ASSESMENT OF THREE DIFFERENT PARAMETERS OF URBAN PONDS AT RAJSHAHI, BANGLADESH

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Abstract

Context: Physico-chemical factors directly affect the water quality. Biological parameters varied from pond to pond according to the water quality.

Objective: To assess the physico-chemical conditions and plankton abundance in the studied ponds.

Materials and Methods: The study was carried out for a period of seven months from June, 2008 to December, 2008 in six ponds of Rajshahi Metropolitan area. Surface water samples were collected once a month at 10-11 am in black plastic bottle and analyzed for the estimation of different parameters. Water temperature, transparency, pH, dissolved oxygen (DO), free carbon dioxide (CO_2), biological oxygen demand (BOD), nitrite nitrogen (NO_2^-–N), nitrite (NO_2), toxic ammonia, ammonium ion (NH_4^+) and total hardness were measured. The density of plankton was also estimated.

Results: The mean values of water temperature varied from 28.73 ± 3.98 (Pond 6) to $29.56 \pm 4.68°C$ (Pond 4) and the pH varied from 7.37 ± 0.26 (Pond 6) to 8.57 ± 0.26 (Pond 4). The DO varied 1.66 ± 1.03 (Pond 1) to 4.68 ± 0.36 mg/l (Pond 6) and the mean value of free CO_2 varied from 4.29 ± 0.37 (Pond 5) to 50.91 ± 19.30 mg/l (Pond 3). The total hardness was 136.79 ± 20.28 (Pond 6) to 183.14 ± 51.17 mg/l (Pond 3) with NO_2-varied from 0.003 ± 0.002 (Pond 5) to 2.08 ± 0.59 mg/l (Pond 4). The mean total phytoplankton was 28761.43 ± 2912.62 (Pond 2) to 63629.29 ± 20214.44 cells/l (Pond 4) and the mean total zooplankton was 13314.24 ± 3189.70 cells/l (Pond 5) to 18820.00 ± 932.51 cells/l (Pond 4).

Conclusion: The deterioration in the physico-chemical quality and plankton population observed in this study is alarming, and periodic monitoring and preventative measures are required to save the aquatic system from eutrophication.

Keywords: Physical parameter, chemical parameter, plankton concentration.

Introduction

The various water sources like ponds, lakes, rivers are used for industrial, domestic and agricultural purposes. These water bodies get polluted due to the discharge of effluents from the industries, domestic waste, land and agricultural drainages resulting in the degradation of water quality. Among the various means of pollutions of pond are washing of the clothes, cleaning of animals, dumping of the waste by unauthorized small scale units functioning in the surroundings to the pond. Haslam (1991) stated that due to the great expansion in the urbanization and industrialization, most of the water bodies especially in the developed countries are polluted.

The pond water is considered as one of the major sources for fishery and domestic uses. The consideration of the physico-chemical factors in the study of limnology is basic to the understanding of trophic dynamics of the water body. Each factor does play its individual role but at the same time the final effect is the actual result of the interaction of these factors. Planktons are sensitive to the environment in which they live, and any alteration in them leads to change in the plankton communities in terms of tolerance, abundance, diversity and dominance in the habitat. Phytoplanktons are the basic members in the aquatic ecosystems and hence change in phytoplankton population has a direct link with the change of water quality in any

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aquatic medium (Dutta *et al*. 1954). Primary production of fish in water bodies depends upon their depth, type of land, chemical nature of the water body. Thus, better understanding of aquatic environments and productivity of aquatic communities are pre-requisite for improve utilization of these resources for human welfare. Therefore, present investigations have been made to find the different water quality parameters of some ponds of the Rajshahi Metropolitan area.

Materials and Methods

Study Ponds: The study was carried out for a period of seven months from June, 2008 to December, 2008 in six ponds of Rajshahi Metropolitan area. Surface water samples were collected once a month at 10-11 am in black plastic bottle and analyzed for the estimation of different parameters.

