STUDY OF HYDROBIOLOGICAL FACTORS AND PRODUCTIVITY OF A FISH POND OF VILLAGE FATEHABAD (MUZAFFARPUR)

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Abstract :

A hydro-biological study conducted in nine different ponds of a rural area of Fatehabad (Muzaffarpur), Bihar, showed that the concentrations of chemical parameters like dissolved oxygen, free carbon dioxide, pH, conductivity, alkalinity, nitrate, phosphate, calcium, magnesium, copper and zinc are within the permissible levels of drinking water quality standard of WHO and ISI. However, iron content was higher in most of the ponds. A clear indirect relationship between iron concentration and euglenoids has been observed. Major phytoplankton taxa present in the ponds are Chlorophyceae, Cyanophyceae, Bacillariophyceae and Euglenophyceae. The study reveals that rural ponds can be very good source of water for drinking, domestic use and fishery and should be conserved at any cost.

Introduction

The world's water resources are under pressure and must be managed for human survival. It is, therefore, necessary to have most relevant information for arriving at rational decisions that will result in the maximum benefit to most people. Accurate and reliable information on the water resource system can, therefore, be a vital aid to strategic management of the resources (Gupta and Deshpande, 2004). Ponds have been used since time immemorial as a traditional source of water supply in India. However, the water of ponds, lakes and river are polluted mainly due to discharged waste water from residential areas, sewage outlets, solid wastes, detergents, automobile oil wastes, fishing facilities and agricultural pesticides from farmlands (Srivastava et. al., 2003; Usha et. al., 2006; Hasan et al., 2007). In recent years, their importance has somewhat declined due to technological advancements leading to more centralized water supply systems. There is a relationship among ecologists and microplanners about the importance of conservation of ponds as sustainable source of water for rural communities (Park and Park, 2005). The present study is an attempt to assess the water quality of ponds in a rural area of Fatehabad (Muzaffarpur), Bihar, so that they may be sustainably exploited for multiple uses like rural water supply, fisheries and even recreation.

Materials and Methods:

The study was carried out in nine different ponds of Fatehabad, a village near Paroo, ($24^0 50$'N,$92^0 40$E), Fatehabad (Muzaffarpur), Bihar. Pond 1,3,4,5 and 6 are household ponds while pond 2,7,8 and 9 are fishery ponds.

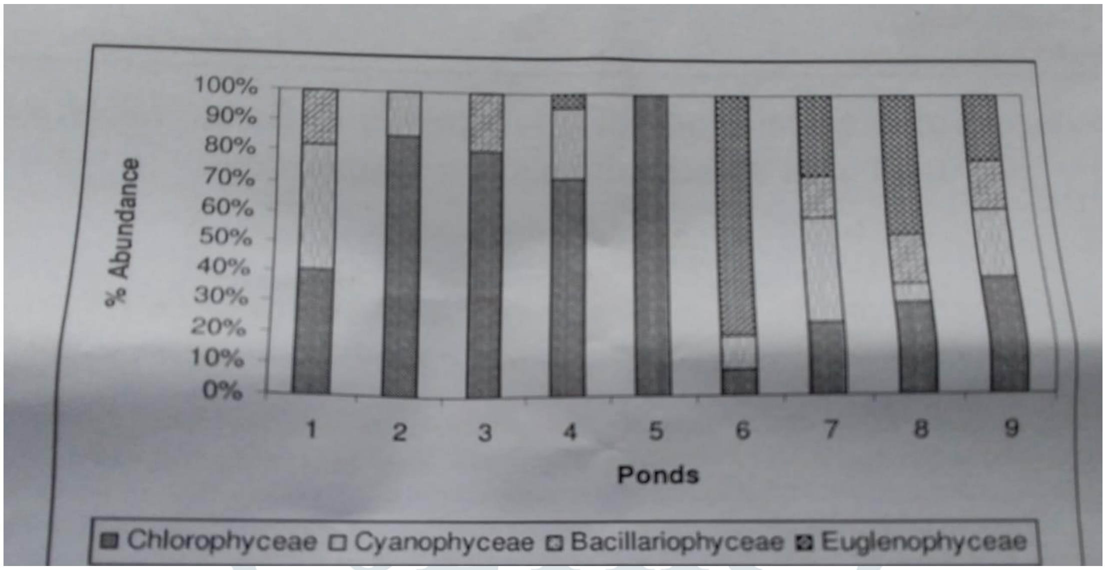
Water samples were collected fortnightly from February to April, 2003 from the sub-surface layer of the ponds in PVC and BOD bottles (for estimating dissolved oxygen). Hydrogen ion concentration and conductivity were measured by a pH and conductivity meter, respectively, while free carbon dioxide, dissolved oxygen and total alkalinity were estimated by standard methods (Micheal, 1984, APHA, 1985; Ramesh and Anbu, 1996). Nitrate content was measured by Ion Meter with Ion Selective electrode (Eutech, Germany) while phosphate content was estimated by Ammonium Molybdate-Slannous Chloride method (Micheal, 1984). Ca, Mg, Fe, Cu and Zn contents were estimated (Gupta, 1996) by Perkin Elmer 2380 flame atomic absorption spector-photometer. The readings were checked with those of standard solutions and procedural blanks, acid washed glassware, analytical grade reagents and double distilled de-ionized water were used to minimize contamination errors. The detection limits for Ca, Mg, Fe, Cu and Zn were 1.0,0.1,3.0,1.0 and 0.8 ugl^{-1} respectively. Quantitative sampling of plankton was done by filtering a known volume of water through a plankton net. After fixation in 6 per cent formalin and pre-concentration, cell counts were made in a sedgewick rafter (Michael, 1984). Statistical analysis was done by using window based statistical package SYSTAT 10.

