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A study to access heavy metal concentration in Paniyala Fish Pond near Roorkee (Haridwar)

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Abstract

Paniyala fish Pond is a multipurpose pond with emphasis on fisheries, irrigation and washing. The present study was conducted to find out the heavy metal concentrations in the fish pond. Water samples were collected on monthly basis from January, 2008 to December, 2008. Concentration of heavy metals (Copper, Nickel, Iron, Lead, Zinc, Aluminium and Arsenic) was analyzed in the pond water by Atomic Absorption Spectrophotometer. Significant variations were found between winters (December, January) and wet summer period (July, August, September) for the studied metals. The relative variability followed the order Fe >Zn>Pb>Cu>Ni>Al>As.

Keywords: *Heavy metals, Fish Pond, Heavy metal concentration.*

Introduction

Lakes and ponds are habitats of great human importance as they provide water for domestic, industrial and agricultural use as well as providing food. In spite of their fundamental importance to humans, freshwater systems have been severely affected by a multitude of anthropogenic disturbances, which have led to serious negative effects on the structure and function of these ecosystems. The pollution of the aquatic environment with heavy metals has become a worldwide problem during recent years because they are indestructible and most of them have toxic effects on organisms (MacFarlane and Burchett, 2000). Heavy metals are introduced to the environment through a variety of sources such as combustion, extraction, agricultural runoff, transportation *etc* (Lars, 2003). Besides, the dangers involved from the presence of metals in the environment derive not only from their persistence and toxicity, but also from the remarkable degree of bioaccumulation they undergo through the trophic chain, thus becoming serious danger to man (Bishop, 2000). Heavy metal contamination in aquatic environment exerts an extra stress on fish which tend to accumulate the heavy metals in metabolically active tissues and organs (Langston, 1989).

The problem of chemical contamination in water bodies like nitrate, sulphate, iron, manganese, zinc and copper may cause several health problems to human beings. Their compounds are destroyed in the water body, that is how heavy metals are referred to conservation substances toxic for hydrobionts and man (Natalia *et al.*, 1997).

Virtually all metals, including the essential metal micronutrients, are toxic if exposure levels are sufficient high. The increased circulation of toxic metals in recent times resulted in the unavoidable build up of such toxic substances in the human food chain. Since heavy metals are rapidly absorbed to particulate materials (*e.g.* detritus, plankton, suspended sediments) and assimilated by living organisms. Heavy metals, especially copper, nickel, lead and zinc, have adverse effects on terrestrial and in aquatic environments. However, their impact can vary depending on the nature of organisms (Clark, 1997; Seidl *et al.* 1998). Although heavy

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metal concentration remains within the permissible limit but regular immersion activity may increase the concentration of heavy metallic ions in the pond water, which may ultimately cause serious health hazards in human beings when get accumulated through food chain.

Materials and Method

Detection of heavy metals in pond water was done following the standard methods of APHA (1998). The surface water samples were collected at four sampling sites for one year period in the Paniyala State Fish Pond. The determination of heavy metals in the water samples was done by the Atomic Absorption Spectrophotometer (AAS). Using the appropriate element, hollow-cathode lamp, monochrometer was set at the selected wavelength. Standard solutions of the different elements of interest were prepared separately. The instrument was zeroed with distilled deionized water. The water samples for this analysis were subjected to acid digestion and subsequently different mineral elements were determined using appropriate methods.

Results and Discussion

Although, these trace metals differ widely in their chemical properties, their relative concentrations and discharges and hence, their bioavailability are very important to terrestrial, aquatic and marine organisms in terms of toxicity (Alloway and Ayres, 1997). The main health risks due to Arsenic are considered to be severe poisoning and carcinogenicity, specially cancer of respiratory system and gastrointestinal tract. During the study time in the water sample of Paniyala pond, Copper, Nickel, Iron, Lead, Zinc and Aluminium were detected while Arsenic was found below detection limit (Table- 2 and Fig. 1-6).

Copper is malleable, ductile metal, and is an excellent conductor of heat and electricity. Adraino (2001) reported that copper toxicity in humans is rare, aquatic organisms are potentially at risk from Cu exposure. During the study Copper concentration was found maximum 0.0058 mg/l in November and minimum value 0.0022 mg/l was found in January. The range obtained was under the WHO permissible limit which is 0.05 mg/l. Zinc has been known for a very long time; it was used in alloys since the 7th century in India and in the 11th century in China. Zn is an essential macronutrient for plants but is phototoxic when in excess (Muvanga and Barifaijo, 2006). Zn was maximum 0.0386 mg/l in September and minimum 0.0270 mg/l was present in June and July, and the observed values were under the WHO permissible limit (5.00mg/l).

