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Physico-Chemical Parameters in Relation to Meteorological and Climatic Conditions in a Fish Pond

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Abstract

Fluctuations of important physico-chemical parameters of a pond were investigated. Different pairs of variables had different relationships with each other by the relevant coefficients of correlation. The pH value was 7.0-7.8 and inversely related to dissolved oxygen. It is highly significant with free CO₂ and CO₃. Dissolved oxygen content is highly significant with water temperature, inverse relationship with free CO₂, CO₃ but no relationship with HCO₃. The carbonate content was 9.8-12.5 ppm. The results showed significant influence of major components on the productivity of fishes in a pond.

Key words : Fish, Pond ecology, Dissolved oxygen, Meteorological properties.

Introduction

The pond ecology have mostly concentrated on the physico-chemical characteristics as they are related to plankton population. The phytoplankton and zooplankton population increased as the water temperature increased (Vasisht and Sharma 1975.) Besides, plankton blooms coincided with the highest amount of light penetration, growth of silicates and alkalinity in water (Connell and Andrews 1972). Different environmental factors which determine the characters of water have great importance to the growth, maturity, reproduction and development of fish

(Bhuiyan *et al.* 1997). Growth and abundance of zooplankton varies from month to month and also in various depth ranges depending on meteorological and water properties (Ali *et al.* 1989). The relationship between the fish and their biotic and abiotic environments is not an isolated phenomenon. Changes of one may reflect and affect on other. Water quality of a pond is influenced by its meteorological and soil conditions. Semi-intensive fish culture is an arrangement by which the fish receives supplemental feed in addition to the food that is naturally available in the pond.

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The objective of this study is to determine the monthly physico-chemical parameters and their evaluation relevant to proper management of fish culture in pond ecosystem.

Materials and Methods

The study was conducted over a period of twelve months between (January to December 2005) in a pond of BCSIR Laboratories, Rajshahi. It is more or less square feet (5 Bigha) with non-uniform depth, the maximum depth being about 3m. The pond had no inlet or outlet and was dependent on rainfall for its water.

The pond received monthly inputs in the form of compost, TSP, urea and oil cake. These inputs were supplied to increase the production of planktonic organism which constitute food for the fish. The quantities of these inputs supplied to the pond/month were urea 40, TSP 40 and oilcake 80 Kg, respectively.

Water sampling collected from three areas around the pond

Area I was located on the northern side, II located on the southern side of the pond. Area III located in between I and II.

The air and water temperature of the three areas were sampled from January 2005 to December 2005 by using centigrade thermometers. Samples were collected from the undisturbed surface of the pond at each specified area and between 9.00am and 2.00pm

daily. Dissolved oxygen of the three areas was determined by the modified Azide Winkler method with drops count titration as per APHA 1976. Free carbon dioxide, carbonate and bicarbonate contents of the water were determined by a 'Field Water Analysis Kit' of HACH Company, USA.

Results and Discussion

The results of various physico-chemical parameters are presented in Table I. The air temperatures were 21.60°C in January and 32.40°C in May 2005. The water temperature was 22.70°C in January but 36.8°C in May. The air and water temperatures were closely related to each other. The correlation coefficient between air and water temperature was found to be ± 0.68 (Table III) with a probability error of 0.10, this relationship was found to be highly significant because the value 'r' is almost six times the value of the probability error (Shukla and Gulshan 1978). Similar results were recorded by (Zafar 1955 and Begum *et al.* 1989).

The direct relationship between air and water temperature was also reported by Islam *et al.* (1974), Miah *et al.* (1981) and Begum *et al.* (1989). The rainfall and water temperature are inversely related ($r=-0.30$). In rainy season, surface run off and organic decomposition occur due to heavy turbidity in summer months. After monsoon, clay and soil particles settle down. So the turbidity began to increase. During spring months and specially in summer months when the air and water

Table I. Monthly mean variation of physico-chemical parameters of the pond under study

Months	Air temp. (°C)	Water temp. (°C)	Dissolved oxygen (ppm)	Free CO ₂ (ppm)	pH	Carbonate (ppm)	Bicarbonate (ppm)
May	29.74	36.8	13.5	38.5	7.4	-	66.3
June	31.00	33.00	12.0	27.8	7.3	11.2	76.2
July	29.16	33.40	16.5	35.2	7.3	-	59.1
August	29.94	35.40	13.6	32.3	7.4	-	72.1
Sept.	29.88	31.60	12.7	36.7	7.1	10.5	65.3
Oct.	26.33	32.10	11.7	24.8	7.0	9.8	63.5
Nov.	22.65	28.10	12.1	30.1	7.1	11.4	61.3
Dec.	19.75	27.20	11.8	45.2	7.5	12.5	63.5
January	17.53	22.70	10.9	52.3	7.4	11.7	65.2
Feb.	21.16	27.30	11.9	32.7	7.5	10.9	63.7
March	26.28	23.80	11.2	44.10	7.3	12.1	68.1
April	29.63	27.70	12.2	65.30	7.8	11.7	79.1

temperatures are very high, then the water level decreased which is responsible for gradual increase of turbidity. Turbidity showed positive correlation with evaporation ($r=0.61$), water temperature ($r=0.56$), rainy day ($r=0.43$), and rainfall ($r=0.21$) and negative correlation with sunshine hour ($r=-0.49$).

