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Heavy metal toxicity in fishes and their impact on human's health: A review

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Abstract
Environmental pollution is a worldwide issue, and the most significant pollutants are heavy metals in aquatic networks due to their toxicity, accumulation, and bio-magnification by marine animals. Heavy metals are derived from both natural and manmade sources. Heavy metal contamination in aquatic settings is caused by direct air deposition, geologic weathering, or the discharge of agricultural, municipal, residential, or industrial waste products, as well as wastewater treatment facilities (WWTPs). Cadmium, lead, mercury, zinc, copper, nickel, cobalt, molybdenum, chromium, and tin are the heavy metals most typically discovered in fish organisms. Heavy metal toxicity can alter individual development rates, physiological processes, mortality, and reproduction in fish. Heavy metals can enter fish bodies through three routes: the gills, the digestive tract, and the body surface. Heavy metals can interfere with numerous developmental processes throughout the embryonic phase, resulting in a decrease in offspring quantity and quality. Heavy metals have a variety of acute and chronic harmful effects on various human organs. Heavy metals' influence on people includes gastrointestinal and kidney dysfunction, neurological system diseases, skin lesions, vascular damage, immune system malfunction, birth defects, and cancer.

Keywords: Hernia, buffalo bull, umbilical, herniorrhaphy

Introduction

Environmental pollution is a worldwide problem, and heavy metals are the most significant contaminants in aquatic systems due to their toxicity, build-up, and bio-magnification by marine species. According to Ali *et al*. (2014) [1], anthropogenic, industrial, and domestic activities may all contribute to the poisoning of natural aquatic systems with heavy metals. For many decades, there has been worry about the effects of pollutants, particularly heavy metals, in fish's aquatic ecosystems (lakes, rivers, and lagoons), which have a serious negative impact on the organisms. Fish are used to measure the health of the aquatic ecosystem because heavy metals bioaccumulate in the food chain and have negative consequences, including death. Because fish can bioaccumulate metals, some fish species accumulate metals more than others. Fish further up the food chain have higher levels of pollution bioaccumulation, and heavy metals are largely obtained from diet (Ali *et al*. 2014) [1].

Metals are classified into two types: those required for life and those that are not. Non-essential metals such as aluminium (Al), cadmium (Cd), mercury (Hg), tin (Sn), and lead (Pb) become more poisonous with concentration, and none of their biological activities have been discovered. They're also referred to as xenobiotics or alien components. On the other hand, the toxic effects of important metals (such as copper (Cu), zinc (Zn), chromium (Cr), nickel (Ni), cobalt (Co), molybdenum (Mo), and iron (Fe)) occur either when there is a metabolic deficiency or when there is a high concentration. As a result, a shortage of an essential metal might have a severe impact on health, whilst a high concentration can have deleterious consequences comparable to or worse than those caused by non-essential metals (Kennedy, 2011) [12].

Cadmium, lead, mercury, zinc, copper, nickel, cobalt, molybdenum, chromium, and tin are the heavy metals most typically found in fish. Cadmium, copper, lead, zinc, mercury, and chromium are the most commonly studied fish abnormalities (Sfakianakis *et al*. 2015) [21].

Heavy metal concentrations in water have impacted the food chain. The bioaccumulation patterns of heavy metals are determined by fish uptake and excretion rates. Metal concentrations in various fish tissues have increased dramatically due to a variety of factors, including seasonal changes, physical and chemical properties of water, and other factors

(Pandey *et al*. 2008) [15]. Because of higher metal concentrations in the water and sediments, there are substantial metal residual concerns with fish epithelium (Wong *et al*. 2001) [24]. Heavy metal bioaccumulation mechanisms, on the other hand, are a major source of concern in this area since they can rapidly travel up the food chain (Ashan *et al*. 2014) [26].

The pattern of heavy metal uptake in fish varies by species and is influenced by a variety of factors such as the fish's age, developmental stage, and psychological makeup. Fish can transport high dietary levels of arsenic and mercury to humans due to their increased absorption mechanisms for these elements in their tissues. Processed water from the detergent, textile, and cosmetic industries near rivers contains significant amounts of heavy metals, which disrupt the natural equilibrium of rivers if present in much higher proportions. Heavy metal build-up in the liver and gills was found to be highest in Cd and Pb, respectively. This review has highlighted the widespread presence of heavy metals in aquatic environments, originating from both natural sources and human activities.

