Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2021; 9(5): 366-369

Received: 07-07-2021
Accepted: 09-08-2021

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# Fish population at the risk of heavy metal contamination: Some recent reports

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**Abstract**
We have a rich biodiversity of fish, and people find fish both as a delicious and nutritious food item, and as a rich source of protein and vital nutrients. Various human interventions in the form of excess industrialization, unethical agricultural practices or such other means would have led to the contamination of our aquatic ecosystems, whether it be marine, freshwater or estuarine, with toxic and other heavy metals. This has deteriorated the fauna, especially fish. Edible fishes thus could form a constant source of bioaccumulation through the food chain. The sources of heavy metal contamination are diverse. Recent literature in this context is discussed and it is advised that proper monitoring of heavy metal contamination of fish be done. Therefore, it is essential that awareness and action programmes be conducted.

**Keywords:** fish, heavy metals, contamination, bioaccumulation

## Introduction
Food habits are changing rapidly around the world in the recent decades. Non-vegetarian food habits, especially fish eating, sometimes pose health hazard due to contamination with diverse heavy metals, as is evident from most of the literature available. Whether freshwater, marine or estuarine, fish is a common delicacy around the globe. Presence of toxic heavy metals is an emerging threat on safe consumption of fish [1].

Heavy metals are ubiquitous in nature. These may move through the food chain, bioaccumulate, and become toxic in different ways. These are notorious owing to the health and environmental risks they cause [2]. Dietary intake and food chain pathways are the major sources of toxic heavy metal accumulation in humans [3]. Electronic waste dumping cause heavy metal pollution and related health problems in many nations [4]. Lead, copper and nickel are some common pollutants released this way. Fast urbanization, industrialization and modern agricultural trends, may be the reasons for this environmental threat. Heavy metals such as Arsenic (As), Cadmium (Cd), Lead (Pb), Mercury (Hg), Chromium (Cr), Barium (Ba), Cobalt (Co), Cesium (Cs) and Selenium (Se) are frequently met with in nature. It is also reported that more than individual ones, heavy metal mixtures can pose more danger due to their additive, antagonistic or synergistic effect [5].

## Fish consumption
Fish is a delicacy and is an important nutrient source to people all over the world. People living near water bodies normally depend on fish for their primary source of protein. Global per capita fish consumption seems to be rising. In India, annual per capita fish consumption is nearly 5–6 kg for the general population and 8–9 kg for fish-eating population, and this is thought to be about 50% of the global consumption [6]. Fish consumption has lot of health benefits like the presence of long-chain polyunsaturated fatty acids (PUFA), high-quality protein, long- chain omega-3 fatty acids, docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) which are important for brain and eye development and also for the protection of cardiovascular system. Fish is also a source of important nutrients like iodine, magnesium, iron, copper, vitamins D and $B_{12}$ [7].

But fish consumption is also a major source of heavy metal exposure to humans, as is evident from various reports. There are many incidences and reports in the past on heavy metals in fish, especially that of mercury. The best example is that of the most notorious Minamata disease, caused by the consumption of sea food polluted by methyl mercury in Minamata bay, Japan, in 1956, which affected more than 50,000 people with brain damage, paralysis,

incoherent speech and delirium, and even now nearly 2 - 4% of the total Hg discharged by the Chisso factory between 1932 and 1968 remains in the bay sediments with flow access to Yatsushiro Sea [8, 9]. Recent two decades witnessed enormous number of studies in this field, pointing to the fact that consumption of fish could expose humans to dangerous levels of methyl mercury accumulation [10].

The risk is not in how much fish is eaten, but in which species of fish is eaten, especially with regard to heavy metals such as mercury [7]. Higher mercury levels were observed in carnivorous fishes than non-carnivorous ones [11]. Methyl mercury levels in fish varies depending on age, size, the position of the species in the food chain, and on pollution level [12]. Mercury strongly binds to thiol groups of proteins, whose content increases with size and therefore, its presence in the muscle is positively correlated with the length and size of the fish [13].

**Recent reports on heavy metals in fish**

Rapid industrialization and other human activities result in discharging enormous toxic wastes into the nearby water bodies, leading to the contamination of aquatic ecosystems with heavy metals or other pollutants and thereby causing threat to fauna [14]. Mostly, marine fishes are prone to heavy metal toxicity due to the mass waste dumping in the ocean. But it is mention worthy that toxic heavy metals and metalloids in freshwater fish is also a reality and is a risk to the health of fish consumers [15].