Metal	Drinking Water (mg/l)
Aluminium	0.2
Arsenic	0.05
Copper	0.05
Iron	0.30
Lead	0.05
Nickel	-
Zinc	5.00

Table-1: Maximum Permissible limit for Heavy Metals (WHO,2006)

Cronstedt discovered nickel in 1751; its name is derived from the Swedish *kopparnickel* (Goblin Copper) Nickel is a hard, malleable, ductile metal, crystallizing in the face-centred cubic system. The metal is produced by roasting the sulphide ores and reducing the oxide with carbon; it is purified by electrolysis (Adriano, 1986). Nickel salts significantly increase the level of lipid peroxidation and simultaneously decrease glutathione level and glutathione peroxidase activity in the liver (Das *et al.*, 2001). Nickel concentration was maximum 0.0036 mg/l in June and July and minimum 0.0017 mg/l in the month of December. It is estimated that 8% of nickel is used for household appliances (IPCS, 1991). Aluminium was observed maximum 0.0027 mg/l and minimum 0.0010 mg/l in the month of June and January respectively during the study period. For Aluminum the permissible limit of WHO is 0.2 mg/l. The main effects of aluminum exposure in fishes are respiratory and ion regulatory disturbances (Neville, 1985; Gensemer and Playle, 1999). Lead has been known since ancient times. Often, it is one of the most widely used metals in industry: in piping, conducting materials, accumulators, lead chambers, printing characters, soldering, anti-knock substances and coloured pigments. Bowen (1966) explained that lead is not essential as a trace metal to nutrition in animals, but is a cumulative poison. In study period maximum concentration of Lead was found in September 0.0075 mg/l and minimum 0.0016 mg/l in March. The observed values were under the permissible limit WHO which is 0.05 mg/l.

Table-2: Monthly average concentration of Heavy Metals of the water of Paniyala Fish Pond

Month	Copper (mg/l)	Nickel (mg/l)	Iron (mg/l)	Lead (mg/l)	Zinc (mg/l)	Aluminium (mg/l)	Arsenic (mg/l)
January	0.0022	0.0018	5.2621	0.0026	0.0340	0.0010	BDL
February	0.0024	0.0021	5.1797	0.0019	0.0340	0.0013	BDL
March	0.0025	0.0023	5.2769	0.0016	0.0314	0.0013	BDL
April	0.0027	0.0030	5.3267	0.0019	0.0336	0.0021	BDL
May	0.0027	0.0033	5.2959	0.0021	0.0336	0.0025	BDL
June	0.0028	0.0036	5.3202	0.0033	0.0270	0.0027	BDL
July	0.0035	0.0036	5.6055	0.0041	0.0270	0.0020	BDL
August	0.0035	0.0027	5.6410	0.0061	0.0323	0.0015	BDL
September	0.0054	0.0025	5.6309	0.0075	0.0386	0.0014	BDL
October	0.0053	0.0022	5.6219	0.0067	0.0351	0.0016	BDL
November	0.0058	0.0019	5.6128	0.0056	0.0353	0.0013	BDL
December	0.0043	0.0017	5.2570	0.0052	0.0327	0.0012	BDL
Average±SD	0.0036 ±0.0013	0.0026 ±0.0006	5.4192 ±0.1832	0.0040 ±0.0021	0.0329 ±0.0032	0.0016 ±0.0005	

±SD- Standard Deviation; BDL-(Below Detection Limit)

