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Examining the Impact of Heavy Metal Pollution on Survival and Protein Modifications in the Liver and Intestine of the Freshwater Fish Tilapia Mossambica

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Abstract:

This study looks at pollution from heavy metals changes proteins in the liver and intestines of the freshwater fish Tilapia mossambica, as well as how many of these fish survive. Heavy metals are the most worrisome pollutants in aquatic ecosystems because they are everywhere and can be found in concentrations that can be measured. Some of the worst pollutants for fish and the aquatic ecosystem are heavy metals described in this study like mercury, cadmium, copper, lead, and zinc. Chromium is a metal that is used get into water when industries like textiles, tanneries, electroplating shops, ore mining, dyeing, printing-photographic, and medical industries dump their waste water into waterways. Heavy metals (HM) are found in small amounts in water, but their levels have gone up because of industrial waste, changes in the earth's chemistry, farming, and mining. Heavy metals from natural and human-made sources are getting into water systems all over the world. The sample size is collected 100 fish were picked out of the randomly.The findings of this study define the heavy metals that are infected or not infected in fish environments but also show how heavy metals hurt fish.

Keywords: water system, heavy metals, fish, HM, pollutants.

1. INTRODUCTION

The water quality is crucial to human survival because it is the most vital resource on Earth. All living things need water to stay alive, but due to human activity, it has become contaminated and toxic, posing a threat to marine and terrestrial ecosystems alike. The harm is a natural by-product of industrialization and urbanisation, the two main drivers of modern economic expansion. Water pollution can also be caused by human activities at home or in the wider environment. A worldwide issue, water pollution has devastating effects on marine life. Most pollution comes from heavy metals (HM). Heavy metals are the metals that are relatively dense and are harmful in even trace amounts. Common heavy metals include arsenic, chromium, cadmium, mercury, thallium, and lead (lead). Other elements, such as zinc, selenium, and copper, are listed here as trace elements (copper). All of these elements play vital roles in proper metabolism, but excessive exposure can be harmful.Fish are especially susceptible to pollution because they must rely on polluted aquatic environments for food and shelter [1-3]. Fish are an easy indicator of ecosystem health because they are more susceptible to several toxicants than invertebrates [4-17]. The origins of heavy metals range from the natural world to human activity [18]. Pollution enters the water through a variety of different channels, including direct white precipitation, geologic softening, the release of municipal, industrial, commercial, or agricultural trash, including waste form wastewater treatment facilities

(WWTPs),are the primary causes of heavy metal pollution in aquatic settings [19-22]. Burning coal is a major contributor to air pollution, and it also provides a significant amount of metals [23]. Because they are poisonous, stay in the environment for a long time, build up in living things, and make other poisons stronger, [24,25], heavy metals and metalloids contaminating water and sediment pose a major hazard when present at higher quantities. When it comes to estimating the level of metal pollution in water systems, fish are widely regarded as the most important biomonitors [26,27]. Also, fish have some unique benefits when it comes to defining the natural features of water systems or figuring out how habitats are changing [28]. Fish, which are at the bottom of the aquatic food chain, may be a source of metals that can be transferred to humans through their diet and cause either chronic illness or acute illness [29]. Studies in the field and in the lab have revealed that the amount of heavy metals inside a tissue depends a lot on how much metal is in the water and how long the tissue has been exposed to metals. But environmental factors like the temperature of the water, the amount of oxygen in it, its pH, hardness, salt content, alkalinity, or dissolved organic carbon can affect how much metal builds up and how toxic it is to fish.Experimental results from the tissues were also discovered to be affected by ecological requirements, individual size and age, life cycle, feeding behaviours, and capture season. Fish can take in metals from the rain they swim throughout or from other animals, like smaller fish, invertebrates, as well as aquatic plants, and store them in their bodies. Pollutants tend to be stored in fatty tissues, such as the liver, and once concentrations in these tissues reach a critical level, consequences are observed in the fish. This buildup, however, is contingent upon their consumption, storage, and excretion. It follows that metals with rapid absorption and poor clearance rates in fish tissues should accumulate to greater amounts. Fish can absorb heavy metals through their gills and skin if they eat contaminated food, or through their digestive system if they ingest uncontaminated food. Metals in fish get into the bloodstream, where they are carried to tissues and organs where they build up. The amount of heavy metals in fish tissues could indeed show how the animals are doing before toxicity upsets the natural balance of population levels in aquatic environments. Dead fish are a telltale symptom of water contamination, yet even at low levels, pollution may just make fish sick. The condition factor, an estimate of fish health, has been reported by Dupuy et al. to be lower in polluted environments. There may be no outward evidence of illness in a fish exposed to extremely low levels of pollution, but this could be a precursor to a long-term decline in fish populations and potentially their extinction if they continue to be polluted. Oxidative stress could also be caused by heavy metals or, possibly, cancer. This is because heavy metals help free radicals and reactive oxygen species do their jobs. Metals can be put into two main groups: those that are essential to life and those that are not. Aluminum (Al), cadmium (Cd), mercury (Hg), tin (Sn), & lead (Pb) are non-essential metals that are hazardous in excessive quantities since they are thought to have no biological purpose (also known as xenobiotics or foreign elements). But essential metals like Cu, Zn, Cr, Ni, Co, Mo, and Fe are known to play important roles in biology, and toxicity happens when there aren't enough of them or when there are too many of them. A lack of an essential metal can be bad for your health, and having too much of that metal can be just as bad or even worse than having too little of a non-essential metal. Also, the shape in which metals are found in water makes a big difference in how dangerous they are to fish. The more complicated something is, the more dangerous it is. This is why ionic metals and simple inorganic compounds are more dangerous than their more complicated counterparts. Due to the toxic effects of metals, which are most noticeable in the early stages of fish development, the most sensitive fish may have their development slowed down, have physical and functional deformities, or even die.This is