Results and Disscussion

Quality of an aquatic ecosystem is dependent on the physic-chemical qualities of water and also on the biological diversity of the system (Ghavzan et al., 2006; Tiwari and Chauhan, 2006; Tas and Gonulol, 2007). Caims and Dickson (1971), stated that analysis of biological materials along with chemical factors of water forms a valid method of water quality assessment.

Table 1 depicts the chemical variables of the water of nine different ponds selected for the present study. The dissolved oxygen content varied between 5.85 mgl^{-1} in pond 5 to 11.28 mgl^{-1} in pond 8, the value of free carbodioxide ranged from 10.1 mgl^{-1} in pond 6 to 23.47 mgl^{-1} in pond 4. Total alkalinity varied from 11mgl^{-1} to 47.87 mgl^{-1} in pond 2 and 4 respectively. The pH value ranged from 6.9 in pond 8 to 7.82 in pond 5. The pH value ranged from 6.9 in pond 8 to 7.82 in pond 5. The minimum recorded value of conductivity is 29.63 uS/cm in pond 2 while maximum value is 182.87 uS/cm in which in turn led to the release of the nutrients, which enhanced the alkalinity and conductivity of pond water (Dutta Gupta et. al., 2004).

Figure 1.1



In lake ecosystems beside the input of nitrate through runoff, decomposition of nitrogenous matter and its further oxidation plays a significant role. Except pond 9, all other ponds have been found to be favourable for fish productivity as nitrate value of these ponds ranged between 0.1-3.0 mgl^{-1}) (Verma, 2002). The low range of phosphate value in all the ponds is due to the fact that a high temperature, phosphate is rapidly assimilated by plankton and micro-organisms (Manna and Das, 2004). The highest value of phosphate and the present of all the four groups of plankton in pond 7 indicate that phosphate regulates the growth of phytoplankton (Welch et. al, 1978; Kwang-Guk et. al, 2003).

