higher value in summer and lower in winter season. They attributed is 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, 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 [1]. 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 [8,21].

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. Other worker considered BOD as an important parameter in aquatic ecosystem to establish the status of pollution [10]. 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. It is reported 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.

Conclusion

The observation of the different parameters revealed that the physico-chemical 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 analysis for BOD of the ponds falls under moderately polluted category which should be solved in future for better productivity.

References

- [1] Ahluwalia AA (1999) Limnological Study of wetlands under Sardar Sarovar command area. Doctoral diss., Gujarat University, Ahmedabad.
- [2] APHA (1998) Standard Methods for the Examination of water and wastewater. American Public Health Association, Washington D. C., 1000p.
- [3] Chaurasia M and Pandey GC (2007) Study of physico-chemical characteristic of some water pond of Ayodhya-Faizabad. *Indian J. of Environmental protection*. **27**(11):1019-1023.
- [4] Chourasia SK and Adoni AD (1985) Zooplankton dynamics in a shallow eutrophic lake. *Proc. Nat. Symp. Pure Appl. Limnology Bot. Soc. Sagar*, **32**:30-39.
- [5] Dwivedi BK and Pandey GC (2002) Physico-chemical factors and algal diversity of two ponds in Faizabad, India. *Poll.Res.* **21**(3):361-370.
- [6] Ehiagbonare JE, Ogundiran YO(2010). Physico-chemical analysis of fish pond waters in Okada and its environs, Nigeria. *African J. Biotech.*, **9**(36), 5922-5928.
- [7] Huct M (1986). Textbook of fish culture 2nd Edn., Fish News Book Ltd., England. vide Study on the Physicochemical properties of water of Mouri River, Khulna Bangladesh, *Pak. J. Biol. Sci.*, **10**(5), 710-717.
- [8] Hulyal SB and Kaliwal BB (2011) Seasonal Variations in Physico-Chemical Characteristics of Almatti Reservoir of Bijapur district, Karnataka State. *Int. J. Env. Prot.* **1**(1): 58-67.

- [9] ICAR (2006). Indian Council of Agricultural Research. Handbook of Fisheries and Aquaculture. Directorate of Inform. and Public of Agric., New Delhi 110 012.pp.755.
- [10] Jain CK, Bhatia KKS and Vijay T (1997) Ground water quality in coastal region of Andhra Pradesh. *Indian J. Environ. Health.* **39** (3): 182-190.
- [11] Jhingran VG (1982) Fish and fisheries of India.2nd Edn., Hindustan Publishing Corporation, India.
- [12] Kadam MS, Pampatwar DV and Mali RP (2007) Seasonal variations in different physicochemical characteristics in Mosoli reservoir of Parbhani district, Maharashtra. *J. aquatic biol.* **22**(1): 110-112.
- [13] Kannan V and Job SV (1980) Diurnal depth wise and seasonal changes of physicochemical factors in Sathio reservoir. *Hydrobiol.* **70**: 103-117.
DOI: 10.1007/BF00015496
- [14] Kaur H, Bath KS, Mandar G and Jerath N (2000) Physicochemical status of Kanjli wetland (Punjab-India), *J. Environ. Pollut.* **7**(1): 39-42.
- [15] Kumar A (1995) Observation on the diel variations in abiotic and biotic components of the river Mayurrakshi (Santal Pargana). Bihar. *Indian. J. Ecol.* **22**(1): 39-43.
- [16] Morrison GO, Fatoki OS, Ekberg A (2001). Assessment of the impact of Point Source Pollution from the Keiskamma River. *Water SA*, 27,475-480.
- [17] Naik S and Purohit KM (1996) Physico-chemical analysis of some community ponds of Rourkela. *I.J.E.P.* **16**(9): 679-684.
- [18] Nair MS Rajendran (2002) Seasonal variations of physicochemical factors and its impact on the ecology of a village pond at Imala (Vidisha), *J. Ecobiol* **12**(1): 21-27.
- [19] Padma S and Periakali (1999) Physicochemical and geochemical studies in Pulicat lake, east coast of India, *Indian J. Mar. Sci.* **28**: 434-437.
- [20] Prasad BN, Jaitly YC and Singh Y (1985) Periodicity and interrelationships of physicochemical factors in pond. Proc. Nat. Symp. Pure and Applied Limnology (ed Adoni AD) *Bull. Bot. Soc. Sagar*, **32**: 1-11.
- [21] Ramulu NK and Benarjee G (2013) Physicochemical factors influenced plankton biodiversity and fish abundance- A case study of Andhra Pradesh. *Int. J. Life Sc. Bt. & Pharm. Res.* **2**(2): 248-260

- [22] Saha LC and Pandit B (1985) Limnological variations in pond and Riverine ecosystem Proc. Nat. Symp., Pure and Appl. Limnology, (ed.) Adoni AD *Bull. Bot. Soc. Sagar* **32**: 124-130.
- [23] Sahni K and Yadav S (2012) Seasonal Variations in Physico-Chemical Parameters of Bharawas Pond, Rewari, Haryana. *Asian J. Exp. Sci.* **26**(1): 61-64
- [24] Singh RP and Mathur P (2005) Investigation of variations in physicochemical characteristics of a fresh water reservoir of Ajmer city, Rajesthan, *Ind. J. Environ. Sci.* **9**: 57-61.
- [25] Sinha MP, Kumar R, Srivastava R, Mishra SK and Choudhuri AK (2002) Ecotaxonomy and biomonitoring of lake for conservation and management. *Biotic Profile In: Ecology and Conservation of Lakes, Reservoirs and Rivers. Vol. II.* Arvind Kumar (Eds) ABD Publication Jaipur, India. 248-289.
- [26] Wadia DN (1961) *Geology of India*, MacMillan & Co. New Delhi.62.
- [27] Wani IA and Sulba (1990) Physicochemical features of two shallow Himalayan lakes. *Bull Environ. Sci.* **8**: 33-49.
- [28] Wetzel RG (1975) *Limnology*, WB Sanders Company Pub. Philadelphia, London, Toronto 740. 65.
- [29] Wetzel RG (1983) *Limnology, II. Ed.* Saunders College Publ. New York. 66.
- [30] Yadav P, Yadav VK, Yadav AK and Khare PK (2013) Physico-chemical characteristics of a fresh water pond 184 *Octa. J. Biosci.* **1**(2): 177-184
- [31] Young JO (1975) Seasonal and diurnal changes in the water temperature of a temperate pond (England) and tropical pond (Kenya). *Hydrobiol.* **47**: 513-526. DOI: 10.1007/BF00039595