Physico-chemical parameters: Physico-chemical parameters were measured and recorded monthly basis thruoughout the study period. Surface water temperature was measured by dipping a Celsius thermometer. Transparency was measured by a secchi disc. pH was measured using a HACH kit, model FF-2, Cat. No. 2430-01, Made in USA. Wide range 4 pH indicator solution was used. Dissolved oxygen (DO) and Biological Oxygen Demand (BOD) were measured by Winkler's Titration method (APHA 1976). Free CO_2 was measured by titration method (Welch 1948). The total hardness was measured by the titration of ammonia buffer solution and resultant data was expressed according to Mishra and Saksena (1992). Nitrite nitrogen (NO_2^-–N), nitrite (NO_2), toxic amonia and ammonium ion were measured by HACH kit, model FF2, USA.

Biological Parameters: Among biological parameters only phytoplanktons and zooplanktons were studies. Qualitative study of plankton was done accordingly to Anagnostidis and Komarek (1985), Skulberg *et al*. (1993), Bellinger (1992), Khondker (1997). The density of plankton was estimated by using a Sedgewick-Rafter (S-R) cell. Calculation of plankton samples were accomplished by the method of Stirling (1985).

Results

Physico-chemical Parameters: Different estimated values of the water qualities varied from pond to pond, and the calculated data are presented in the Table 1. The mean values of water temperature varied from 28.73 ± 3.98 °C (Pond 6) to 29.56 ± 4.68°C (Pond 4). Water transparency was 26.46 ± 5.13 (Pond 4) to 41.35 ± 10.88 cm (Pond 1) and the average pH in the present study was found to vary from 7.37 ± 0.26 (Pond 6) to 8.57 ± 0.26 (Pond 4). DO varied from 1.66 ± 1.03 mg/l (Pond 1) to 4.68 ± 0.36 mg/l (Pond 6) whereas free CO_2 varied from 4.29 ± 0.37 mg/l (Pond 5) to 50.91 ± 19.30 mg/l (Pond 3). The average BOD varied from 1.34 ± 0.66 mg^{-l} (Pond 4) to 2.53 ± 0.48 mg/l (Pond 6). The mean total hardness was 136.79 ± 20.28 mg^{-l} (Pond 6) to 183.14 ± 51.17 mg/l (Pond 3). The concentration of NO_2-N varied form 0.06 ± 0.04 mg^{-l} (Pond 5) to 0.63 ± 0.18 mg/l (Pond 4). NO_2^- varied from 0.003 ± 0.002 (Pond 5) to 2.08 ± 0.59 mg/l (Pond 4) and the toxic ammonia ranged from 0.0007 ± 0.0005 (Pond 6) to 0.27 ± 0.02 mg/l (Pond 1).

Biological Parameters: Chlorophyceae was found to be the most dominant group followed by Euglenophyceae, Myxophyceae, Bacillariophyceae and Cyanophyceae (Table 1). Among the zooplanktons Cladocera was found to be the most dominant group followed by Rotifera, Copepoda and Nauplius. The variations in the mean values of plankton under different pond are shown in Table 1. A total of five groups of phytoplanktons and four groups of zooplanktons were identified during the study. The mean value of total phytoplankton varied from 28761 ± 2913 (Pond 2) to 63629 ± 20214 cells/l (Pond 4) (Table 1) and zooplankton varied from 13314 ± 3190 cells/l (Pond 5) to 18820 ± 932 cells/l (Pond 4) (Table 1)

