

Heavy Metal Accumulation in Brain of Fishes Consequent to River Pollution

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Abstract: Periyar, one of the major rivers of Kerala state passes through the highly polluted industrial area, Eloor and Chitrapuzha region. Heavy metal pollution is one of the major problems of the water pollution in this region. Heavy metals are vigorous oxidizing agents and thus are highly bound to biochemical inability of tissues and thus affect fishes.

The main objective of the study was to check whether the heavy metals have targeted the most vitally protected tissue – the brain and to analyse the increasing tendency of heavy metal accumulation with age in fishes. The study area includes the highly polluted Eloor and Chitraphuzha area, nearly 11 kms away from Kochi.

The Fish, *Gobius malabaricus*, belonging to the family *Gobiidae* were collected, weighed and grouped. Fishes were dissected for brain tissue, weighed, homogenized and heavy metals were detected using ICPAES (Inductively coupled plasma atomic emission spectrophotometer). The study showed heavy metal accumulation in the order Copper \geq Manganese \geq Zinc (0.55 ppm). Cadmium and Chromium were found below detection limit. The greatest accumulation of heavy metals was found in the brain of older fishes. Accumulation of heavy metals even in the brain of fishes, thus, indicates the extent of heavy metal pollution in the industrial area.

Key words: Heavy metal, brain, *Gobius malabaricus*.

Introduction

Kerala, with an inimitable physiography, monsoon climate, variable land use pattern, is endowed with highly diverse and plentiful bounty of aquatic habitats. The river Periyar, the longest river of the state (PWD, 1974; Chacko et al., 1953) is considered to be the lifeline of central Kerala.

Among the different rivers flowing in Kerala, Periyar too has been performing a pivotal role in shaping the economic prospects of Kerala, as it helps in power generation, domestic water supply, irrigation, tourism, industrial production, collection of various inorganic resources and fisheries. However, as in the case of many

other inland water bodies, river Periyar too is gradually undergoing eco-degradation throughout its course due to various anthropogenic stresses, which includes indiscriminate deforestation, domestic – agricultural – industrial water pollution, excessive exploitation of resources, large scale sand mining various interference in the flow of water, etc. Most of the industries and power plants are located on the banks of rivers or estuaries because of enormous amount of water they require for cooling.

Heavy metals include transitional metals and metal-loids. Metals like chromium, cadmium, copper, zinc, cobalt, nickel, mercury, lead, arsenic, etc., are included under this category. Mercury, lead, zinc and copper are

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the most toxic heavy metallic pollutants among the above metals. The seriousness of heavy metal contamination is further compounded by the fact that they are generally soluble in water, non-degradable, vigorous oxidising agents are strongly bounded to biochemical inability by their function (Lakshman Nayak, 1993).

The five heavy metals taken for the study include cadmium, chromium, copper, manganese and zinc. The study checks whether these heavy metals had targeted even the most vitally protected tissue like brain and the increasing tendency of heavy metals accumulation with the weight of the fish thus with age.

Materials and Methods

Study Area

Study area includes Eloor, about 20 kms from where the river Periyar meets the Arabian Sea and Chithrapuzha, one of the tributaries of Periyar river and nearly 11 kms away from Kochi.

Heavy Metal Determination

Brain from fish *Gobius malabaricus* belonging to the family *Gobiidae* was selected for the study, of three different sizes and weight of 10 gm, 60 gm, 110 gm were collected from Eloor and Chithrapuzha region. The brain tissue was dissected, weighed and homogenised by adding 5 ml of concentrated HNO_3 and 2 ml of perchloric acid to get a yellow coloured solution containing organic matter and certain suspended particles. This was then heated for 5–10 minutes to get a clear yellow coloured solution by removing organic matter, and filtered using Whatman filter paper. The filtrate was subjected to heavy metal analysis using ICPAES at CUSAT Sophisticated test and instrumentation centre (STIC).

Statistical Analysis

Data was statistically analysed by student 't' test to see the level of significance.

Results and Discussion

Fishes apparently can accumulate metals either directly from the water or directly through food chain. Since they form complexes with organic substances they have a tendency to be fixed in the tissue and not to be excreted (Nammalwar, 1983). The concentration of heavy metals, such as cadmium and chromium were found below detection limit (BDL) in both study sites. Other metals such as copper, manganese and zinc showed difference in accumulation in both sites with increase in the weight of fish (Table 1 and Figure 1).