In this study, we find that concentration of iron is beyond the permissible level of water quality standard in ponds 1,3 and 5 while other parameters are within the limits in all the ponds. Gobler and Cosper (1996) and several Indian workers (Munnawar, 1970; Khan, 1993, a, b; Choudhary et al., 1998; Khan and Bhat, 2000), have recorded much higher concentration of iron in lake and pond waters and emphasized its role in inducing chrysophyte and euglenoid blooms regularly. In our study, it has been observed that it is totally absent in the ponds where iron level is quite high where as in pond 4,7 and 9, comparatively lower iron value is associated with moderate abundance of Euglenophyceae. From our study and previous studies, it can be said that as in these types of shallow water bodies boom and bust cycle continues with the entry of nutrients water bodies boom and bust cycle continues with the entry of nutrients via surface runoff, concentration of iron in the pond 1,2 and 3 was not conducive for the initiation of the growth of euglenoids while in ponds 4,7 and 9 with the optimum concentration of iron euglenoids started to develop and spread, thus utilizing and reducing the iron content of water. Further in onds 6 and 8 higher growth of euglenoids must have accumulated iron in their body resulting in the lowering of its level in water. Similarly calcium and magnesium are found to be lowest along with lowest iron content and highest percentage occurrence of Euglenophyceae in pond 6. This confirms our previous study, which showed that besides iron, calcium and magnesium also have a great role in simulating and maintaining Euglena blooms. (Dutta Gupta et al., 2004). This is possible because calcium increases the availability of other irons and magnesium acts as a carrier of phosphorus (Wetzel, 1984). Lake Manasbal of Kashmir valley of India which is infested by Euglena pedunculata also has calcium rich water (Khan and Bhat, 2000). The concentration of copper in all the ponds have been found to be very low compared to other elements and concentration of zinc also has not shown much fluctuation. Though zinc is involved in nucleic acide involving carbohydrates, lipids, proteins and nucleic acid (McDowell, 1992). It can be toxic also when present in excess amount as changed in blood parameters and issue structures have been Banerjee, 1998). However, in the present study, the highest recorded value of zinc is much below the standards given by WHO (1971) and ISI (1982) (Table 2).

Correlation coefficients computed among the chemical parameters of nine ponds showed a number of significant relationships (Table 3). The classical inverse relationship between dissolved oxygen and carbon dioxide was found to be significant as dissolved oxygen is mainly regulated by photosynthetic activity of algal flora when free carbon dioxide is utilized (Wetzel, 1984). In contrast, positive relationship between dissolved oxygen and nitrate may be explained by the fact that nitrate concentrations in all the ponds were not very high, the maximum value being 2.2 mgl^{-1}. The moderate nitrate concentration is likely to have enhanced the growth of phytoplankton which in turn produced more dissolved oxygen. Significant positive correlations of conductivity with phosphate and magnesium indicate that they are the key factors governing the conductivity regimes of the ponds investigated. Phosphate is essential for the growth of organisms and can limit primary productivity (Wetzel, 1984). Again magnesium is required by the chlorophyllous plants as it acts as a micronutrient in enzymatic transphosphorylations by algae. It was also shown that low available magnesium can influence the phytoplankton productivity in pond 5. The value of nitrate ranged from 0.9mgl^{-1} to 2.2mgl^{-1} in pond 9 and 8 respectively. The highest value of phosphate is 43.5 ugl^{-1} in pond 7 and not detected in pond 2. Calcium content varied from 0.013 mgl^{-1} in pond 1 to 2.6 mgl^{-1} in pond 9. The value of magnesium ranged from 2.04 mgl^{-1} in pond 6 to 5.15 mgl^{-1} in pond 1. The minimum recorded value of iron is 0.01 mgl^{-1} in pond 6 while the maximum recorded value is 1.78 mgl^{-1} in pond 3. The concentration of copper ranged from 0.02 mgl^{-1} in pond 8 to 0.11 mgl^{-1} in both pond 3 and 5. The zinc content of water varied from 0.2 mgl^{-1} to 0.82 mgl-^{1} in pond 6 and 1 respectively.

