

Seasonal Variation in Physico-Chemical Parameters and Planktons Population of Fish Pond in Jalandhar, Punjab

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Received August 23, 2008; revised and accepted May 29, 2009

Abstract: The present study has been carried out to determine the water quality in terms of physico-chemical and biological factors in fish pond in Jalandhar city of Punjab, India. The surface temperature varied from 26.3 to 37.1 °C. Dissolved oxygen and pH fluctuated from 8.5 to 11.5 mgL⁻¹ and 7.6 to 8.4 respectively. The conductivity, turbidity and total dissolved solids varied from 445 to 650 µΩ/cm, 6.00 to 11.00 NTU and 210 to 376 mgL⁻¹ respectively. The total hardness and alkalinity range from 113 to 312.5 mgL⁻¹ and 145.1 to 216.2 mgL⁻¹. COD and BOD varied from 41.03 to 84.12 mgL⁻¹ and 16.05 to 35.10 mgL⁻¹. The concentrations of nitrate (0.92 to 2.00 mgL⁻¹), phosphate (0.08 to 0.301 mgL⁻¹) and sulphate (13.6 to 27.2 mgL⁻¹) varied independently. Total organism found in study pond was 801 out of which 697 were phytoplankton and other 104 were zooplanktons. The numbers of species were different in every month. The diversity of phytoplankton ranged from 1.98 to 2.37 and maximum in July and minimum in March. The diversity index of zooplankton ranged from 0.64 to 0.83 and maximum in July and minimum in June.

Key words: Fishpond, physical, chemical, zooplankton, phytoplankton, diversity index.

Introduction

The pond water is considered as one of the major source for fishery and domestic use. The quality of water affects aquatic life in many ways and it must be of good quality for the survival of organisms. The quality of pond water usually depends on its physical, chemical and biological parameters. The water quality measurement of pond water helps to maintain the minimum levels which affect the production. The variation in the climatic condition influences the water quality and the quality affects the aquatic life (Boyd and Tucker, 1998). The addition of undesirable substances into water also changes the water quality. The water quality monitoring of pond with respect to physico-chemical and biological parameters have been

given attention all around the world as the pond water is used as one of the major source for aquaculture. In India, many artificial ponds and temporary water bodies have been made for fishery and domestic uses and have given little attention with respect to quality. Very little information is available on the freshwater ponds in Punjab state of India.

Wood (1976) pointed out that density of aquatic organism in fish water pond was influenced by physical and chemical factors. Takahashi (1978) studied the seasonal variation in fresh pond water. Boyd (1981) found that phytoplankton was predominant type of plant. Boyd and Tucker (1998) found that climatic characteristics influence of the water quantity and quality affect the biodiversity. Roa (1953) studied the correlation on group

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of six small ponds and observed that volvocaleans and chlorococcalean algae were poorly present in pond; blue green algae were more in water having high concentration of organic matter; low concentration of oxygen and pH around neutrality; and diatom were present more in alkaline pond than in acidic ponds. Jana (1973) has observed the significant correlation between pH and phytoplankton, phosphate and green algae and between rotifers and diatoms. Vasisht and Sharma (1980) have concluded that low temperature and turbidity were main cause for the development of plankton and pH was a controlling factor in some of the rotifers. Kohli et al. (1982) have found the variation of phytoplankton and zooplankton and also determined the trophic status of the ponds.

Presently no such data is available on the physical, chemical and biological conditions of the fishpond water, so the water chemistry and biology of the fishpond have been conducted to understand limiting value which affects the fish production.

Material and Methods

The water samples were collected from the pond at Devi Talab Mandir in Jalandhar district of Punjab, India. Sampling of water samples was done once in a month for six months. The water samples were analyzed for the physical, chemical and biological characterization by using standard methods (APHA, 1971).

Physical Analysis

The temperature of water sample was recorded by using digital thermometer. Turbidity was measured with the help of turbidity meter. Conductivity was measured by conductivities meter. In such measurement it is frequently possible to adjust the meter to correct for background currents so that conductivity meter reading immediately indicates the level of pollution. Total dissolved solid was measured by multi range TDS meter.

Chemical Analysis

Dissolved oxygen was estimated by Winkler's method. pH was measured by pH meter. Other chemical

parameters and nutrients were measured by standards methods (APHA, 1971, 1998; Trivedi et al., 1986).