Sources of heavy metal

Heavy metals are produced through a variety of anthropogenic and natural processes. Heavy metal pollution in aquatic environments is caused by direct air deposition, geologic weathering, or the discharge of industrial, municipal, residential, or agricultural waste materials, including wastewater treatment facilities (WWTPs). Coal combustion is a substantial source of trace element emissions and a significant source of some metals. Heavy metals and metalloid contamination in water and sediment constitute a serious threat at higher concentrations due to their toxicity, long persistence, bioaccumulation, and bio-magnification in the food chain (Authman *et al*. 2015) [2].

Effect of heavy metal on embryonic development of fish

Fish in their early stages of development are extremely vulnerable to water contamination. Heavy metals can disrupt a number of embryonic developmental processes, reducing the number and quality of offspring (Jezierska *et al*. 2009) [8]. Waterborne metals can accumulate in spawners' gonads, reducing gamete viability and output or directly harming developing embryos. Metals may accumulate in the egg because the eggshell may not fully protect the embryo from metal penetration, particularly during the swelling process. The effects might range from embryonic death to developmental issues, depending on the metal content. Metals inhibit and slow down specific developing processes in fish embryos. The most disturbances and embryonic mortality occur in the early stages following fertilisation, which are particularly vulnerable to metal toxicity. Waterborne metals can also induce bodily malformations and other developmental abnormalities during organogenesis. Heavy metals are frequently responsible for premature or delayed hatching, deformations, and mortality in newly hatched larvae. As a result of all of these changes, there are fewer larvae and they are of poor quality, with small bodies, frequent malformations, and low viability.

Effects of heavy metals on fishes

Heavy metal toxicity can affect fish physiological systems, individual growth rates, mortality, and reproduction. Fish can take heavy metals through their gills, digestive system, or body surface, among other possible entrance channels. According to Romeo *et al*. (1999) [17], the body surface is assumed to have a minor role in heavy metal uptake by fish, but the gills are an essential site for direct metal uptake from water. The food source can also contribute to heavy metal accumulation, which may result in bio-magnification-the augmentation of toxins as they migrate up the food chain (Per-Arne *et al*. 1997) [16].

The harmful effects of mercury on aquatic life have been linked to a risk to human health, neurological damage (brain-damaged fish), foetal malformation in fingerlings, permanent disabilities, fatty liver and degeneration, and immune system harm. Toxic heavy metals are known to disrupt fish's external organs, resulting in loss of equilibrium, increased opercular movement, abnormal vertical motions, and ultimately death. According to Ali *et al*. (2014) [1], cadmium, lead, mercury, and arsenic seriously harm fish's neurological and renal systems in addition to their gills (Shah and Altindag 2005) [22]. Mercury has been connected to a risk to human health, neurological damage (brain-damaged fish), foetal deformity in fingerlings, irreversible impairments, fatty liver and degeneration, and immune system harm. Toxic heavy metals are known to alter the external organs of fish, resulting in loss of equilibrium, increased Opercular movement, aberrant vertical motions, and, eventually, death. According to Ali *et al*. (2014) [1], cadmium, lead, mercury, and arsenic are toxic to fish's neurological and renal systems as well as their gills.

Effects of chromium on fish

Fish swallowed either food from the environment or heavy metals from the water surrounding them. As a result of human activities, natural water is increasingly contaminated with this element. Despite the fact that the concentration of chromium in rivers and lakes is documented to range between 1 and 10 ug/L, the EPA recommends an acceptable threshold of 50 to 100 ug Cr/L for the protection of aquatic life and human health. Several fish species demonstrate the chromium poisoning impact based on blood changes such as anaemia, eosinophilia, and lymphocytosis, as well as bronchial and renal illnesses. Although chromium is known for its modest accumulation in fish bodies, higher quantities of Cr injure fish swimming near the point of Cr disposal (Ashan *et al*. 2014) [26].