Table :-1 Variation of Chemical parameters in ponds 1 to 9 (n^{+}=6)

Variables	Ponds								
	1	2	3	4	5	6	7	8	9
DO	6.37 (1.01)	8.19 (1.07)	6.55 (2.40)	5.91 (2.38)	5.85 (2.2)	7.57 (0.67)	7.34 (0.44)	11.28 (0.029)	7.29 (0.27)
Free CO_2	12.47 (3.36)	13.27 (4.68)	12.53 (0.53)	23.47 (16.66)	22.29 (28.37)	10.1 (1.15)	17.45 (0.18)	17.53 (0.50)	13.39 (0.54)
TA	20.00 (3.60)	11.00 (3.6)	17.00 (6.10)	47.87 (56.23)	18.37 (24.83)	22.5 (0.5)	43.67 (0.38)	43.8 (2.30)	37.67 (1.53)
pH	7.40 (0.34)	7.47 (0.25)	7.24 (0.14)	7.5 (0.21)	7.82 (0.12)	7.2 (0.02)	7.18 (0.1)	6.9 (0.21)	7.01 (0.07)
Cnd.	123.8 (8.26)	29.63 (1.7)	66.4 (9.93)	114.3 (36.96)	182.87 (17.4)	124.2 (3.7)	177.1 (36.9)	147.17 (0.47)	91.3 (1.13)
TDS	56.30 (3.79)	14.00 (1.0)	28.90 (7.10)	52.67 (16.56)	82.67 (7.77)	56.5 (2.12)	82.00 (15.1)	61.92 (0.38)	41.00 (1.0)
Nitrate	0.720 (0.38)	0.210 (011)	01.70 (1.15)	0.38 (0.32)	0.63 (0.43)	0.7 (0.11)	0.43 (0.06)	2.2 (0.15)	0.09 (0.01)
Phosphate	0.850 (0.01)	0.00	0.49 (0.04)	2.56 (0.25)	1.22 (0.03)	0.85 (0.04)	43.5 (0.78)	15.2 (0.03)	3.35 (0.06)
Calcium	0.013 (0.01)	0.03 (0.01)	0.70 (0.02)	0.14 (0.001)	0.17 (0.002)	0.012 (0.01)	1.58 (0.13)	1.07 (0.01)	2.6 (0.05)
Magnesium	5.15 (0.05)	2.05 (0.05)	04.70 (0.08)	3.37 (0.01)	3.66 (0.01)	2.04 (0.05)	3.96 (0.86)	4.3 (0.01)	4.13 (0.01)
Iron	1.13 (0.01)	0.71 (0.045)	01.78 (0.02)	0.49 (0.01)	1.23 (0.02)	0.01 (0.02)	0.35 (0.57)	0.02 (0.01)	0.18 (0.01)
Copper	0.081 (0.01)	0.07 (0.01)	0.110 (0.025)	0.09 (0.02)	0.11 (0.03)	0.08 (0.02)	0.03 (0.01)	0.02 (0.01)	0.03 (0.01)
Zinc	0.820 (0.03)	0. 39 (0.02)	0.300 (0.01)	0.30 (0.01)	0.39 (0.02)	0.2 (0.01)	0.26 (0.04)	0.23 (0.00)	0.34 (0.01)

+n= number of replicate samples from each pond: all the values are in mgl^{-1} except and EC (uS/cm) and phosphate (ugl^{-1})

Values in parenthesis are $\pm$ SD

DO= Dissolved oxygen, Cnd. Conductivity, T.A.=Total alkalinity, TDS=Total dissolved solid.

Table-2 Maximum permissible values (WHO and ISI) of some chemical variables estimated in the present study.

Variable	Maximum permissible value (WHO, 1971)	Maximum permissible value (ISI, 1982)
pH	6.5-9.2	6.5-9.2
Magnesium (mgl^{-1})	150.0	150.0
Iron (mgl^{-1})	1.0	1.0
Copper (mgl^{-1})	1.0	1.5
Nitrate (mgl^{-1-})	45.0	45.0
Zinc (mgl^{-1})	15.0	15.0

The present findings indicate that water quality of all the nine ponds is suitable for drinking and domestic use. Further, they have good potential for fishery except pond 9 where nitrate content is marginally low for fish production. Thus small rural ponds can be a very good source of water for drinking, domestic use and also for generating income from fishery which can be augmented with scientific management as small reservoirs are more manageable and high yielding than larger ones. Hence, it is necessary to protect and conserve these small water bodies. This demands immediate action from ecologists, planners and policy makers.

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