Planktons Analysis

The counting and identification of phytoplankton population was done by haemocytometer method using Lugol's solution. The plankton population was expressed in orgs/L. The identification and counting of zooplankton was done by compound microscope. The identification of phytoplanktons and zooplanktons up to generic level was done with the help of study of Ward and Whipple (1959). Diversity index of plankton during the study was calculated by using the following formula:

$$\text{Diversity index (H)} = \frac{S - 1}{\ln N}$$

where S is number of genera of phytoplankton and zooplankton and N is total number of phytoplankton and zooplankton.

Results and Discussion

The present investigation was carried out in pond situated in Jalandhar city of Punjab. The physico-chemical and biological factors were analyzed for period of six months from March 2007 to August 2007. The results of these analyses showed that the temperature range varied between 28.3 and 37.1 °C. The maximum temperature was recorded during the month of June (Table 1), because of low water level, clear atmosphere and greater intensity of light. Temperature showed an inverse correlation with dissolved oxygen. This was due to more oxygen holding capacity of water at low temperature. However, in certain months inverse relation was not observed. This was due to presence of phytoplankton resulting in liberation of dissolved oxygen and more photosynthetic activity.

In present study, the turbidity value increased during July-August. The maximum turbidity value was found to be 11.00 NTU during the month of May and minimum was 6.00 NTU in the month of March as shown in Table 1. The high turbidity value decreased the rate of photosynthesis due to blanking effect, which in turn decreased the growth of phytoplankton and thus, zooplankton.

Table 1: Physical parameters of pond water

Parameters	March	April	May	June	July	August
Water temperature (°C)	26.3	31.1	34.2	37.1	35.2	33.1
Turbidity (NTU)	6.00	10.00	11.00	8.00	900	11.00
Conductivity (μΩ/cm)	515	530	590	650	445	460
Total dissolved solids (mgL ⁻¹)	210.00	306.00	351.00	376.00	231.00	276.00

The value of electrical conductivity ranged between 445 and 650 $\mu\Omega/\text{cm}$ (Table 1). The maximum value was obtained in the month of June (650 $\mu\Omega/\text{cm}$). The values of electrical conductivity are shown in Table 1. The minimum values of conductivity were recorded during monsoon, which was due to dilution in the concentration of salts by rain. The maximum value 376.00 mgL^{-1} of TDS was observed in June while minimum value 210.00 mgL^{-1} in March as shown in Table 1. The increase in TDS in water increased the turbidity, which causes the ecological imbalance in aquatic ecosystem.

The value of pH ranged between 7.6 and 8.4 (Table 2 and Figure 1). The higher values of pH were recorded in May and June. These were due to absence of free carbon dioxide, as it was utilized for photosynthesis. Low values of pH were recorded during monsoon, due to low photosynthetic activity. Total hardness of pond water ranged between 113.00 and 312.50 mgL^{-1} . The maximum value of total hardness was observed in June and minimum during August (Table 2). This was due to dilution by heavy rain.

In the present study, the value of alkalinity recorded from the pond under investigation ranged between 145.1 and 216.2 mgL^{-1} . The different values of alkalinity are

shown in Table 2. Dissolved oxygen content fluctuated between 8.50 and 11.50 mgL^{-1} in the study pond water. Dissolved oxygen showed maximum value in month of March (Table 2 and Figure 1). This was due to better illumination and abundance of phytoplankton. The minimum value was recorded in the month of August, due to high value of turbidity, cloudy weather that decreases the rate of photosynthesis and high temperature. The free carbon dioxide in most of the months was absent due to its consumption in the photosynthesis. High value of free carbon dioxide was recorded during monsoon (Table 2), due to bringing of carbonic acid by rains and poor photosynthetic activity of phytoplankton.

The value of chemical oxygen demand ranged between 41.03 and 84.12 mgL^{-1} . The maximum value was observed in the month of March and minimum value was noted in June. High value of chemical oxygen demand causes depletion of oxygen, which affects the aquatic life (Table 2 and Figure 2). The biological oxygen demand ranged between 16.05 and 35.10 mgL^{-1} . The high values of BOD were found in summer season. This was due to higher microbial activity and reduced water flow (Table 2 and Figure 3).