In the present study increased accumulation of heavy metals with increased age is noticed. Among the four metals copper showed the highest degree of increase and the order of accumulation is $\text{Mn} > \text{Zn}$. These were similar in both the sets of fishes. But this accumulation may not be true for all species of fish (Honda et al., 1986). The present study reveals that the accumulation of heavy metal in brain tissue is greatly related to the weight of fish. Size of the fish may thus be an important factor in heavy metal accumulation of aquatic animals (Canali and Furness, 1993a and 1993b) as in the present study.

It has shown that the target tissues of heavy metals are metabolically active ones, like that of liver, kidney and gill. Metal accumulation in these tissues occur in higher levels compared to some other tissue like the muscle, where metabolic activity is relatively low (Heath, 1987; Langston, 1990; Serra et al., 1993; Roesijadi and Robinson, 1994; Canali et al., 1998). In the present study the brain also shows greater accumulation of heavy metals as in the case of other metabolically active tissue. Brain being a vital organ controlling the whole body activities, accumulation of heavy metals in the tissue should be taken as a serious pollution problem.

Padmalal and Seralthan (1993), proved that the heavy metals like Cd, Cr, Cu, Mn, Zn were found in increased level in the water of the pollution hit areas of Periyar

Table 1: Mean concentration of heavy metal in the brain of fishes in the Eloor (EL) and Chithrapuzha (CH) region

Heavy metal	Heavy metal concentration in ppm according to body weight (Mean \pm standard deviation)					
	EL			CH		
	10gm	60gm	110gm	10gm	60gm	110gm
Cadmium (Cd)	BDL	BDL	BDL	BDL	BDL	BDL
Chromium(Cr)	BDL	BDL	BDL	BDL	BDL	BDL
Copper (Cu)	0.97 \pm 0.45	1.93 \pm .10	3.1 \pm 0.21	0.76 \pm 0.01	0.93 \pm 0.02	1.5 \pm 0.16
Manganese(Mn)	0.34 \pm 0.3	0.44 \pm 0.02	0.62 \pm 0.2	0.16 \pm 0.06	0.22 \pm 0.03	0.32 \pm 0.01
Zinc(Zn)	0.16 \pm 0.01	0.26 \pm 0.04	0.55 \pm 0.16	0.22 \pm 0.02	0.24 \pm 0.04	0.31 \pm 0.05

BDL – below detection limit.

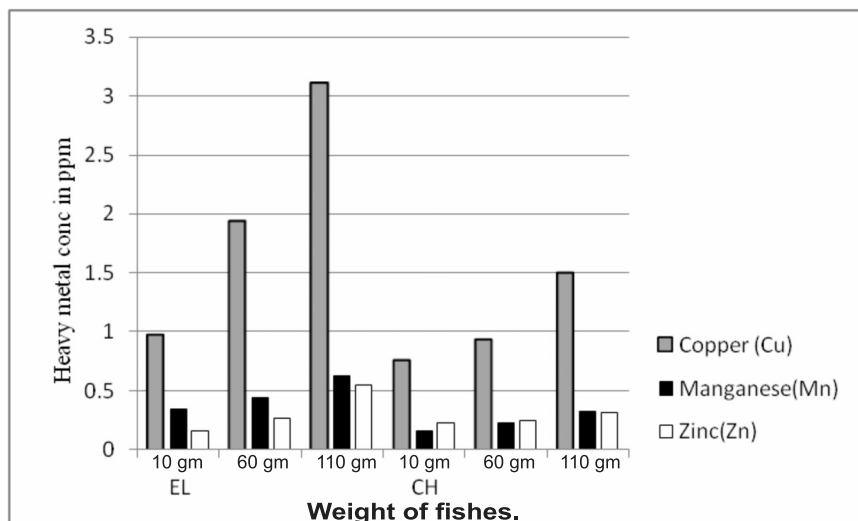


Figure 1: The mean concentration of heavy metal in the brain of fishes in the Eloor (EL) and Chitrapuzha (CH) region.

river. The present study showed the effects of heavy metal contamination in many aquatic forms. Among these the endemic fishes were proved by the studies of Arun (1998). Heavy metal accumulation in various fishes in the Periyar have been studied by Paul and Pillai (1976). The Periyar river and its estuarine area show a maximum heavy metal contamination (Paul, 2001).

Wittman (1963), in his work proved that the metals are a serious threat to aquatic ecosystem because of their properties and potential for bioaccumulation which is similar to the present work. Among the heavy metals Cu is identified as the most bioaccumulative metal in the brain tissue whereas Cd and Cr was found BDL due to low accumulation in the effluents. Moreover, the increased heavy metal concentration even in the brain shows the intensity of pollution in the river Periyar.

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