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because metals interfere with a number of metabolic processes in developing fish (especially embryos), leading to these undesirable outcomes. At high enough levels, heavy metals become toxic, and hence they may be causal factors in a variety of disorders. Fish, which are not only a vital part of ecosystems but also a source of food, can be poisoned by heavy metals, which can disrupt their physiological and biochemical pathways. Due to how common they are in water and how much they build up inside the flesh of fish and seafood, marine and farmed shellfish and fish have been shown to be a major source of certain pollutants that people eat.

1.1 EFFECTS OF HEAVY METALS ON FISHES

Heavy metals are hazardous to fish and can have negative impacts on their growth, physiological processes, mortality, and reproductive success. There are three entry points for heavy metals into fish bodies: the gills, the digestive tract, and the skin. When it comes to absorbing metals directly from the water, fish are thought to use their gills more than their body surface [30]. The food source may also contribute to heavy metal accumulation, which in turn may promote bio-magnification, the enhancement of poisons up the food chain [31]. Heavy metals showed the following periodic difference based on data from two years in a row and samples taken from the fish farm: The order of the seasons is: summer > fall > winter > spring. Polyunsaturated fatty acids (particularly omega-3 fatty acids), protein, zinc, iron, and calcium can all be found in plentiful amounts in fish, making it a healthy option for human consumption. In the future, seafood and aquaculture products will provide an even larger proportion of the world's protein and fatty acid needs (WHO, 1999). Size, developmental stage, and salinity all play a role in the toxicity of heavy metals to marine and estuarine creatures, but each in their own unique way. Heavy metals cause a variety of responses in affected species, including accumulation in the body and/or a move to higher trophic levels.

1.2 ACUTE TOXIC EFFECTS OF CHROMIUM

1.2.1 Effect on behavior of the fish

An acute research using varying doses of potassium dichromate solution indicated that within 24 hours, Labeorohita (Rohu fingerlings) lose their balance. After 24 hours at a concentration of 56.59 mg/l, the fingerlings' activity and swimming speed were shown to change. Under these conditions, fingerlings are agitated, have impaired equilibrium, and produce more mucus than normal [32]. After 24 hours in a chromium concentration of 56.59 mg/l, H. fossilis fingerlings show a minor improvement in activity, as seen by a faster swimming rate. Higher concentrations (more than 56.59 mg/l) have been shown to have normal results for all other parameters. Upon investigation, it was discovered that fingerlings exposed to chromium concentrations of 42.45 mg/l and 56.59 mg/l experienced a decline in body balance after 48 hours. Fingerlings have been found to experience the issue of imbalance after being exposed for 96 hours across all concentrations tested. After 96 hour exposure, the rate at which mucus is made goes up everywhere. In another experiment with Channapunctatus, the parameters of a study (irregular snorkelling, hyperactivity, loss of balance, increased swimming rate, tendency to convulsions, or increased heart rate) were different inside the 20 mg/l and 40 mg/l potassium dichromate concentrations compared to the control group system (0 mg/l) [33]. Exposure of freshwater fishes to a chromium contaminated environment has been linked to hyperactivity and irregular swimming.