Table 2: Chemical parameters of pond water

Parameters	March	April	May	June	July	August
pH	7.6	8.0	8.2	8.4	8.0	7.8
Total hardness (mg/L)	285.4	291.6	297.2	312.5	204	113
Alkalinity (mg/L)	145.1	149.6	150.1	165.7	205.2	216.2
Dissolved oxygen (mg/L)	11.50	11.25	9.40	9.20	8.90	8.50
Free carbon dioxide (mg/L)	—	2.6	—	—	—	4.2
Chemical oxygen demand (mg/L)	84.12	62.02	53.02	41.03	56.01	80.01
Biological oxygen demand (mg/L)	16.05	21.31	35.10	30.31	25.20	27.31
Nitrate (mg/L)	0.92	1.62	1.75	1.65	2.00	1.90
Phosphate (mg/L)	0.080	0.091	0.121	0.096	0.301	0.290
Sulphate (mg/L)	15.8	13.6	14.1	21.1	25.3	27.2

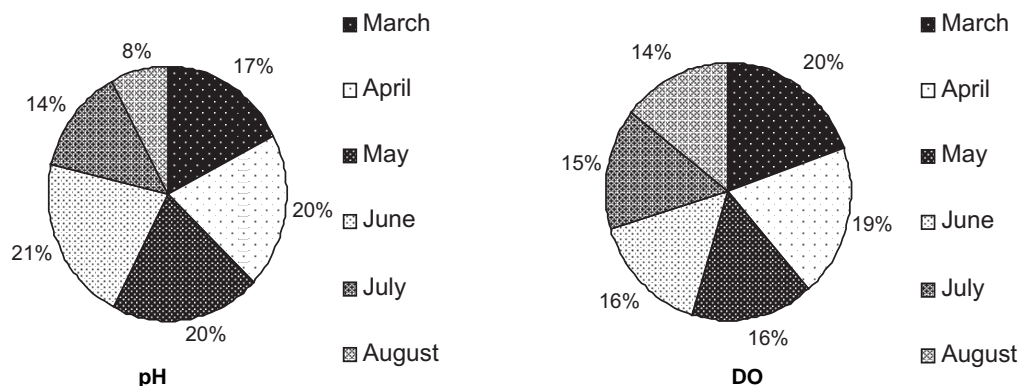


Figure 1: Variation of pH and DO in different months.

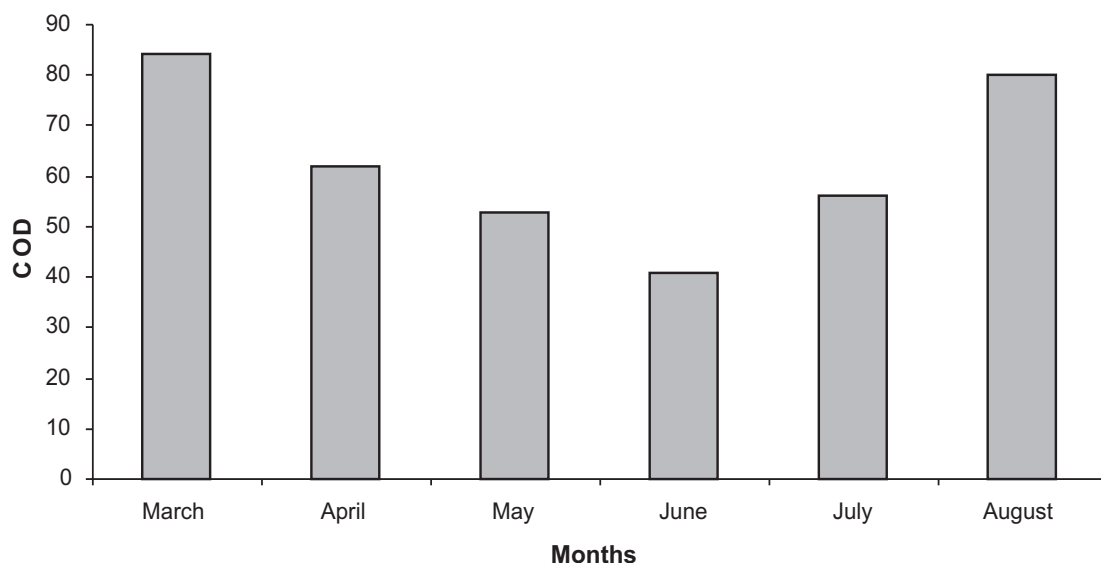


Figure 2: Variation of COD during the period of study.

