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Original Research Paper

Assessing the Bioaccumulation of Heavy Metal in Freshwater Fishes at Gingee River Near Puducherry, India

K. Tirupurasundary and D. Ramamoorthy
Deptt. of Ecology and Environmental Sciences, Pondicherry University, Puducherry-605 014, India

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ABSTRACT

An investigation was made on the bioaccumulation of heavy metals, mercury (Hg), zinc (Zn) and copper (Cu) in fishes of the Gingee river at Vadamangalam and Ariankuppam in Puducherry region. Results revealed that the concentration of the heavy metals was higher in sediments than that of water. There is also seasonal variation in heavy metal concentrations at the sites. Fishes of the river showed bioaccumulation of heavy metals. The concentration of metals was found in the order as sediment > fishes > water.

INTRODUCTION

India is one of the major fish producing countries in the world, ranking ninth among all the nations with cultivable freshwater and brackish water resources offering tremendous scope for establishing the aquaculture as a prime industry (Sukumaran 2001). There is a growing global concern over the toxicological hazards caused by industrial effluents to man, livestock and environment, especially during the last three decades. In recent years, most of the aquatic systems are under severe threat of pollution due to increasing industrialization, urbanization and other developmental activities (Das & Joshi 1992).

Fish is an indicator organism for heavy metal pollution of water and it becomes possibly unfit for human consumption. Fish is the end consumer in the aquatic food chain and, thus, is useful as an indicator enrichment of heavy metal. The study of fish muscle is one of the means for investigating the amount of heavy metals entering the human by food chain enrichment and has, therefore, been investigated more than other organs (Brown & Chow 1974).

In 2003, the total world production of fisheries product was 132.2-million tons of which aquaculture contributed 41.9-million tons or about 31% of the total world production. The growth rate of world-wide aquaculture is very rapid (> 10% per year for most species) while the contribution to the total from wild fisheries has been essentially flat for the last decade (Piedrahita 2003).

The concentration of heavy metals such as Mn, Hg, Cu and Zn is rich in the experimental area. The factors influencing the physiology of an organism, such as salinity and temperature also alter the heavy metals of organisms (Agarwal & Gautam 1995). Main objectives of this study were to assess the accumulation of heavy metals (mercury, zinc and manganese) in various species of fishes, water, and sediment in post-monsoon and pre-summer seasons.

MATERIALS AND METHODS

Puducherry region lies on the Coromandel coast between 11°372’ and 12°302’ north latitude and

79°372' and 79°532' east longitudes. The boundary of the region was encircled by the three side lands of south district and eastern side by the Bay of Bengal and on the other three sides by the Cuddalore district of Tamilnadu State. The boundary of the region is encircled by the three side lands of south Arcot district and eastern side by the Bay of Bengal. The physiographic map of the district presents more or less a flat land. There are no hills or forests in this district. The main soil types met with in this district are red ferrallitic black clayey and coastal alluvial. There are 2 main drainage basins, the Gingee river, which crosses diagonally from northwest to the southeast, and the other, Pennaiyar, which forms the southern border of the district. Puducherry attracts a large number of tourists visiting India.

Experimental sites were located in different parts of Gingee river. Industrial effluents are mixed into the river. There were two sites from Vadamangalam, site-1, and Ariankuppam, site-2 in both of which, heavy metal contaminations such as of mercury, copper, zinc and iron are present. On the north-west part of the Puducherry region, Vadamangalam is one of the selected areas. Most of the small and large-scale factories were constructed by private Organizations at vadamangalam. From here, the manufacturing of chemicals such as hydrochloric acid, plastics, soap, oil, paper, cosmetics, batteries etc. discharge their wasteswaters since the river is very close to these factories.

On the southern side of Puducherry, Ariankuppam is the other selected study area. In this area, river water intermixes with salt water. The samples of water, sediment and fishes were brought to the Department of Agriculture and Environmental Monitoring System at Auroville, Puducherry for getting tested. Atomic Absorption Spectrometer (AAS) model 220-varian was used to test the samples for heavy metals. Sample preparation for determination of heavy metals such as Pb, Zn, Cu, Fe and Mn was done after digestion of sediment samples. Digestion of fish samples, standardization, analysis of samples and calculation accurately completed.

RESULTS AND DISCUSSION

The concentration of heavy metal mercury was indicated as the highest in both the seasons (December 2003 and March 2004) in the muscle of *Mystus aor* (1. 868 and 1. 703 ppb), followed by *Tilapia mossambica* (1.637 and 1.713 ppb), *Ophiocephalus gachuva* (0.982 and 1.086 ppb), *Ophiocephalus striatus* (1.261 and 1.086 ppb) and *Borus puntius* (0.862 and 0.613 ppb). These findings are in conformity with the investigations of Forstner & Wittman (1983) who found that the average was 88.9% of the total mercury in fish musculature in Ariankuppam and Vadamangalam (Table 1).

The concentration of mercury, copper, zinc and manganese in the water samples of the study area I and II (Vadamangalam and Ariankuppam) recorded higher concentrations during post-monsoon period (December 2003) than the pre-summer period (March 2004). The concentration of mercury, copper, zinc and manganese in the water samples of the study area showed higher concentrations during post-monsoon period (December 2003) than the pre-summer (March 2004) because the heavy metal concentration correlated well with the summer amount of solid discharged.

The results recorded that the accumulation of heavy metals in various species of fishes is dependent upon their occurrence in water and sediments indicating the existence of localized pollution. Various processes, repeatedly mobilized through the biological chain in freshwater ecosystems in which fishes are large carnivores at the end of food chain, made heavy metals to reach humans and possibly in different species of fishes. The concentration of metals was found in the order as sediment > fishes > water.

