Studies on the role of metallic pollution in riverine ecosystem

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SUMMARY

The present study was exclusively aimed to study the role of metallic pollution in riverine ecosystem on phytoplankton health. The concentration of metals in river water and in algal population were recorded at four sites viz., Kalichabad ghat (S_1), Hanuman ghat (S_2), Achala devi ghat (S_3) and Ram ghat (S_4) Site S_2 and S_3 were the mixing zone where effluents were discharged into the river while S_1 and S_4 were up and down stream of the river. There was an increasing trend of metal concentration in river water from S_1 to S_3 and decreased at S_4. The concentrations of metals were found to be higher at S_3 which showed a direct correlation with river water metal concentration. Metal concentration in river water and algal cells were found higher in summer season followed by winter and rainy seasons. In the present observation, there was high metallic level in river water at effluent mixing zone, which directly correlates with metal concentration in algal cells which may significantly reduce the biotic community and trophic level in riverine ecosystem.

Key words : Metallic pollution, Riverine ecosystem, Algae, trophic level

The river ecosystem is unique in its basic characteristics due to short residence time of water and changing boundary conditions throughout the length. Thus, each section of the river is unique for study purposes. The high concentrations of toxic metals not only pollute the river water but also jeoparadise the aquatic biota. The concentration and distribution pattern of metal within ecosystem is especially important. Metals and metalloids are ubiquitous. Industrial effluents are the prime source of heavy metal concentration in aquatic body environment. Metals are an unique class of toxicants since they cannot be broken down to non-toxic forms. Once the ecosystem is contaminated by them, they remain a potential threat for many years because of their extreme persistance, high toxicity and tendency of bioaccumulation (Verma, 1990).

Most of the Indian rivers are polluted to a great extent by domestic sewage and industrial wastes (Ajmal, *et al.*, 1985; Anawar and Siddiqui, 1988; Shukla *et al*., 1989; Singh and Mishra, 2007; Chanu and Devi, 2008). Reports are available on studies of heavy metals in water, plankton, sediment and animal tissues (Ayyadurai and Krishnasamy, 1989; Roy and David, 2002).

Jaunpur representing southeastern part of U.P. and lies 42.6^{O}E longitude and 25.7^{O}E latitude embracing an area of nearly 4038km^2. A preliminary survey of the river Gomati at Jaunpur showed that there was several points of interest. An average wedth of the river is 120 meters. It directs the city into two halves. The objective of the present work is to study the role of metallic pollution in riverine ecosystem in order to estimate the health implication and to mantain the aquatic biota.

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MATERIALS AND METHODS

Water samples and algal populations were randomally collected at four sampling sites (*viz.*, Kalichabad ghat (S_1); Hanuman ghat (S_2), Achala Devi ghat (S_3) and Ramghat (S_4), the confluence of sewage discharge point. Samples were taken at a distance of about 3 meter inside the river from the bank and depth of about 0.20 meter in the second week of each month and brought to the laboratory for the analysis of various metals. Algal population was dried and crushed to power form for the analysis of heavy metal in cells. Known weight of the algae was digested in Kjeldahal flask with conc. HNO_3. Samples were then treated with perchloric acid and digestion continued till the end of white fumes. The samples were filtered and estimated according to APHA (1989).

RESULTS AND DISCUSSION

Monthly variation in heavy metal concentration in river water and algae, at different sampling sites were observed. The heavy metal concentration was found to be considerably varried with maximum occurrence

Table 2 : Heavy metal concentration in algal cell at different sampling sites

Sampling site	Heavy metal concentration (mg.100g-l dry wt)				
	Zn	Cu	Fe	Pb	Cd
S_1	17.6	16.2	15.7	3.9	2.9
	± 1.5	± 3.5	± 1.62	± 1.15	± 0.56
S_2	96.8	46.7	43.9	10.7	8.4
	± 2.12	± 6.8	± 2.4	± 0.8	± 0.95
S_3	109.8	57.9	49.7	18.2	11.2
	± 5.8	± 7.2	± 6.3	± 3.5	± 0.8
S_4	92.6	52.2	47.1	9.1	10.2
	± 4.5	± 4.2	± 6.5	± 1.2	± 0.08

Data presented are mean of three replicates with their representative ± SD.