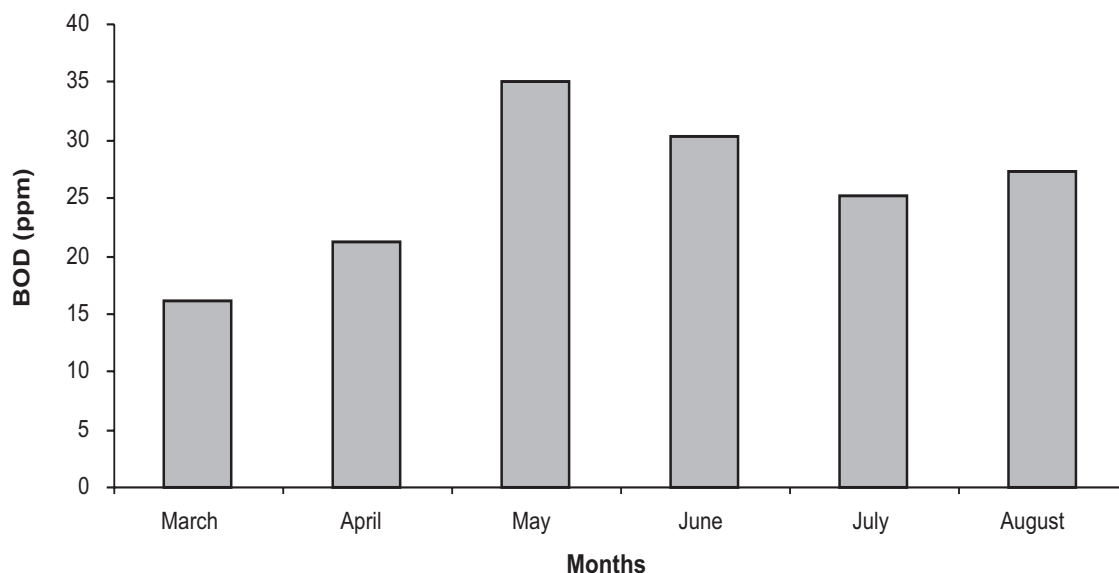


Figure 3: Variation of BOD during the period of study.

Nitrate value in study pond water ranged between 0.92 and 2.00 mgL⁻¹ (Table 2). The maximum values of nitrate were observed during monsoon seasons, which was due to rain, surface runoff and lesser number of phytoplankton. The value of phosphate showed direct correlation with temperature and rainfall. The value of phosphates ranged from 0.080 to 0.301 mgL⁻¹. Higher values of phosphate were recorded during monsoon season (Table 2). Depletion in the value of phosphate was noted in the time of plankton maxima in the present investigation. The values of phosphate are shown in Table 2. The values of sulphate ranged between 13.6 and 27.2 mgL⁻¹ (Table 2). Maximum concentrations of sulphates

were found in monsoon season. This was due to heavy rain as the water runoff brings sulphate with it, which enters into pond water. Different species of phytoplankton, which were observed in the study pond water and their fluctuations during the study period are shown in Table 3. According to study phytoplankton were compressed by the members of *Chlorophyceae*, *Bacillariophyceae*, *Cyanophyceae* and *Euglenophyceae*. *Cyanophyceae* and *Euglenophyceae* constitute the less species diversity and *Chlorophyceae* and *Bacillariophyceae* showed the maximum species diversity. Phytoplankton showed direct correlation with temperature, dissolved oxygen, total hardness, nitrates

Table 3: Diversity and abundance of phytoplankton in the pond water

Phytoplankton	March	April	May	June	July	August	Total
Chlorophyceae							
<i>Scenaesmus</i> sp.	15	9	16	18	12	14	84
<i>Chlorella</i> sp.	28	15	25	28	22	19	137
<i>Pediastrum</i> sp.	14	12	16	17	10	12	81
Bacillariophyceae							
<i>Gomphonema</i>	9	8	4	2	3	2	28
<i>Navicula</i> sp.	8	7	4	5	5	3	32
<i>Fragilaria</i> sp.	15	14	12	13	10	9	73
<i>Cyclotella</i> sp.	18	12	15	20	12	12	87
Cyanophyceae							
<i>Oscillatoria</i> sp.	2	3	8	3	3	3	22
<i>Spirulina</i> sp.	2	5	8	12	8	4	39
<i>Pnornidium</i> sp.	11	12	8	16	14	14	75
Euglenophyceae							
<i>Euglena</i> sp.	-	2	3	4	2	-	11
<i>Phacus</i> sp.	3	4	4	6	3	8	28

Table 4: Diversity and abundance of zooplankton in pond water

Zooplankton	March	April	May	June	July	August	Total
Rotifera							
<i>Keretella</i> sp.	4	9	6	9	2	4	34
<i>Brachionus</i> sp.	3	2	4	8	3	6	26
Cladocera							
<i>Moina</i> sp.	10	8	6	5	6	8	44

and inverse correlation with rainfall. *Chlorophyceae* was a dominant group of phytoplankton and shows maximum species diversity. *Chlorophyceae* showed three species namely *Scenaesmus*, *Chlorella* and *Pediastrum* during the study period. *Chlorophyceae* were recorded minimum during August and March-April.

