

Public Health Hazards of Heavy Metal Contaminants in Fish Meals

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Abstract

In spite of the fishes are recognized benefits, the fishes can bio accumulate nonessential toxic heavy metals, which may be a potential public health hazard to the consumers at high concentrations. The heavy metals are natural nonessential trace elements of the aquatic environment, which have no known beneficial functions; but their levels have increased to toxic concentrations due to the contamination from agricultural, industrial, and mining activities. Most of the fishes can easily be contaminated by a wide variety of toxic metals such as cadmium, lead, arsenic and mercury. The heavy metals contamination may originate from different sources, including the discharge from agriculture, industrial and the sewage effluent, the waste from accidental chemical spills, and the gasoline from the fishing boats. The heavy metals reach fish flesh via their feeding on benthic species as benthic worms and crustaceans, which in turn feed on the surrounding sediment having a high amount of heavy metals. In particular, because the toxic heavy metal elements cannot deteriorate, they can be persisted and accumulated in the environmental media, including the water and the sediments, and bio accumulate in the aquatic biota including the fish to levels that are hazardous to the consumers. The bioaccumulation of the heavy metals in the fish depends on several factors, such as, the area and the time of fishing, the feeding habits of the fish, the fish species, the gender, the age, the size, their levels in the water, and the duration of exposure, in addition to other factors including the water pH, the salinity, and the water temperature.

Keywords: public health, fish, heavy metals, contamination, cadmium, lead, arsenic, mercury

Introduction

The fish are food of high nutritive value that support the humans with a balanced healthy diet and are considered a good source of the high biological value protein, containing a good balance of the essential amino acids and the fats with high levels of beneficial poly-unsaturated fatty acids, which contribute to the improvement of the human health by minimizing the risk of cardiovascular diseases (López-Alonso, 2012; Rahma et al., 2012; Al Shorman et al., 1999; Akter et al., 2021; Edris et al., 2013; Ahmed et al., 2015; Edris et al., 2012). The fish are characteristically tender, easily digestible, and a good source of most B-complex vitamins and also contribute significant levels of minerals including cobalt, iron, copper, zinc, sodium, potassium, magnesium, phosphorous, iodine, and fluorine. The good taste and low cost of the fish are some of the appealing factors that make them a substitute for red meat as a source of animal protein, providing an opportunity for the consumers to meet their daily nutritional requirements. The heavy metals produce many of their hazardous effects on the humans through the formation of free radicals, resulting in damage to the DNA. The fish are caught and collected either from the wild sources or the aquacultures distributed in the different localities all over the world. The different fish species from the aquacultures, the

contamination of the freshwater fish with the heavy metals from the wild sources such as the Lakes, which is an important source for the fisheries (Hassan et al., 2013; Sahnquillo et al., 2003; Hassan et al., 2004; Bonsignore et al., 2018; Hassan et al., 2013). The *Oreochromis niloticus* (Nile tilapia), the *Mugil cephalus* (flathead grey mullet), and the *Clarias gariepinus* (African catfish) are among the most popular fish species, consumed widely, and are the most frequently caught. The heavy metal contaminants in these fishes up till now and the toxic effects of these metals on public health, the levels of the most toxic metals, such as the mercury, the arsenic, the lead, and the cadmium, in the muscles of the three common freshwater fishes as the Nile tilapia, the flathead grey mullet, and the African catfish and to assess the risk resulting from the consumption of the heavy metal contaminated the fish to the public health (Tchounwou et al., 2012; Hassanin et al., 2017; Zhuang et al., 2009; Saad et al., 2022; Duruibe et al., 2007; Farag et al., 2023).

The Heavy Metal Concentrations in the Fish

The heavy metal pollution is a serious issue in many countries in the world and is caused by the agricultural and industrial waste disposal into the sea or brackish water, where it becomes toxic for many aquatic organisms (Pieniak et al., Farag et al., 2023; El-Moselhy et al., 2014; Shaltout et al., 2023; Forti et al., 2011; Shaltout et al., Alhashemie et al., 2012). The heavy metals, especially Hg, As, Pb, and Cadmium, are toxic elements that have no biological role and can have carcinogenic effects, and may lead to reduced the cognitive development and the mental health in the children and increased the cardiovascular diseases in the adults, in addition to the kidney and the reproductive dysfunction. The heavy metal concentrations in the muscle of the fish species as mercury, As, Pb, and Cadmium in the Nile tilapia, the flathead grey mullet, and the African catfish (Shaltout et al., 2020; Goldhaber et 2003; Shaltout et al., 2019; Sapkota et al., 2008; Shaltout, 2019; Hina et al., 2011).

The Daily Intake

The estimated daily intake (EDI) of tested heavy metals was determined by using the following equation:

$$EDI = Mc \times \text{consumption rate}$$

Where Mc is the metal content ($\mu\text{g}/\text{kg}$) in the fish muscles in wet weight basis (Hassanin et al., 2019; Suchana et al., 2021; Hazaa et al., 2019; Ezemonye et al., 2019; Gaafar et al., 2019; FAO, et al., 1983; Shaltout et al., 2019; Mansour & Sidky, 2002).