at site 3 (Achala Devi ghat). Zinc was recorded in the range of 0.12 ±0.06 to 0.2 ± 0.02 mgl^{-1}, 0.4 to 0.12 mgl^{-1}, 0.25± 0.015 to 0.44 ± 0.02 mgl^{-1} and 0.19 to 0.08 mgl^{-1} at S1, S2 and S4, respectively. Highest concentration of zinc was observed during summer season (May and June) while lowest in rainy season (Aug. and Sept.) Copper was estimated as 0.014± 0.002 to 0.019 ± 0.002 mgl^{-1} at S1 and S2, S3 and S4 it was recorded in the range of 0.025 ± 0.015 mgl^{-1} to 0.04± 0.01 mgl^{-1}; 0.038 ± 0.006mgl^{-1} to 0.045±0.005 mgl^{-1} and 0.017± 0.008 mgl^{-1} to 0.02± 0.015 mgl^{-1} respectively. The highest Iron (Fe) concentration (1.6 mgl^{-1}) in the river water was observed in summer month i.e. May while lowest concentration was 1.40 mgl^{-1} in the month of February at S1. Maximum and minimum concentration of iron was 1.98 ± 0.20 mgl^{-1} and 1.6 ± 0.5 mgl^{-1} in the month of March and July, respectively at S2, 2.2 ± 0.005 mgl^{-1} and 1.70 ± 0.30 mgl^{-1} at S3 in March and November and 1.80 ± 0.50 and 1.50 ± 0.25 mgl^{-1} in January and August respectively at S4. Lead (Pb) concentration was 0.440 ± 0.005 mgl^{-1} to 0.59 ± 0.03 mgl^{-1}, 0.60 ± 0.005 mgl^{-1} to 0.89+ 0.25 mgl^{-1}; 0.60 ± 0.08 to 0.90± 0.25 mgl^{-1} and 0.65+ 0.08 to 0.88 ± 0.02 mgl^{-1} at S1, S2, S3 and S4 respectively. Cadmium concentration ranged from 0.002± 0.001 mgl^{-1} to 0.004 + 0.045 mgl^{-1} (S1); 0.0026+0.0002 mgl^{-1} to 0.004 ± 0.0005 mgl^{-1} (S2); 0.0038 0.0001 mgl^{-1} to 0.0048 ± 0.0005 mgl^{-1} (S3).

The average concentration of heavy metal in algal cells in presented in Table 1. The concentration of all six metals was found to be higher at Site III. The average concentration of zinc was 17.6±1.5 mg. $100g^{-1}$ insite I followed by 96.8 ± 2.12mg. $100g^{-1}$, 109.8 ± 5.8 mg. $100g^{-1}$ and 92.6± 4.5 mg.$100g^{-1}$ in 2, 3 and 4. Copper concentration in algal cells ranged from 16.2± 3.5 mg. $100g^{-1}$ (S1) 46.7± 6.8.$100g^{-1}$ (S2); 57.9±7.2 mg.$100g^{-1}$ (S3) and 52.2± 4.2 mg.$100g^{-1}$ (S4) Fe concentration in cells was found highest (49.7± 6.3 mg.$100g^{-1}$) at S3 followed by 47.1±6.5 mg.$100g^{-1}$ (S4); 43.9±2.4 mg.$100g^{-1}$ (S2) and 15.7±1.62 mg.100g-1 (S1). Pb and Cd concentrations also followed the similar trend of earlier metals with highest concentration 18.2±3.5 mg.$100g^{-1}$ and 11.2± 0.8 mg. $100g^{-1}$, respectively at S3 while the lowest concentration was 3.9 ± 1.15 mg.$100g^{-1}$ and 2.9 ± 0.56 mg.$100g^{-1}$ respectively at S1 (Table 1).

Significant number of heavy metals contaminants in aquatic environment have now been major concern for the environmentalists around the world. Many workers have studied metal load in riverine ecosystem (Say and Whittan 1982; Verma, 1990; Singh and Mishra 2007). Although riverine ecosystem desire trace elements due to extensive land – water interchange, still the major source is the direct industrial discharges into river. Maximum concentration of heavy metals at S3 is directly related to the point of sewage discharged into the river. There was an increasing trend of metal concentration in river water upto S3 and reduced at S4 in accordance with earlier findings of Drinker and Nolting (1977) who observed a gradual decrease of metallic concentration from point source of pollution to down stream in rine Rhine. All these may be attributed to industrial and domestic discharge. The highest level of metals in summer months may be due to slow and reduced water level while lower concentration in rainy season might be due to dilution as a result of rain. The concentration of heavy metals depends on organic matter content and pH of water plays an important role for their precipitation as most of heavy metals and precipitated at pH 7 (Polprasort, 1982). Whitton (1985) quoted that stream with low pH favours high concentration of heavy metal.

The level of heavy metals in algae was observed highest at S3 which correlates with the highest concentration of metals in the river water. The accumulation of heavy metals by algal population may be as a result of either absorption by metallic means or adsorption by physical and ion-exchange phenamenon. Similar observation was reported by Whilton (1985) as the higher level of metals in the environment, high the level will be in algae. Thus, the present study may establish a metal polluted food chain in riverine ecosystem. The concentration of heavy metals at more polluted site subsequently evolves the level of metals in river water and their more uptake by algae, a producer in trophic level, which may ultimately pass to planktivore fishes to higher trophic level animal and man, reveals the role of metallic pollution in the environment.

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