The most abundant species of *Bacillariophyceae* were *Cyclotella*, *Fragilaria* and *Navicula* but the least found species was *Gomphonema*. *Bacillariophyceae* species was abundant in low temperature (26.3 °C), low alkalinity (145.1 mgL⁻¹), low nitrate (0.92 mgL⁻¹), low phosphate (0.080 mgL⁻¹) and high value of DO (11.5 mgL⁻¹) and COD (84.12 mgL⁻¹). The minimum value of *Bacillariophyceae* was found in the month of July, due to high temperature, low hardness and low DO (8.90 mgL⁻¹). *Cyanophyceae* shows three species namely, *Oscillatoria*, *Spirulina* and *Pnornidium*. *Pnornidium* species and *Spirulina* species were more in number, whereas *Oscillatoria* species was present rarer. *Cyanophyceae* was abundant during late summer (June). These start multiplying in April and attained peak in June. *Cyanophyceae* started decline in monsoon.

Euglenophyceae was considered a subdominant component of phytoplankton. These were represented by only two species namely, *Euglena* and *Phacus*. *Euglenophyceae* show maximum value in late summer (May-June) and decreased with monsoon due to heavy rainfall.

In present study Rotifers and Cladocera constitute the components of zooplankton (Table 4). Rotifers showed maximum species diversity and Cladocera showed minima. Two species of Rotifera was found in study pond water namely, *Keratella* and *Brachionus*. Both species have their maximum density in summer. According to correlation study the pH value ranged 8.2-8.4 and was found suitable for the abundance of Rotifera.

In the present study phytoplankton were most abundant as compared to zooplankton. Total 15 genera were studied out of which 12 genera were of phytoplankton. The total number of organisms was 801 out of which 697 were of phytoplanktons and 104 were zooplanktons. The diversity of phytoplanktons ranged between 1.98 and 2.37 (Table 5 and Figure 4). It was maximum in July and minimum in March. The diversity index of zooplanktons ranged

Table 5: Diversity index of phytoplanktons

Months (H)	No. of genera (S)	Total No. of individuals	ln N	Diversity Index
March	11	155	5.04	1.98
April	12	103	4.63	2.37
May	12	123	4.81	2.28
June	12	144	4.96	2.21
July	12	104	4.64	2.37
August	11	100	4.60	2.17

Table 6: Diversity index of zooplanktons

Months (H)	No. of genera (S)	Total No. of individuals	ln N	Diversity Index
March	03	17	2.83	0.70
April	03	19	2.94	0.68
May	03	16	2.77	0.72
June	03	22	3.09	0.64
July	03	11	2.39	0.83
August	03	18	2.89	0.69

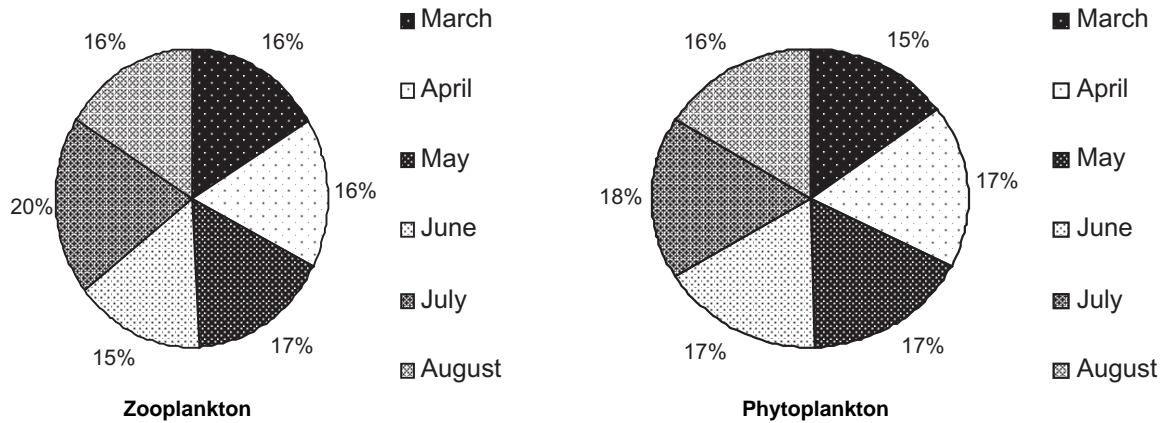


Figure 4: Diversity index of zooplanktons and phytoplanktons.

from 0.64 to 0.83 and was maximum in July and minimum in June (Table 6 and Figure 4). The diversity index was inversely affected by total dissolved salts.

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