The pH value of the pond water was found to be 7.0 in October and 7.8 in April indicating its neutral to alkaline character. The pH value of water was inversely related to dissolved oxygen ($r=-0.32$) and rainfall ($r=-0.02$). The relationship of pH with free CO₂ and CO₃ are highly significant ($r=0.75$ and 0.69). Observed pH value around neutrality indicates that the pond quite suitable for fish culture.

Dissolved oxygen content of the pond having 16.5 ppm in July is highly significant with water temperature ($r=0.65$), inverse relationship with free CO₂ ($r=-0.23$) and CO₂ ($r=-0.37$) but no relationship with HCO₃ (Table III). Dissolved oxygen decreased suddenly after February due to high temperature. It was higher in winter but and lower in summer. Similar results were noticed by Islam and Mendres (1976), Ali *et al.* (1989) and Bhuiyan *et al.* (1997).

The amount of free carbondioxide was 24.8 ppm in October but 65.30 ppm in April. The increased free carbondioxide was possibly due to the accelerated bacterial decomposition. Highly significant relationships are also observed between free CO₂ with CO₃ ($r=0.73$) and HCO₃ ($r=0.39$). The free CO₂

Table II. Weather components at Rajshahi in 2005.

Month	Air max temperature (°C)			Rainfall (mm)	No. of rainy-days	Average sunshine (hour)	Evaporation (mm)	Relative Humidity at 12 noon (%)
	Avg. temp. (°C)	Max. temp. (°C)	Avg. min					
January	23.77	11.3	17.53	13.5	5	7.45	1.97	80
February	28.17	15.06	21.61	101	3	8.40	3.76	70
March	32.9	19.67	26.28	104	9	7.07	4.7	70
April	35.76	23.6	29.63	26.8	4	8.36	5.9	72
May	35.06	24.43	29.74	107.8	3	7.57	5.2	76
June	36	26	31	91.4	11	7.96	4.96	77
July	32.23	26.1	29.16	493.4	23	3.93	2.76	87
August	33.13	26.76	29.94	161.3	21	4.10	3.7	86
September	33.73	26.03	29.88	129.9	18	5.47	4.3	85
October	29.86	23.2	26.53	272.0	10	5.03	2.96	87
November	28.3	16.8	22.65	-	-	7.60	3.13	81
December	26.3	13	19.75	0.8	1	8.23	2.6	76

Table III. Correlation of co-efficients between physico-chemical parameters

Physico-chemical pairs	Correlation co-efficient 'r'	Probability error	Comments
Air temperature water temp.	0.68	0.10	Highly significant
pH dissolved O ₂	-0.02	0.19	Inversely related
pH Free CO ₃	0.75	0.08	Highly significant
pH CO ₃	0.69	0.10	Highly significant
pH HCO ₃	0.17	0.18	Not significant
Dissolved O ₂ Free CO ₂	-0.23	-	Inversely related
Dissolved O ₂ CO ₃	-0.37	-	Inversely related
Dissolved O ₂ HCO ₃	0.14	0.19	Not significant
Free CO ₂ CO ₃	0.73	0.09	Highly significant
Free CO ₂ HCO ₃	0.39	0.16	Significant
CO ₂ HCO ₃	0.20	0.18	Not significant
Dissolved O ₂ water temp.	0.65	0.11	Highly significant
Dissolved O ₂ Rainfall	-0.14	-	Inversely related
pH Rainfall	-0.32	-	Inversely related

content varied together with water temperature and rainfall (Verma 1969). CO₂ level fluctuated widely while pH constant during the study period. The pH ranged from 7.0 to 7.8 indicating the alkalinity in the pond mainly due to bicarbonate.

The carbonate content was 9.8 ppm in October but 12.5 ppm in December. Carbonate was not observed in the water during the months of May, July and August. On the other hand, bicarbonate alkalinity was always present and it was 59.1 ppm in July and 79.1 ppm in April. Bicarbonate showed no relationship with carbonate.

The CO₃ alkalinity showed positive relationship with rainfall ($r=0.31$) and evaporation ($r=0.11$). The bicarbonate showed inverse relationship with rainfall ($r=-0.50$) and evaporation ($r=-0.11$). The HCO₃ alkalinity above 40 mg/l is considered to be hard water (Moyle 1947 and Mathew 1975) which help to maintain the pH value in alkaline condition.

Conclusion

From the above observation it is evident that the productivity of the pond is medium to high. So, it may be concluded that physico-chemical changes which occurred in the pond will not affect fish culture considerably.

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