The Effects of the Heavy Metals on the Public Health

The fish is important for a healthy diet because they are rich in essential nutrients. However, when the fish tissues accumulate metals in various concentration, and when that exceeds the safety levels, the toxic metals reach the humans body and cause various forms of diseases. So, the fish consumption could become a major pathway to the heavy metal exposure and the consequent risk for the public health (Shaltout, et al., 2018; Mustafa, 2009; Shaltout, et al., 2019; Rohani, et al., 2022; Shaltout, et al., 2017; Mansour & Abou-Arab, 2009; Mahmuda, et al., 2020). The heavy metals such as the cadmium, the mercury, the lead, and the arsenic pose a number of hazards to the humans, these metals are also potent carcinogenic and mutagenic. The heavy metal toxicity can result in damage or reduced the mental and the central nervous system function, lower energy levels, and the damage to the blood composition, the lungs, the kidneys, the liver and other vital organs. The long term exposure may result in the slowly progressing physical, muscular, and Alzheimer's disease, Parkinson's disease, muscular dystrophy, and multiple sclerosis. The allergies are not uncommon and the repeated long term contact with some metals or their compounds may even cause cancer. The heavy metal toxicity is a chemically significant condition when it does occur. When unrecognized or inappropriately treated, toxicity may cause significant illness and reduced the quality of the life. The acute heavy metals intoxications may cause the damage of the central nervous function, the cardiovascular and the gastrointestinal systems, the lungs, the kidneys, the

liver, the endocrine glands and the bones. The specific threats to public health associated with the exposure to the Cadmium, the Lead, the Mercury and the Arsenic include the foregoing (Shaltout & Daoud, 1996; Saha & Zaman, 2013; Shaltout et al., 2003; Choudhury, et al., 2022; Shaltout, et al., 2015; Li, et al., 2013).

The Public Health Hazards of Cadmium

The Cadmium is a by-product of zinc production is one of the most toxic elements to which man can be exposed to at the work or in the environment. Once absorbed, the Cadmium is efficiently retained in the human's body in which it accumulates throughout the life. The Cadmium is primarily toxic to the kidney especially, to the proximal tubular cells; the main site of the accumulation. The Cadmium can also cause bone demineralization either through direct bone damage or indirectly as a result of renal dysfunction (Maruya et al., 2019; Shaltout, & Ibrahim, 1997; Abdel-Baki et al., 2011; Shaltout, et al., 2014; Kadim & Risjani, 2022; Shaltout, et al., 2018; Islam, et al., 2020).

Public Health Effects of the Lead:

The Lead poisoning can happen if a person is exposed to very high levels of lead over a short period of time. When this happens, a person may experience the following: abdominal pain, constipation, tiredness, headache, irritability, loss of appetite, memory loss, pain or tingling in the hands and or feet and weakness. The lead poison can easily be overlooked because these symptoms may occur slowly or may be caused by other things. The exposure to high levels of the lead may cause anemia, weakness and kidney and brain damage (Hassanin, et al., 2019; Suchana, et al., 2021; Hazaa, et al., 2019; Ezemonye, et al., 2019; Gaafar, et al., 2019; FAO, 1983). The very high lead exposure can cause death. The Lead can cross the placenta barrier, which means pregnant women who are exposed to the lead also expose their unborn children. The Lead can damage a developing baby's nervous system. The low level lead exposures in developing babies have been found to affect behavior and intelligence. The Lead exposure can cause miscarriage, stillbirths, and infertility in the both men and women. The Lead affects children more than it does adults. The Children tend to show the signs of severe lead toxicity at lower levels than adults (Bonsignore, et al., 2018; Hassan, et al., 2013; Tchounwou, et al., 2012; Hassanin, et al., 2017; Zhuang, et al., 2009; Saad, et al., 2022; Duruibe, et al., 2007). The persons who are exposed to the lead overtime may experience abdominal pain, constipation, depression, distraction, forgetfulness, irritability, nausea. The peoples with prolonged exposure to the lead may also be at risk of high blood pressure, heart disease, kidney disease, reduced fertility and the lead is probably cancer-causing in the humans (Akter, et al., 2021; Edris, et al., 2013; Ahmed, et al., 2015; Edris, et al., 2012; Saha, et al., 2020; Edris, et al., 2012; Erdoğan & Ateş, 2006; Ragab, et al., 2022; Al-Busaidi, et al., 2011; Pan & Wang, 2012).

Conclusion

The consumption of the heavy metal contaminated the seafood may carry potential public health risks for the consumers in the form of acute and chronic degenerative changes, especially to the liver, kidneys, and the nervous system and they also have carcinogenic and teratogenic effect, in addition to their immunosuppressive impact, although they may play a role in enzymatic inhibition and impaired antioxidants metabolism.

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Conflicts of Interest

The author declare no conflicts of interest

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