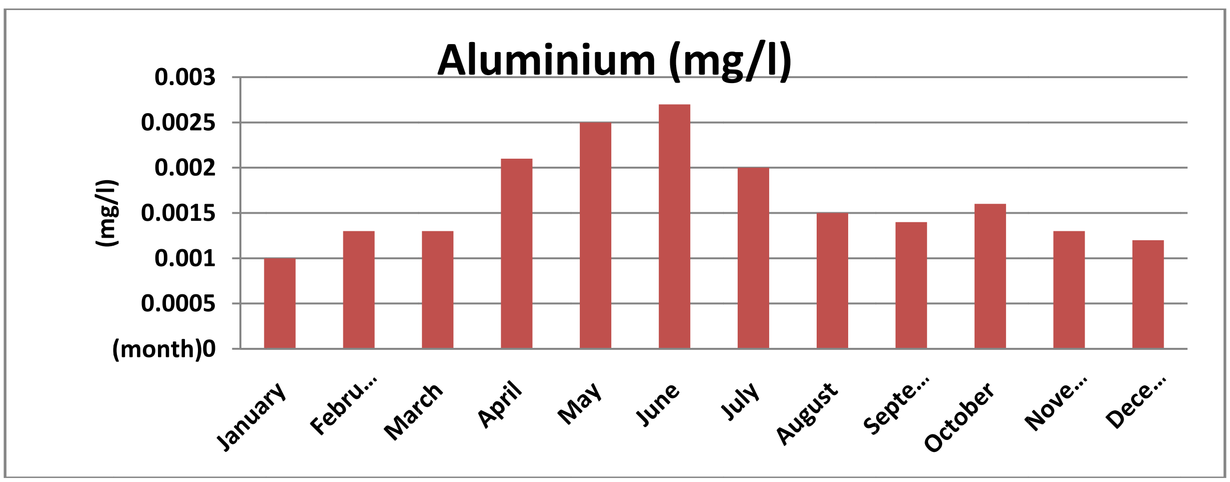

Fig.1:Showing monthly fluctuation of Aluminum in Paniyala Fish Pond in 2008.

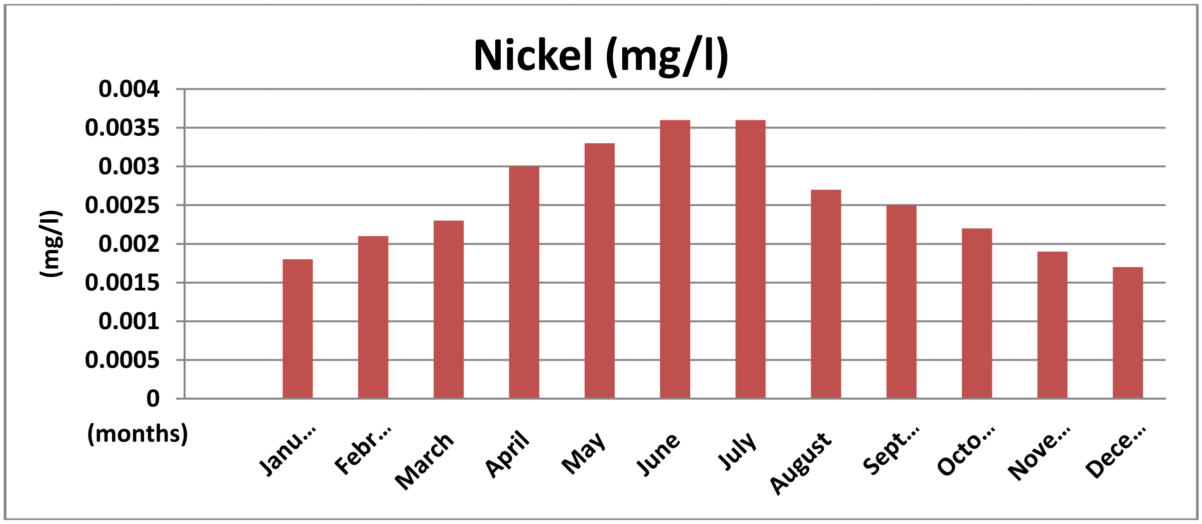

Fig. 2: Showing monthly fluctuation of Nickel in Paniyala Fish Pond in 2008.