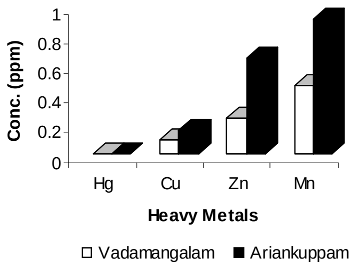

Fig. 1: Mean concentrations (ppm) of selected heavy metals in river, water collected from both the areas.

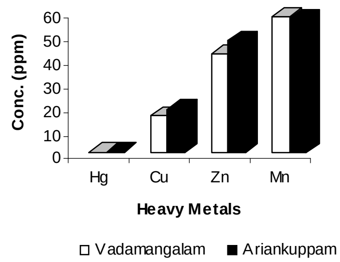

Fig. 2: Mean concentrations (ppm) of selected heavy metals in sediments collected from both the areas.

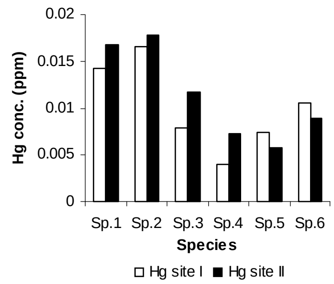

Fig. 3: Mean concentration of Hg in two sites.

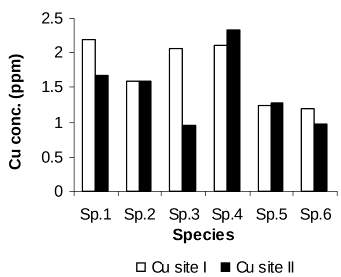

Fig. 4: Mean concentration of Cu in two sites.

Fig. 5: Mean concentration of Zn in two sites.

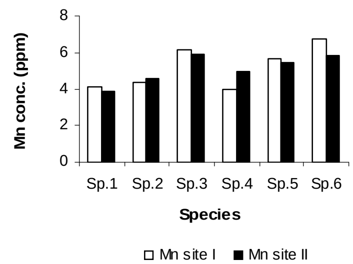

Fig. 6: Mean concentration of Mn in two sites.

The concentration of heavy metals such as Mg, Cu, Zn, and Mn showed variations (Fig. 1 and Fig. 2) in different species and in different seasons. The heavy metal concentration was recorded at higher level during post-monsoon than summer. The maximum concentration of mercury (Fig. 3) was identified at both the seasons in the muscles of *Mystus aor* followed by *Tilapia mossambica, Ophiocephalus gachuva, Ophiocephalus striatus, Etruplus muculatus* and *Barbus puntius.* The highest concentration of Cu (Fig. 4) was recorded in both the seasons in the muscle of *Tilapia mossambica.* The highest concentration of zinc (Fig. 5) was found in both seasons in the muscles of *Mystus aor* and the maximum concentration of Mn (Fig. 6) recorded in both the seasons in the muscles of *Ophiocephalus gachuva.*

The mean concentration of heavy metals in water and sediments samples of both the study areas recorded higher concentration during post-monsoon on December 2003 than pre-summer of March 2004, since the heavy metal concentration was well associated with the removal of discharging materials.

CONCLUSION

Heavy metal pollution is likely to reach disturbing levels in Puducherry region due to industrialization and urbanization. Most industries discharge effluents into the environment without prior precautionary action. Therefore, hazardous effluents of the factories established in the undisturbed place and monitored. Regular attention is necessary to keep clean the environment to all respects. It is essential to concentrate on key indicator organisms such as top carnivore fish or mammals.

Table 1: Mean seasonal concentrations of selected heavy metals in some freshwater fishes from the study area.

Species	Seasons	Hg (ppb)	Cu (ppm)	Zn (ppm)	Mn (ppm)
		Ariankuppam			
Tilapia mossambica	Post-Monsoon	1.631	1.786	3.612	3.908
	Pre-Summer	1.713	1.58	3.193	3.812
Mystus aor	Post-Monsoon	1.868	1.608	6.193	4.597
	Pre-Summer	1.703	1.593	6.226	4.601
Ophiocephalus striatus	Post-Monsoon	1.261	0.812	4.671	5.972
	Pre-Summer	1.086	1.108	4.608	5.896
Barbus puntius	Post-Monsoon	0.862	2.612	5.576	4.971
	Pre-Summer	0.613	2.064	5.489	5.002
Etruplus muculatus	Post-Monsoon	0.67	1.286	3.901	5.301
	Pre-Summer	0.492	1.261	3.896	5.567
Ophiocephalus gachuva	Post-Monsoon	0.982	1.087	3.886	5.982
~	Pre-Summer	0.786	0.87	3.802	5.614
		Vadamangalam			
Tilapia mossambica	Post-Monsoon	1.482	2.121	3.405	4.126
	Pre-Summer	1.361	2.262	3.046	4.082
Mystus aor	Post-Monsoon	1.701	1.602	6.529	4.637
	Pre-Summer	1.672	1.583	6.138	4.108
Ophiocephalus striatus	Post-Monsoon	0.852	2.258	4.516	6.164
	Pre-Summer	0.716	1.873	4.487	6.076
Barbus puntius	Post-Monsoon	0.483	2.116	5.684	4.108
	Pre-Summer	0.328	2.108	5.601	3.816
Etruplus muculatus	Post-Monsoon	0.766	1.261	3.876	5.674
	Pre-Summer	0.712	1.212	3.782	5.621
Ophiocephalus gachuva	Post-Monsoon	1.087	1.27	4.364	6.801
~	Pre-Summer	1.016	1.118	3.986	6.678

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