Reports on heavy metal contamination in both marine and freshwater fishes in the recent past few years are available. Heavy metals like lead, chromium and zinc were found to exceed the permissible limit in fish samples from three reservoirs at the Delta region of Cauvery River, India [16] and fishes such as, *Catla catla and Etroplus suratensis* showed the highest accumulation of metals suggesting risk for human consumption. The health hazard associated with the consumption of common fishes like *Clarias batrachus* and seven other species from the Gomti River in Uttar Pradesh, India, was also reported [17], in which contamination with Chromium, Copper, Manganese, Ni, Pb, and Zn were studied.

Seventeen commercially important marine fish species from Mumbai Harbor were studied for heavy metal bioaccumulation [18] and *J. elongatus* and *C. dussumieri* had the highest levels of all the eight metals tested. Mercury levels in six species of fish including Mackerel (0.048 $\mu g^{-1}$) and Sardine (0.027 $\mu g^{-1}$) were studied from Sundarban wetland in India [19]. Reports on mercury in fish and seafood products from eastern central Atlantic is available [20]. But mercury analysed in canned fishes including Sardine and Mackerel species from Ghana market were found to be below the FAO/WHO limit of 0.5µg/g [21].

Study from Kalpakkam, located on the southeast coast of India [22], where intense nuclear power plant activities were common, revealed that metal concentrations in plankton were much higher than those in water, sediment and fish, but, there is every chance of this bio accumulating through food chain. Heavy metal concentration in five marine edible puffer fish species collected from Mandapam fish landing centre, South east coast of India was reported [23]. The values were higher than the WHO recommended values. Likewise, heavy metal analysis in ten commercially important and frequently consumed fish species from Thondi fish landing, southeast coast of India, found significant levels of Cd, Pb, Cu, and Zn but were less than the permissible levels specified for human consumption [1]. Diet or consumption of fish showed significant relationship with Arsenic, Lead, and Mercury levels in blood, in a study in Kerala [24]. High heavy metal accumulation was found in the liver of all selected fish species in the order of highest in zinc and least in chromium [25], in seven most commonly consumed fish species including *Catla catla and Labio rohita,* collected from local markets of some regions in Uttar Pradesh, India. Twenty three metals were analyzed in *Channa striata* and *Puntius chola*, from freshwater in Visakhapatnam area and has reported that Chromium, Aluminum, Manganese, and Arsenic were above the permissible limits [26]. Out of ten selected deep-sea fishes assessed for heavy metal from the south west coast of India two species showed slightly higher lead content [27]

**Discussion**

It is clear that heavy metal contamination of fishes in the aquatic ecosystems is a reality in the present scenario. The sources of heavy metal contamination are diverse. Growth of industrial activities and modern agricultural trends of using excess of fertilizers, fungicides and pesticides, have made heavy metal poisoning a growing public threat [28]. Heavy metals are poisonous to living organisms even at low [29]. Therefore, every effort to minimise such contamination of aquatic ecosystems may be taken.

Toxicity associated with exposure to heavy metals, if neglected or inappropriately treated, could lead to a clinically significant medical issue [2]. When heavy metals are ingested, the acid medium in the stomach convert the heavy metals to its stable oxidation states, which then combine with proteins and enzymes [30], to get accumulated in the human body. Inside the body, they may influence the formation of highly reactive free radicals and oxidise sulfhydryl groups of proteins. Therefore, heavy metals are considered as systemic toxicants. All toxic elements have the potential to produce multi organ damage or cancer, but some like Cobalt and Selenium are essential human nutrients in small amounts [31]. Although fish has lot of other health benefits in humans, regular fish consumption causes mercury to get into human body and can cause neurotoxicity, teratogenicity, nephrotoxicity, cardio toxicity, and immune-toxicity [32]. is of the opinion that ingestion of prey fish with significant levels of high-value nutrients such as poly unsaturated fatty acids is better than consumption of predatory fish species that contribute to methyl mercury toxicity, in order to benefit from fish nutrients [33].

**Conclusion**

Our aquatic ecosystems, whether it be marine, freshwater or estuarine, our fish and other aquatic fauna need to be protected from being contaminated with toxic and other heavy metals. Proper monitoring of heavy metal contamination of fish is needed. More research in this area could help to a great extent. Simultaneously, since a vast majority of people find fish both as a delicious food item and as a rich source of protein and vital nutrients, they need to be made aware of the related risk involved. For instance, while consuming fish, one should choose. In conclusion, health and environmental risks from heavy metal toxicity is a serious issue to be addressed worldwide. This could especially be true in developing countries. Proper monitoring of heavy metal pollution may be done routinely. Therefore, giving awareness to public in this regard, and action programmes are the need of the hour.

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