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1.2.2 Effect on mortality of fishes

One of the best ways to predict and stop the fast harmful effects of any xenobiotic in any aquatic system is to test it on experimental organisms for short periods of time. Rapid, environment-relevant information can be gleaned through acute toxicity tests. Evidence from studies of the acute toxicity of various xenobiotics to aquatic creatures demonstrates the extreme specificity of xenobiotic responses. Bakshi found that the 96-hour LC50 Value for Labeo rohita (fingerlings) is 30.36 mg/l and for Heteropneustes fossilis (fingerlings) it is 33.39 mg/l. Mishra and Mohanty's research shows that Channa punctatus has a half-lethal level of chromium inside the form of potassium dichromate salt of 41.75 mg/l (Bloch).Labeo rfrohita has a value of 39.40 mg/l, according to reports [34]. For the purpose of verifying the aforementioned result, Svecevicius [35] has devised an experiment. In the experiment, five types of fish were given large amounts of Cr (VI) all at once. The results revealed that rainbow trout were also 1.16–2.52 times more sensitive to chromium compared to the other fish.Acute toxicity of chromium was reviewed using data from a variety of fish samples, and it was found that the 96-hour LC50 value varies depending on the metal used, the experimental settings, the age of the fish used, and the species of fish being tested. Heavy metal poisoning can cause death for a variety of reasons, some of which are time-sensitive and others that are dependent on concentration levels. Acute toxicity can also be affected by experimental conditions, such as changes in pH, temperature, and other water quality characteristics.

1.2.3 Effect on immune system

Prabakaran et al. [36] made an experiment to study the immune response and non-specific immunity of tilapia fish (Oreochromismossambicus) exposed to sublethal doses. They used chromium (88.2 mg/l), calcium carbonate, and sodium sulphate from a tannery effluent as a model toxicant. ELISA as well as bacterial agglutination assays have been used to figure out the exact immune response of fish to Aeromonashydrophila that has been killed by heat. In the lab, measurements of serum lysozyme activity, intracellular reactive oxygen species (ROS), and reactive nitrogen intermediates (RNI) production by peripheral blood leucocytes (PBL) have all been made to figure out non-specific immune pathways. When fish were exposed to tannery effluent at a concentration of 0.53% for a long time, the amount of reactive oxygen species (ROS), reactive nitrogen intermediates (RNI), and antibody response all decreased significantly. When fish were exposed to tannery waste water at a concentration of 0.053% (1% LC50), they had similar but less severe reactions.The same authors also argue that investigations of this nature might inform crucial considerations. exploring the significance of immunological research in fish health monitoring and risk evaluation.

1.3 CAUSES OF HEAVY METAL POLLUTION

Many human activities, such as the smelting of copper and the processing of nuclear fuels, contribute to the release of heavy metals into the environment. Chromium and cadmium come primarily through electroplating. Heavy metal contaminants can become concentrated and dormant in soils and muds either through the precipitation of their compounds or through ion exchange. Heavy metals, in contrast to organic pollutants, do not decompose and present a unique difficulty for cleanup. Some heavy metals, including mercury, are being tentatively removed using plants or microrganisms. Hyper-accumulating plants can be utilised to clean contaminated soils by sequestering the toxic metals in their organic material. It is common practise to burn vegetation in order to recover heavy metals from mine tailings during the treatment process. Some water sources contain heavy metals like draw, cadmium, iron, hexavalent chromium, aluminium, and magnesium. If these metals are in the sediment, plants and aquatic animals will eat them, and they will eventually move up the food chain. Heavy metal poisoning could happen if the amount of metal in the water is high enough.

2. REVIEW OF LITERATURE

Bakshi, A., et al (2018) conducted a study ofA comprehensive study of changes caused by chromium in freshwater fish. Natural chromium metal is nonexistent, but substance is frequently recognised as among the most prevalent ocean contaminants. Chromium can be in one of three oxidation states: Cr (II), Cr (III), or Cr (VI). Among them, Cr (II) is the most volatile. In nature, Chromium is most commonly found in its stable (III) and (VI) oxidation states. In the cytosol, this trivalent chromium binds to a variety of macromolecules, including DNA, exposing them to the carcinogenic and mutagenic changes that characterise chromium poisoning. With this review, we make an effort to synthesise the mountain of information about chromium's effects on freshwater fish into a coherent whole. The main goal of this study is to give scientists and public officials who assess and manage health risks a set of rules to follow in the future, with the ultimate goal of improving environmental conditions for human health.

