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Heavy metals accumulation in the water and tissues of heteropneustes fossilis collected From polluted elenga beel, morigaon, Assam

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ABSTRACT: The role of metals in environmental pollution has been recognized and gaining significance in recent years. Many of such metals occur naturally in the environment and in trace amounts are essential to the normal metabolism of aquatic life. Although, some heavy metals are physiologically essential elements and are also known to be toxic to aquatic organisms when its concentration higher. There is a fast increase in the level of metals in the environment due to human intensive activities. However, effluents from paper industries, agriculture base wastes, etc. have elevated the natural level of heavy metals in the aquatic environment. Elenga beel receives heavy amount of effluent from Nagaon Paper Mill, located at Jagiroad, Morigaon district, Assam. Hence, the accumulation of heavy metals including Cadmium, chromium, Copper, Zinc and Lead (mg/l) in polluted Elenga beel water and in gill, liver and muscle tissues of H. fossilis were investigated. Elenga beel water showed higher concentration of all the selected heavy metals (Zinc > Copper > Lead > Chromium > Cadmium). The tissues of H. fossils collected from Elenga beel showed greater concentrations of most of the studied heavy metals. The maximum mean values of the measured metals Cadmium (0.305±0.101µg/g), Chromium (0.295±0.193µg/g), Copper (0.413±0.372µg/g), lead (0.721±0.398µg/g) and Zinc (0.822±0.386µg/g) in gill tissues; Cadmium (0.352±0.256µg/g), Chromium (0.497±0.192µg/g), Copper (1.026±0.041µg/g), Lead (1.025±0.015µg/g) and Zinc (1.387±0.113µg/g) in liver tissues and Cadmium (0.327±0.049µg/g), Chromium (0.413±0.311µg/g), Copper (0.677±0.464µg/g), Lead (0.462±0.094µg/g) and Zinc (0.731±0.144µg/g) in muscle tissues were recorded. Cadmium, chromium, Copper, lead and Zinc recorded levels were above the international permissible limits (USEPA). Gills and Liver of H. fossilis recorded the highest concentration of selected heavy metals than the muscles tissues. The edible parts of H. fossilis caught from polluted Elenga beel may pose health hazards for consumers.

KEY WORDS: **Heavy metals, Accumulation, Elenga beel, Water, Tissues, *H. fossilis.***

I. INTRODUCTION

Pollution of aquatic environment by heavy metals (HMs) is a major factor for posing serious threat to the survival of aquatic organisms including fish. Industrial activities are responsible for heavy metal concentration in polluted areas and these HMs are the potential source of contamination of aquatic environment [40,2,19,30,23]. Studies on water quality are highly important as this water is liable for direct consumption by animals and human population. Disposal of HMs or other toxicants in water may appreciably alter the physico-chemical properties of water. The aquatic environment and its water quality are considered the main factor controlling the state of health and disease in both cultured and wild fishes. Pollution of HMs in aquatic ecosystem may cause devastating effects on the ecological balance of the recipient environment and its diversity of aquatic organisms [4,8,39]. Fish occupies higher level in the food chain and is an important source of protein food for human beings. The HMs are transferred through the food chain in to human beings. Some HMs are harmful to fish consumers [36]. Until 1995, Elenga beel has always contributed more than 7% of the district's total fish production, but at present the fish production has decreased to less than 1%. In addition, large parts of the beel are overgrown with aquatic vegetation which reduces the open water to nearly 80% of its total area. The most anthropogenic sources of HMs are industrial effluents, petroleum contamination and sewage disposal [20,26]. Bio-accumulation of HMs in freshwater life and the pollution potentiality caused by industrial effluent is least studied in North Eastern Region of India. With this view in mind, this study is proposed to find out the accumulation of certain HMs like Cadmium (Cd), chromium (Cr), Copper(Cu), Zinc (Zn) and Lead (Pb) in Elenga beel water and in the tissues (gill, liver, muscle) of *H. fossilis* collected from polluted Elenga beel.

II. MATERIALS AND METHODS

A) Water sample collection

The study area, Elenga beel is a natural wetland located in Jagoroan, Morigaon district, Assam. The water samples were collected from five sites of Elenga beel for measuring HMs. Water samples which were taken from three different

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sites by a PVC tube column sampler at depth of half meter from the water surface. The samples at each station were mixed in a plastic bucket and a sample of 1 liter was placed in a polyethylene bottle, kept refrigerated and transferred cold to the laboratory for analysis following standard methodology [28]. The results were expresses as mg/l for beel water.