Discussion

Boyd (1982) suggested the suitable temperature for fish culture is 26.06-31.97°C. Sweeting (1994) mentioned that water temperature changes due to the discharge of effluents and may also cause physical pollution in the water bodies. Trivedi and Raj (1992) found thermal pollution can affect fish culture. A

transparency value in between 15 to 40 cm is found good for fish culture (Boyd 1982). According to Chhatwal *et al*. (1989), pH of natural water remains nearly 7 but generally high due to the presence of sufficient quantities of carbonate and bicarbonate. Generally free CO_2 was found lower than the dissolved oxygen contents. It appears that low concentrations of free CO_2 in samples of pond-4 and 5, due to its utilization by aquatic plants (rooted emergent and floating hydrophytes) during the process of photosynthesis. However, at pond-1, 2 and 3, it fluctuated frequently higher than dissolved oxygen. Among all the ponds studied, lowest oxygen concentrations was recorded in the samples of Pond-1 (Hadirmore) due to excess use of pond water for washing cloths and household utensils.

Table 1. Mean variation of physical and chemical factors in different ponds

Parameters	Pond-1	Pond-2	Pond-3	Pond-4	Pond-5	Pond-6
Temperature ^oC	29.37 ± 4.54	29.08 ± 4.35	29.27 ± 4.50	29.56 ± 4.68	29.19 ± 3.39	28.73 ± 3.89
Transparency cm	41.35 ± 10.88	29.30 ± 8.96	28.40 ± 10.41	26.46 ± 5.13	29.64 ± 0.38	27.86 ± 0.73
pH	8.16 ± 0.42	8.09 ± 1.07	8.41 ± 0.31	8.57 ± 0.26	7.53 ± 0.39	7.37 ± 0.26
DO (mg/l)	1.66 ± 1.03	2.85 ± 1.35	1.68 ± 0.72	1.93 ± 0.23	4.49 ± 0.46	4.68 ± 0.36
Free CO_2 (mg/l	42.60 ± 16.77	34.09 ± 7.71	50.91 ± 19.30	59.49 ± 11.96	4.29 ± 0.37	4.37 ± 0.84
BOD (mg/l)	1.60 ± 0.99	2.34 ± 1.15	1.68 ± 0.72	1.34 ± 0.66	2.48 ± 0.50	2.53 ± 0.48
Hardness (mg/l)	154.43 ± 18.82	142.71 ± 28.02	183.14 ± 51.17	159.04 ± 17.81	140.59 ± 10.37	136.79 ± 20.28
NO_2^-–N (mg/l)	0.34 ± 0.11	0.16 ± 0.12	0.33 ± 0.44	0.63 ± 0.18	0.06 ± 0.04	0.17 ± 0.04
NO_2^-(mg/l)	1.11 ± 0.35	0.53 ± 0.38	1.08 ± 1.46	2.08 ± 0.59	$.0003 \pm 0.002$	0.004 ± 0.003
Toxic NH_3 (mg/l)	0.27 ± 0.02	0.006 ± 0.004	0.05 ± 0.23	0.05 ± 0.03	0.0009 ± 0.0007	0.0007 ± 0.0005
NH_4^+ (mg/l)	1.38 ± 0.42	0.29 ± 0.10	0.31 ± 0.21	0.15 ± 0.11	0.0005 ± 0.0002	0.0004 ± 0.0001
Euglenophyceae	4598.57 ± 802.83	$4160.14\pm5 08.67$	4546.57 ± 5506.99	5111.71 ± 2506.99	5121.43 ± 1411.54	5387.00 ± 1121.17
Bacillariophyceae	1943.29 ± 436.26	$2044.86\pm4 42.10$	$2052.86\pm1 03.93$	$1413.71\pm2 48.33$	3764.43 ± 1595.36	3265.57 ± 1221.07
Cyanophyceae	2202.43 ± 1023.19	$2041.14\pm7 33.03$	$3970.71\pm4 38.85$	4210.71 ± 2801.68	4625.14 ± 1269.97	$4539.86\pm9 69.78$
Mixophyceae	1922.00 ± 1123.87	$2151.71\pm9 30.49$	2222.00 ± 1080.00	$288.29\pm2 06.45$	5078.43 ± 1882.67	5300.14 ± 1392.74
Cholorophyceae	18915.29 ± 1044.83	18363.57 ± 967.58	19860.43 ± 860.56	14707.86 ± 6891.10	15219.57 ± 2088.39	15631.14 ± 3493.40
Total (cells/l)	29581.57 ± 3048.18	28761.43 ± 2912.62	32652.57 ± 1821.33	63629.29 ± 20214.4	33809.00 ± 4979.32	34123.71 ± 5668.97
Cladocera	$5313.86\pm9 46.22$	$5168.29\pm1 041.40$	$4832.14\pm8 38.24$	$6292.57\pm5 76.62$	$3826.43\pm1 379.31$	$3972.71\pm1 446.92$
Rotifera	$4892.43\pm6 44.13$	$4838.86\pm1 67.89$	$5647.86\pm4 01.94$	$5482.14\pm3 00.69$	$4924.71\pm1 074.65$	$5113.71\pm1 469.11$
Copepoda	$4533.29\pm7 00.64$	$4405.43\pm5 01.74$	$4537.43\pm5 28.54$	$4262.43\pm4 85.58$	$3037.00\pm6 75.69$	$3165.86\pm6 26.90$
Nauplius	$3143.71\pm8 54.77$	$2644.00\pm4 03.67$	$2673.57\pm1 98.75$	$2782.86\pm3 70.39$	1526.14 ± 75797	1115.14 ± 625.10
Total (cells/l)	17883.29 ± 2348.84	17056.57 ± 1714.88	17691.00 ± 303.13	18820.00 ± 932.51	13314.29 ± 3189.70	13367.43 ± 3734.04

