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REVIEW ARTICLE

Bioaccumulation of Heavy metals in Fish from Waste water: A Review

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ABSTRACT

India is endowed with vast and varied resources possessing river ecological heritage and rich biodiversity. Freshwater fishery sites are varied like 45,000 km. of rivers; 1, 26,334 km. of canals, ponds and tanks 2.36 million ha and 2.05 million ha of reservoirs. About 21,730 species of fishes have been recorded in the world of which, about 11.7% are found in Indian waters. Out of the 2546 species so far listed, 73 (3.32%) belong to the cold freshwater regime, 544 (24.73%) to the warm fresh waters domain, 143 (6.50%) to the brackish waters and 1440 (65.45%) to the marine ecosystem. The Indian fish fauna is divided into two classes, *viz*., Chondrichthyes (cartilage fishes) and Osteichthyes (bony fishes). The endemic fish families form 2.21% of the total bony fish families of the Indian region. Also 223 endemic fish species are found in India, representing 8.75 % of the total fish species known from the Indian region. The Western Ghats is the richest region in India with respect to endemic freshwater fishes. Northeastern India, which has a very high diversity among freshwater fish, does not have many endemic species within India because of its jagged political boundary. There are about 450 families of freshwater fishes globally. Roughly 40 are represented in India (warm freshwater species). About 25 of these families contain commercially important species. Number of endemic species in warm water is about 544. Freshwater fishes are a poorly studied group since information regarding distribution, population dynamics and threats is incomplete, and most of the information available is from a few well-studied.

Key words: Fish, Heavy metals, waste water and Water ecosystem.

HEAVY METALS IN FISH FROM WASTE WATER

India's inland water resources are diversified, as they are plentiful. Reservoirs contribute the single largest inland fishery resources both in terms of size and production potential only [1, 2]. Fish fauna of a reservoir basically represents the fish diversity and their abundance. Indian reservoirs preserve a rich variety of fish species, which supports to the commercial fisheries. Reservoirs present a good opportunity for studying the effect of scale on the relative importance of factors that determine diversity. On a broad scale, reservoirs are recent and their communities are a combination of species from the former riverine fish fauna as well as introduced species [3, 4, 5].

Fish accumulate toxic chemicals such as heavy metals directly from water and diet, and contaminant residues may ultimately reach concentrations hundreds or thousands of times above those measured in the water, sediment and food [6, 7, 8]. Heavy metals are normal constituents of marine environment that occur as a result of pollution, principally due to the discharge of untreated wastes into rivers by many industries. Bioaccumulation of heavy metals in tissues of marine organisms has been identified as an indirect measure of the abundance and availability of metals in the marine environment [9]. For this reason, monitoring fish tissue contamination serves an important function as an early warning indicator of sediment contamination or related water quality problems [10, 11] and enables us to take appropriate action to protect public health and the environment.

Multiple factors including season, physical and chemical properties of water can play a significant role in metal accumulation in different fish tissues [12, 13]. Several studies [14 - 18] have also indicated that fish are able to accumulate and retain heavy metals from their environment depending upon exposure concentration and duration as well as salinity, temperature, hardness and metabolism of the animals. [19] also showed that the concentration of metals was a function of fish species as it

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accumulates more in some fish species than others.

Histological examinations of gills of fingerlings of *Salmo gairdineri* exposed to methyl mercury indicated necrosis of gill epithelium at 16.0 and 24.0 ppm during 105 days of exposure. Mercury at 0.003 ppm also caused significant increase in cough frequency of fish. [20] found that exposure of *Lepomis macrochirus* to 0.087 ppm as methyl mercuric chloride for 24, 48 and 72 hours resulted in mean serum cholesterol levels of 0.5, 0.08 and 0.2 mg/ml compared to a mean control value of 0.3 mg/ml. [21] exposed *Pleuronectes platessa* in 0.3 ppm mercury for 4 and 7 days and resulted in 47 and 72 per cent reduction in blood haematocrit on 4th and 7th day respectively due to erythrocytolysis. [22] reported that exposure of 0.036, 0.060 and 0.181 ppm mercuric chloride caused various changes in erythrocytes of freshwater teleost *Barbus conchonius* [23] experimenting exposure of *Barbus conchonius* for 120 days to 0.003 ppm mercury observed that mercury treated fish were hypoglycemic and hypolactaemic, the glycogen content of liver and muscle were unaltered but muscle lactic acid was decreased and the rate of intestinal glucose absorption was reduced and further reported alterations in several enzyme activities of gills, brain and kidney. [24] reported that exposure of 0.01 ppm mercuric chloride for 6 months resulted in inhibition of growth of gonads in fish. [25] noted significant reduction in growth of *Tilapia mossambica* at 0.04 ppm mercury. In humans, methyl mercury is more toxic than inorganic mercury, because of its greater lipid solubility which permit the metal to cross biological membranes more easily into the brain, spinal cord and peripheral nerves and across the placenta. Inorganic mercury is concentrated in the human kidney and exerts its major effect there. [26] studied the histo-pathological changes induced by tannery and textile dyeing effluents in the kidney of *Labeo rohita* and observed marked alterations in renal interstitial tubules and inflammatory reaction in kidney. [27] studied the toxic effects of copper and zinc mixtures on some haematological and biochemical parameters in common carp *Cyprinus carpio* and after 30 days exposure of the copper and zinc mixture showed decreased protein in serum. [28] studied the histopathological changes in the gill tissues of the fish *Labeo rohita* exposed to chloropyrifos. Keeping in mind the above mentioned references, an attempt has been made in the present study to understand the effect of heavy metal, Cadmium sulphate on the histology of liver, kidney and gills and biochemical changes especially protein and glycogen in the selected tissues in the fresh water fish *Cirrhinus mrigala*.