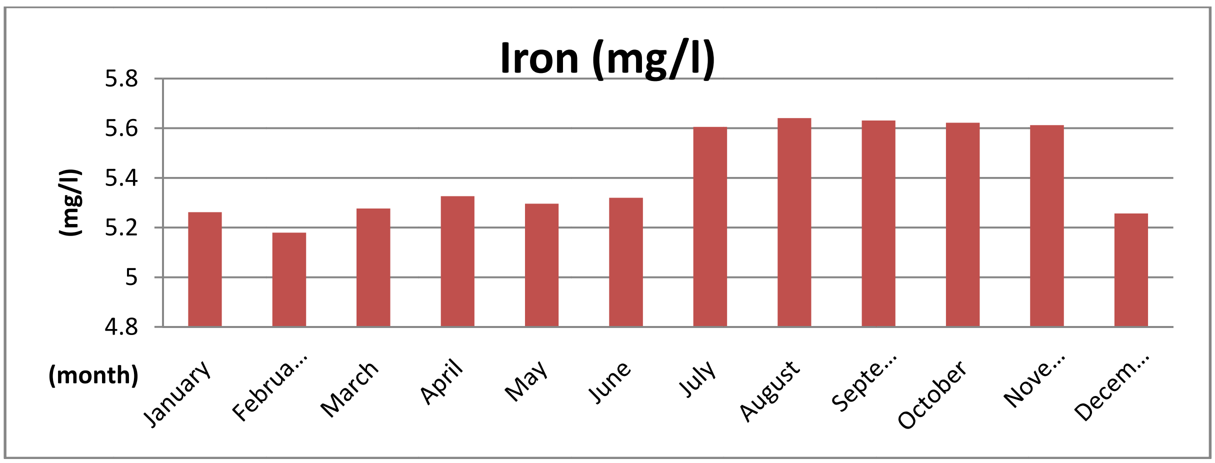

Fig. 3:Showing monthly fluctuation of Iron in Paniyala Fish Pond in 2008.

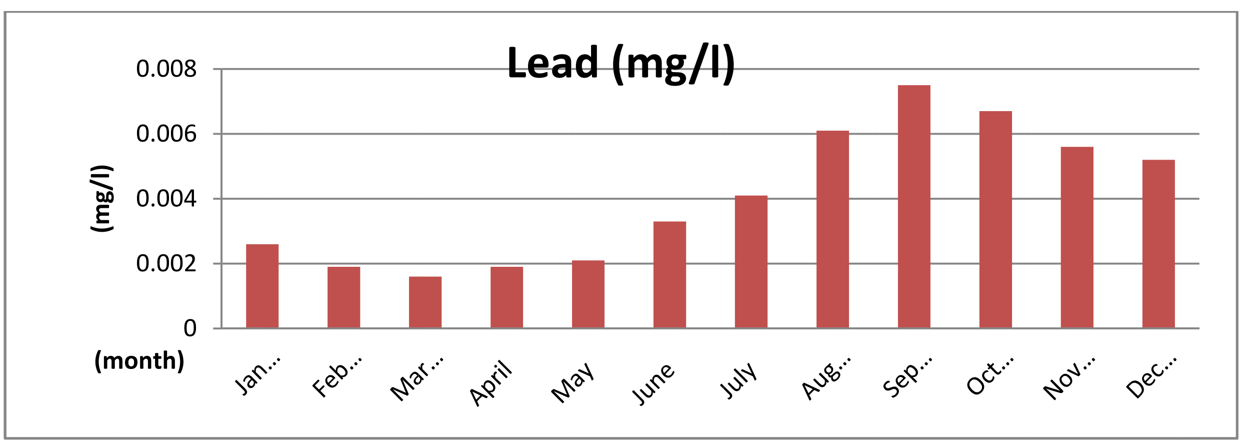

Fig. 4: Showing monthly fluctuation of Lead in Paniyala Fish Pond in 2008.