B) Tissue sample collection

A total of 20 fishes (*H. fossilis)* were collected from Elenga beel, ranging between 80-90 g in weight and 15-18 cm in length were collected with the help of fishermen. Then fishes were brought to the laboratory, dissected out and cleaned the tissues with sterilized instruments. Tissues such as gill, liver and muscles were then digested with HNO_3 and $HClO_4$ in 2:1 ratio on a hot plate set at 130^0 until all materials were dissolved. Digested samples were diluted with double distilled water and tissues were extracted [3]. Atomic Absorption Spectrophotometer was used to detect the heavy metals. The concentrations of heavy metals were expressed as µg/g dry wt. for fish tissues.

C) Statistical analysis

Mean and Standard Deviation were used to evaluate the significant difference in the concentration of different studied HMs. Standard Deviations were also determined following standard methodology [5].

III. RESULTS AND DISCUSSIONS

A) Heavy metals in Elenga beel water

HMs enters in to the water bodies through discharges of industrial or agricultural wastes. Na, K, Ca, Mg, Fe, Mn, Al, Cu and Zn are the common nontoxic metals found in water. Metals which are toxic even a minute quantities include As, Ba, Cd, Cr, Pb, Hg and Ag. These metals are concentrated in the food chain and therefore, are very essential. The concentration of Cd lies in between 0.005mg/l and 0.142mg/l, Cr in between 0.051 mg/l and 0.113mg/l, Cu in between 0.954mg/l and 4.01mg/l, Pb is in between 0.011mg/l and 0.211mg/l and Zn is in between 5.004mg/l and 7.25mg/l. In the present study, metal concentrations in water were detected in the order of Zn > Cu > Pb > Cr > Cd are above the permissible limit of WHO (1992) in Elenga beel water (Table-1). This may be attributed to the abundance of these metals due to the presence of HMs in Elenga beel water. HMs accumulation in water, sediments and in aquatic organisms are remarkably inter-related [1,16,17,32,25].

It is evident that the investigated values of all the studied metals are higher than that of permissible limits of WHO (1992). The permissible limit of Cu in water is 2.0 mg/l and hence Cu is toxic for consumption as far as Elenga beel water is concerned. Prolonged intake of Cu is injurious to the liver [19]. Zn is present in substantial amounts in Elenga beel water. Zn is essential and beneficial for metabolic activities but excessive amounts have a toxic effect and may be created anemia like conditions [35]. The maximum permissible limit of Zn for water is 5.0 mg/l. Excessive Cd in drinking water is the cause of dreaded diseases. Cd content was also higher than the permissible limit in Elenga beel water. The safety limits for Cd is 0.003 mg/l for domestic water.

Table-1: Mean ± SD of five replicates, HMs (mg/l) in polluted Elenga beel water

Heavy Metals	WHO,1992	Polluted Elenga beel water		
		Site-I	Site-II	Site-III
Cd (µg/g)	0.003	0.005-0.042 0.015±0.014	0.007-0.082 0.024±0.032	0.015-0.142 0.041±0.051
Cr (µg/g)	0.05	0.07-0.17 0.074±0.044	0.051-0.067 0.059±0.006	0.055-0.113 0.057±0.021
Cu (µg/g)	2.0	2.11-4.01 2.78±0.772	1.791-2.205 2.031±0.157	0.954-2.367 2.096±0.229
Pb (µg/g)	0.01	0.017-0.211 0.082±0.078	0.034-0.116 0.046±0.039	0.011-0.105 0.052±0.041
Zn (µg/g)	5.0	5.02-7.25 5.35±0.909	5.112-6.279 5.329±0.572	5.004-6.015 5.192±0.382

The high concentration of paper mill effluent in Elenga beel water has resulted in the high concentration of this element in the beel water. The permissible limit of Cr is 0.05mg/l hence Elenga beel water is toxic in respect to this element. Hexavalent Cr is irritating and corrosive to the mucous membrane and is thought to be responsible for different diseases [19]. The Pb level in Elenga beel water is much higher than permissible limit (0.01mg/l). Pb is supposed to have teratogenic property [19]. In Elenga beel ecosystem, the main source of metals is paper mill effluent, besides, pesticides and chemical fertilizers coming along with agricultural drainage water.

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Industrial effluent, sewage, pesticides, chemical fertilizers, etc. contribute huge quantities of inorganic anions and HMs [7,19,25,26].