Sreenivasan (1964) has argued that high level of free CO_2 in comparison with oxygen indicates high level of decomposition for organic matter in a water body rather than its production. Naz (1999) noticed that the highest value of BOD in summer to early monsoon may be attributed due to the maximum biological activity at elevated temperature, whereas the lower BOD values indicates lower biological activity. Higher value of BOD indicates very high degree of organic pollution (Rao 1979). The range of total hardness in the study indicates that the water of these ponds between soft to hard condition according to the range of hardness described by McCutcheon *et al.* (1992). High values of total hardness in the samples perhaps occurred due to the surface runoff. The concentration of NO_2-N in the present study varied form 0.06 ± 0.04 mg^{-1} (Pond 5) to 0.63 ± 0.18 mg/l (Pond 4). This range varied due to enrichment through drainage of decomposed material,

surface run of from outside of the ponds. Water bodies subjected to organic pollution consist of high concentration of NO_2-N (Khondkar, 2000). Popma (2005) reported that prolonged exposure (several weeks) of *Tilapia* to unionized ammonia concentration greater than 1 mg/l caused losses, especially among fry and juveniles in \water with low DO concentration. In the study NH_4^+ ranged from 0.0004 ± 0.0001 (Pond 6) to 1.38 ± 0.42 mg/l (Pond 1).

Total concentration of phytoplankton in the present study is more or less similar with Hossain *et al.* (2007) who found the value ranged from 60880 to 239400 units/l in fishpond of Bangladesh. This variation is due to the effect of seasonal abundance and similar results was observed by Rahman *et al.* (1999) and Hossain and Bhuiyan (2007). In the present study the mean concentration of cladocera was highest followed by rotifera, copepoda and nauplius larvae respectively. This findings agreed with Choudhury and Mamun (2006) and Bhuiyan *et al*. (2008).

Conclusion

The present investigations accomplished that phytoplankton and zooplankton are showing direct relationship with favourable conditions of alkalinity, maximum DO, minimum BOD which develop most favourable environment of fish production in the study ponds. It is clear from the results that the pond is mesotrophic and aging towards eutrophication. Hence measures should be taken to minimize the fresh water pollution by preventing washing of clothes and other bad practices of human.

Acknowledgement

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