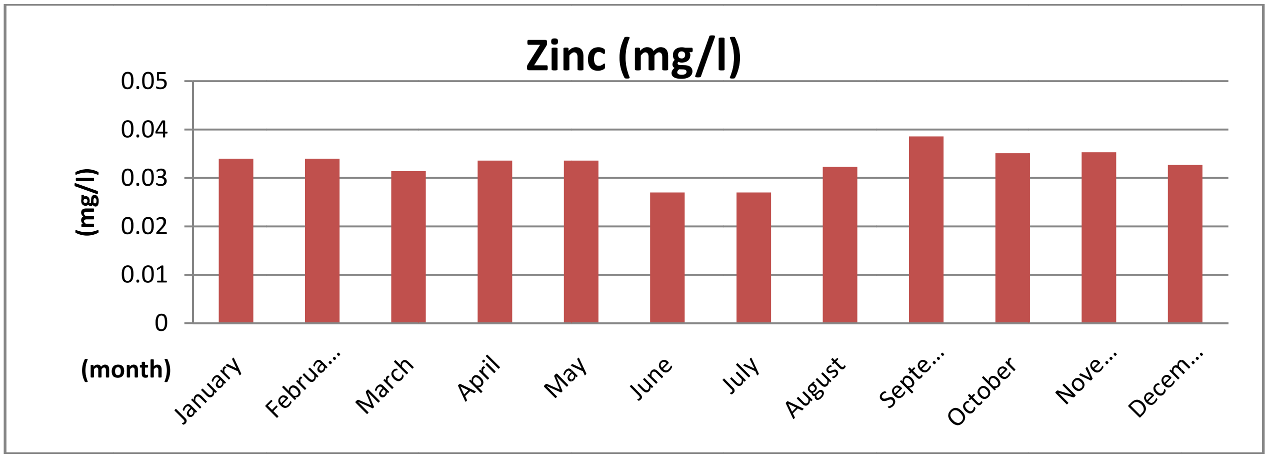

Fig. 5: Showing monthly fluctuation of Zinc in Paniyala Fish Pond in 2008.

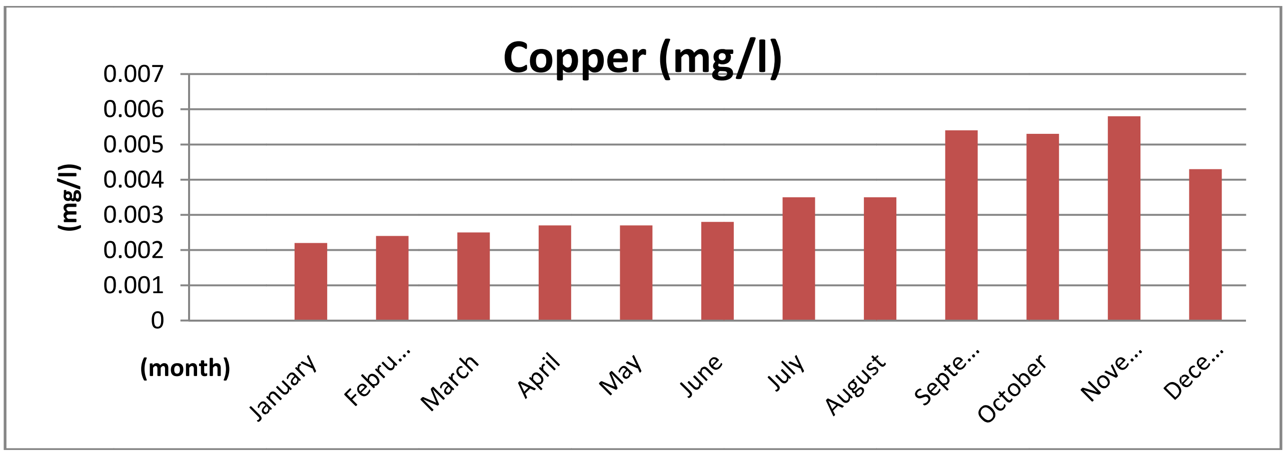

Fig. 6 : Showing monthly fluctuation of Copper in Paniyala Fish Pond in 2008.

Water containing iron does not show deleterious effect on human health, its presence in drinking water is objectionable for various reasons. Iron is moderately toxic to many species of aquatic plant, above permissible limit. Excessive iron content makes the water turbid, discoloured and imparts an astringent taste to water. As per the standards set by WHO, the permissible level of iron is 0.3 mg/l. Iron concentration was maximum 5.6410 mg/l in August month and minimum 5.1797 mg/l was present in February month. This observation is similar to Adefemi *et al.*, (2008) who studied heavy metal concentration in Ureje dam in south-western Nigeria.

The maximum values in summer months was may be due to the discharge of huge amount of domestic sewage and agricultural runoff from surroundings in to the pond. The solubility of trace metals in surface water is predominantly controlled by the water temperature (Iwashita and Shimamura, 2003). At a higher temperature, plants grow and die faster, leaving behind matter that requires oxygen for decomposition. Trace elements where are accumulated to phytoplankton may become soluble during the decay of plants (Pendias and Pendias, 1992). Except for iron and zinc, the concentrations of the other heavy metals were relatively low. The result shows that only Iron in pond water exceed the WHO permissible level and Copper, Nickel, Lead, Zinc and Aluminium does not exceed the WHO permissible limits, while Arsenic was found below detectable limit.

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