B) Heavy metals in tissues of H.fossilis

The release of increasing quantities of HMs into the water resources endangers the life of aquatic organisms. The studied fish contained variable amounts of HMS and that HMs accumulate in variable levels in different tissues. The results presented in the table-2, 3 and 4 shows that the species investigated contain levels of Cd, Cr, Cu, Pb and Zn are above the permissible limit recommended by USEPA (1979). The harmful effect of HMs as pollutants result from incomplete biological degradation therefore, these metals tend to accumulate in the aquatic environment [9]. Since HMs is non-biodegradable they can be bio-accumulated in fish, either directly from the surrounding polluted water or by ingestion of food residing in the beel water. Similar results have been reported in *C. fasciatus* [22] and in *M.sephalus* [23].
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Highest concentration of Zn in liver followed by Cu, Pb, Cr and Cd were recorded in the present investigation which are also recorded by different authors in different fishes [27,25,31,34]. Comparative evaluation of different levels of accumulation in tissues suggests that Zn, Cu and Pb were relatively higher in this freshwater fish, *H.fossilis*. These findings of the present study confirm the results of earlier workers [38,6,11]. This accumulation of Zn and Cu over the Pb, Cr and Cd can be explained that Zn and Cu are highly utilized in the metabolic activities of the fish. When HMs reaches sufficiently high concentrations in body cells, they can alter the physiological functions of the fish [12]. Cd takes its entry probably through the alimentary tract, the main route through which the major damages are produced in various organs of fishes. Excess amount of Cd enters the body of the fish through the food chain and is absorbed from the intestine.

Table-2: Mean ± SD of five replicates, HMs (µg/g) in gill, liver and muscles of *H.fossilis*.

Heavy Metals	USEPA,1979	Fish (*H.fossilis*)		
		Gill	Liver	Muscle
Cd (µg/g)	0.002	0.225-0.451 0.305±0.101	0.99-0.695 0.352±0.256	0.297-0.415 0.327±0.049
Cr (µg/g)	0.05	0.113-0.595 0.295±0.193	0.327-0.492 0.497±0.192	0.073-0.538 0.413±0.311
Cu (µg/g)	0.2	0.097-0.978 0.413±0.372	0.977-1.071 1.028±0.041	0.221-1.302 0.677±0.465
Pb (µg/g)	0.05	0.301-1.295 0.721±0.398	1.017-1.054 1.025±0.015	0.533-0.911 0.731±0.144
Zn (µg/g)	0.5	0.195-1.172 0.822±0.389	1.244-1.572 1.387±0.113	0.371-0.602 0.462±0.094

The bioaccumulation of Pb was found to be relatively higher in the liver, gill and muscles. Similar results have also been reported by different authors [15,31,14,19]. It has also been observed that concentration of Cu was higher in liver followed by gills and muscle. The same was also reported in fish, *C. madrasensis* [23]. The accumulation rates of Zn, Cu, Pb, Cr and Cd increased when increasing effluent concentration in the water as well as in the tissues. This suggests that metabolic activities increased at higher levels of metals in order to metabolize chemicals when they are at toxic levels [13,29].

It is significant in the present study that the concentration of HMs in fish liver and gill is much higher than that of muscle tissues [25,36]. Because liver acts as an important organ for storage and detoxification and gill acts as depot tissue. Gills are always in direct contact with the ambient medium and when the fishes are exposed to polluted water, gills rapidly accumulate the HMs [24,21,19]. It is also reported that the amount of pollutants in the fish liver is directly proportional to the degree of pollution in the aquatic environment by heavy metals [33]. Similar observations were also reported by different authors in various fish species [10,32]. When HMs are accumulated in liver and gill tissues metallothionein proteins are synthesized to detoxify them in the tissues. These proteins are thought to play an important role in protecting them from damage by HMs [18,20].

IV. CONCLUSION

The chemical characteristics of an aquatic ecosystem play a major role in defining its trophic status. A nutrient turns into a toxic one if its concentration exceeds a certain tolerance limit. Accumulation and availability of such chemical substances have a profound impact on the metabolic activities that is going on in the ecosystem. Maximum accumulation of these metals was found in all tissues of the studied fishes. The metal concentrations of the species examined here indicate that the contents could be dangerous to the health of aquatic organisms or for the health of consumers. Therefore, restricted release of partially treated or untreated effluent into freshwater bodies is absolutely necessary to protect aquatic organisms. High accumulation of HMs in fishes may cause serious threat to their survival and therefore needs immediate attention to prevent them from further depletion.

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