Effect of Chromium on Humans by Fish Intake

Fish, which are at the top of the food chain, acquire a lot of metals, and the amount depends on how much is consumed and how much is excreted by the body (Karadede *et al*. 2004) [11]. Cr is bad for people's health, especially if they work in the steel and textile industries. Additionally, smokers have a higher chance of disclosing to Cr. Numerous health problems might be brought on by chromium. Leather items containing chromium may lead to allergic-like skin rashes. After inhalation, Cr can produce nosebleeds and irritations. Other health issues brought on by Cr include a weakened immune system, skin conditions, stomach ulcers, and skin infections. Problems with the respiratory system, genetic material alteration, lung cancer, liver damage, and kidney damage, as well as death (Karadede *et al*. 2004) [11].

Effects of cadmium on fish

Cadmium, the non-essential and most dangerous heavy metal, is abundant in the marine environment and the earth's crust. Heavy metals such as lead, mercury, and cadmium are regarded to be hazardous to public health (Sastry and Gupta 1979) [20]. It is widely acknowledged that the major sources of cadmium discharge into the environment (such as coal or oil) are municipal rubbish burning and fossil fuels. Cadmium may also be released into the atmosphere when copper, lead, or zinc are melted. Waste from businesses and families can be disposed of, allowing new water to enter. Heavy metal exposure may also impede aquatic creature reproduction, leading to the slow extinction of generations in contaminated settings. Cadmium is commonly found in fertilisers. Long-term toxicity from Cd and mercury (Hg), for example, may appear as kidney damage, tumours, hypertension, and hepatic dysfunction, among other symptoms. Fish is a major source of protein in human food. Given the importance of fish in the human diet, it is not surprising that several studies on metal pollution in diverse species of edible fish have been done. The nutritional needs of different fish tissues are determined by their biochemical makeup, which includes the levels of minerals, amino acids, protein, and vitamins, among other things. At sublethal Cd doses, the electrophoretic structures of protein segments in *O. mossambicus* gills and muscle displayed abnormalities (Ali *et al*. 2014) [1].

Health effects of cadmium in humans by intake of fish

Unfortunately, the lipid component of fish protects the chemical contaminants until they reach the human body. Some polluted areas may have infected wild fish. Non-essential elements such as lead, cadmium, mercury, and arsenic are toxic to living beings (Barka *et al*. 2001) [3]. These heavy metals accumulate in the food chain and accumulate in larger quantities than in the water in the tissues and bodies of aquatic species, causing physiological harm to consumers at higher trophic levels as well as humans. The majority of CD is consumed by humans through food. Foods having a high Cd content can significantly raise the body's Cd levels. High-Cd foods include dried seaweed, dried mushrooms, fish liver, and shellfish. Cd is initially transported by blood to the liver, where it binds to proteins to form complexes, which are then transported to the kidneys, where it destroys the purification systems. As a result, carbohydrates and essential proteins are evacuated from the body, putting the kidneys at risk. Time must pass before Cd accumulated in the kidneys is removed from the body. Cadmium causes diarrhoea, vomiting, stomach problems, bone fractures, DNA damage, infertility, damage to the brain and immune systems, cancer, and other health effects.

Effects of Zinc on Fish

Zinc may accumulate in the bodies of fish that live in zinc-contaminated streams. The bodies of these fish absorb zinc, causing bio-magnification up the food chain. Toth and Brown (1997) [23] found that as fish length rose, Zn concentrations in tissue decreased dramatically. One of the most common heavy metal pollutants is zinc, a vital element.

Zinc and other heavy metals in natural streams can be traced back to geological rock weathering, human activities such as industrial and domestic wastewater discharges, and animal sources where it serves as a component function in cytoplasmic integrity. However, at higher concentrations, Zn caused structural damage in fish, affecting their growth, development, and survival. When zinc accumulates in fish gills, it impairs tissue respiration, resulting in hypoxia and death. Zinc pollution can also alter the physiology of the heart and ventilator (Olaifa *et al*. 1998) [14].

Zinc has a detrimental impact on fish hatchability, survival, and haematological limitations. Subacute effects of zinc on fish behaviours are possible. Because most of the fins in the affected fish remain fixed, these observed behaviours include imbalanced swimming, air guzzling, restless swimming, periods of dormancy, and death. According to Kori and Ubogu (2008) [19], Zn is particularly harmful due to its almost endless persistence in the environment and its inability to be eliminated biologically. It simply switches from one oxidation state to another or from one chemical complex to another. Zinc may be harmful to fish, since it interferes with their capacity to control their acid-base and ions, destroys their gill tissue, and promotes hypoxia.