According to [29], cadmium accumulates in liver and kidney, and more in the kidney than liver [30, 31]. The cadmium concentration reported in the kidney and heart of *C. gariepinus* is in agreement with the studies by [32] who reported a concentration of 0.41ppm in the kidney of *Epinephelus microdon* fish from [33] who reported a concentration of 0.69 ppm in the kidney and 0.25 ppm in the heart of *C. gariepinus* from Ogun River. Several studies have reported higher levels of Cd in different fish samples from some Nigerian rivers. These include [34] who reported 1.50 ppm and 1.23ppm in *Alestes nurse* and *Synodontis nigritis* respectively from [35] reported 0.927 ppm and 0.994 ppm in *C. gariepinus* and *T. zillii* respectively from River Benue. [36] reported concentration of 2 ppm for cadmium and [37] reported cadmium of 0.79-0.98ppm. The levels of Cd (0.00 - 0.45ppm) recorded in fish samples were lower than the maximum recommended limits of 2.00ppm [38, 39] in fish food. Lower level (0.24 and 0.36ppm in *Mormyops deliciosus* and *Mormyrus macrophthalmus*) has been reported by [40] from Ikpoba river dam. The result from the present study (0.00 - 6.33ppm) was higher compared with the maximum recommended limits of 0.5 - 0.6ppm in fish food. [41] reported 1.19ppm in *Chyrsichthys nigrodigitatus* from lotic freshwater. The results in this investigation were lower than 29.8 - 31.6ppm in *T. zillii* and 28.1 - 32.2ppm in *C. gariepinus* from River Benue [42]. The levels of Cr (0.37 - 5.64ppm) recorded in fish samples were higher than the maximum recommended limits of 0.15 - 1.0 ppm [43, 44, 45] in fish food. [46] reported 0.039 - 1.44ppm in *Oreochromis mossambicus* from Jannapura Lake in India. The distribution of cobalt in *H. forskahlii* showed that the kidney has about 36% which suggests that the route of exposure of the fish to cobalt could be through water [47]. This is different with other fish species suggesting that the route of uptake of the metal could be through food. Furthermore, the result showed that the bottom feeding fish (*H. bebe occidentalis*) has higher level of cobalt accumulation. This can be as a result of the higher exposure of bottom feeding fish due to the high cobalamine concentration in the sediments and feeding habits. Surface water fish in the study (*H. forskahlii & C. gariepinus*) have higher level of Cd compared to the demersal

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fish species. This could be attributed to the fact that the bottom sediment concentration of cadmium is less available because of continuous release of electrons to the environment through microorganism respiration processes [48], thus making the exposure to be higher for the pelagic species.

The concentration of lead varied; in *H. forskahlii* from 0.02ppm in the vertebrae to 0.25ppm in the gills, in *H. bebe occidentalis* from 0.01ppm in the muscle and vertebrae to 0.04ppm in the operculum and in *C. gariepinus* from 0.01ppm in the gills and heart to 0.10ppm in the operculum. This result was lower compared to the findings0.395 - 0.62ppm of [49] and 9 ppm [50] of lead in some fishes from Lagos lagoon. [51] also reported 0.73 - 4.12 ppm in *C. gariepinus* from Ogun River, [53] reported 0.10 - 0.83ppm in some fishes from Ogba river and [54] also gave 3.53 ppm and 2.67 ppm in *Mormyrops delicisus* and *Mormyrus macrophthalmus* from Ikpoba river dam. The values obtained for lead in this study is in line with that of [55] who obtained 0.01 - 0.06ppm in fish species from Azuabie creek in the Bonny estuary, Nigeria.

Some results revealed high accumulation of heavy metals, for example, [56] reported 0.44ppm and 0.62ppm of lead in *C. nigrodigitatus* and *T. guineensis* respectively. The levels of Pb (0.01 - 0.25ppm) recorded in fish samples under this investigation were lower than the maximum recommended limits of 2.0 ppm in fish food. The accumulation of the metals (Cd, Ni, Cr, Co and Pb) was higher in the gills than muscle of *H. forskahlii* and *H. bebe occidentalis*. This is in line with the previous studies of Nwani *et al*. (2010) and Edem *et al*. (2009). This accumulation was, however, significantly higher ($P<0.05$) only in *H. bebe occidentalis*. Gill tissues play an important role in interface with the environment in performing its functions in gas exchange, ion regulation, acid balance and waste excretion while muscle, on the other hand, is not an active tissue in bioaccumulation [57, 58].

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