Effects of zinc on humans by intake of Fish

More time is needed to ascertain the quantities of heavy metals present in order to evaluate the danger associated with consuming commercial fish and prawns. Although other environmental factors including salinity, pH, hardness, and temperature also have a significant impact on metal accumulation, the concentration of heavy metals in water and the length of exposure are the main factors that determine the accumulation of heavy metals in tissues (Blackmore and Wang 2003) [4]. Zinc is a unique element whose contribution to human health is merely marginal. Obstacles to childbirth can arise from a lack of zinc. Lack of appetite, diminished taste and smell, delayed wound healing, and skin ulcers are all symptoms of insufficient Zn exposure in humans. Although high Zn concentrations are tolerable for humans, too much Zn can cause major health problems such as skin irritations, stomach pains, anaemia, vomiting, and nausea. High Zn concentrations damage the pancreas and cause arteriosclerosis and disruption of protein metabolism. Zn chloride exposure over a lengthy period of time may cause respiratory issues. But it's crucial to remember that some research supports the idea that cooking fish cancels out any potential drawbacks. Furthermore, such negative effects are considerably reduced when packing the fish for human consumption (Healey, 2009) [7].

Effects of lead in fish and human

When accumulation reaches an appreciably high level, heavy metals can become dangerous in aquatic animals' tissues (Yildirim *et al*. 2009) [25]. Aquatic animals may absorb considerable amounts of heavy metals if there is a rise in their concentration in the water. Fish is usually one of the biggest eaters. Pb is primarily consumed through food and is also breathed in by both fish and people. Lead accumulates in the blood, fat, muscles, and bones (Elder and Collins 1991) [5].

Effect on Fish

Lead enters water systems through runoff, industrial waste, and sewage waste streams. Pb concentrations in the water can change the blood and nervous systems of other animals, fish, and other organisms, as well as injure some aquatic species (McCoy *et al*. 1995) [13].

Effects of lead on humans by intake of fish

Species at the top of the food chain and freshwater ecosystems may be exposed to toxic amounts of a pollutant as a result of bio-magnification. Lead (Pb) is a serious environmental contaminant. Due to the serious risks, it poses to human health, lead toxicity has taken on a lot of significance (Rossi and Jamet 2008) [18]. Young children and newborns are particularly sensitive to even very low levels of lead (Healey, 2009) [7].

Effects on organs

Lead damage to the liver, kidneys, brain, nerves, and other organs from lead (Pb). Pb exposure can result in osteoporosis, also referred to as brittle bone disease, in addition to problems with reproduction.

Affects the blood and heart

Exposure to Pb, especially in males, is linked to an increase in heart disease and high blood pressure. Pb can also cause anaemia (Kalay *et al*. 1999) [9].

Affects the nerves and brain

While low levels of Pb exposure diminish IQ and cause learning disabilities in infants and early children, high levels of Pb exposure cause memory problems, appropriations, behavioural disorders, and mental retardation (Weis and Weis 1989) [10].

Conclusion

The contamination of aquatic ecosystems with heavy metals represents a significant threat to both fish populations and human well-being. Fish, being essential components of aquatic food chains, play a crucial role in reflecting the overall health of the environment due to their capacity to accumulate these harmful substances. These adverse effects can ripple through the food chain, impacting humans who consume fish contaminated with these toxic elements. The detrimental consequences of heavy metal exposure on fish encompass damage to their nervous and renal systems, disruptions in their immune function, and various physiological irregularities. Heavy metals such as chromium, cadmium, and lead can impose severe health risks on humans when they consume fish tainted with these substances. These health hazards include digestive issues, impaired kidney function, neurological disorders, skin problems, damage to blood vessels, compromised immune responses, birth defects, and even the potential for cancer. Efforts to alleviate the problem of heavy metal pollution in aquatic ecosystems are of utmost importance to protect both aquatic life and human health. This involves enhancing monitoring techniques, imposing stricter regulations on the disposal of industrial and municipal waste, and encouraging sustainable practices in industries that release heavy metals into water bodies. Furthermore, it is essential to raise public awareness about the dangers associated with consuming fish that may be contaminated.

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