Rajeshkumar, S., et al (2017) explained the study on Effects of multiple heavy metal exposure on histopathological and biochemical changes in common carp, Cyprinuscarpio L. In many cases, heavy metals are found in combinations with other, less crucial elements. Thus, a true estimation of their impact on biological systems cannot be obtained from evaluation of their harmful effects in isolation. The common carp was used as a biomarker freshwater fish to study the effects of exposure to mixtures of essential as well as toxic metals (Cr, Cd, and Pb) on the biochemistry, immunotoxicity level, and shape of the different tissues. In the lab, fish were given a mixture of metals in their tank water for 7, 15, or 30 days. This study's findings make it abundantly evident that metals in water can have a profound effect on cytokine levels, leading to immunological suppression or over activation in common carp that has been exposed to high concentrations of any single metal or a combination of metals.

Bhardwaj, S., et al (2015) conducted a study onTilapiamossambica, a freshwater fish, is affected by heavy metal pollution in terms of survival and protein alterations in the liver and intestine. As persistent molecules that are resistant to removal via oxidation, participations, or other processes, heavy metal salts are a particularly pernicious form of pollution due to their negative impact on animal behaviour. Many people have been studying the effects of mercury, cadmium, and zinc, as well as their compounds, on fish, in recent times. Protein content was shown to decrease with rising metal concentrations and respiratory surface injury in the present investigation. Increasing metal concentrations were associated with a decrease in fish survival, as shown in the current study.

Authman, M. M., et al (2015) discussed the study onUse of fish as a bio-indicator of the consequences of contamination from heavy metals. This study provides a concise overview of the research on the dangers of heavy metals to fish. Because they are ubiquitous in aquatic ecosystems and can be detected at detectable levels, heavy metals are among the most worrisome contaminants. Among the most significant contaminants that affect fish and the aquatic environment are heavy metals like mercury, cadmium, copper, lead, and zinc. Fish exposed to certain metals can suffer impaired vital functions, reduced reproductive success, lowered resistance to disease, and other

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pathologies. At the end, suggestions are made for how various wastewaters, sewage, and agricultural wastes can be treated before being released into waterways. In addition, it is important to think about the importance of enforcing rules and regulations that aim to protect aquatic ecosystems.

Kaoud, H. A., et al (2010) explained the study on Bioaccumulation and histopathological alterations of the heavy metals in Oreochromisniloticus fish. Oreochromisniloticus from Egyptian fish farms have elevated levels of copper, lead, cadmium, and mercury in their water and tissue samples taken between 2007 and 2009. Copper, lead, mercury, and cadmium all had bioconcentration factors of 3.93 or higher in liver and muscle tissue, 8.10 or higher in skeletal muscle, and 0.079 or higher in skeletal muscle as well as bioconcentration factors of 38.25 or higher in skeletal muscle. Muscles bioaccumulated and biomagnified mercury at the highest rates, but copper lagged far behind. Mercury (Hg) concentrations were highest in muscles and lowest in kidney tissue, while cadmium (Cd), lead (Pb), and copper (Cu) values were reversed. Muscle, liver, gill, kidney, and intestinal tissue were all shown to have undergone various histological abnormalities as a result of heavy metal exposure.

3. METHODOLOGY

Table 1 shows how the individual infections of intestinal parasites change the amount of HMs in fish tissues.TheTilapia mossambika samples were taken from India, where they were tainted by waste from factories nearby. From November to May, 100 fish were picked out of the collection above at random. Under a microscope, parasites were looked for in fresh fish that had been cut up. In the organs that were hurt, parasites were found and counted. Heavy metals were taken out of seawater by mixing Pb, Cd, Fe, Cu, As, and Zn with concentrated hydrochloric acid (HCl). The FAAS atomic absorption test was then used to look at the samples.

4. RESULT

Table 1: Heavy metals concentrations (mg/g) in Tilapia mossambika muscle tissues single infection of Helminths.

Uninfected	**InfectionWith(Trematodea)**	**PValue**	**InfectionWith(Cestodea)**	**PValue**	**InfectionWith(Nematodea)**	**PValue**
As						
386.03 ± 50.97	902.04 ± 28.20	0.000*	373.25 ± 20.45	0.129	1025.45 ± 217.37	0.001*
Cd						
0.017 ± 0.008	0.005 ± 0.002	0.000*	0.005 ± 0.004	0.03*	0.003 ± 0.001	0.008*
Cu						
0.096 ± 0.046	0.027 ± 0.013	0.057*	0.005 ± 0.001	0.020*	0.023 ± 0.010	0.026*
Fe						
2.949 ± 0.954	6.985 ± 5.029	0.018*	0.191 ± 0.071	0.019*	4.353 ± 2.558	0.248
Pb						
0.076 ±	0.103 ± 0.014	0.210	0.128 ± 0.001	0.001	0.105 ± 0.009	0.011

0.009				*		*
Zn						
0.948 ± 0.326	1.436 ± 0.876	0.441	3.014 ± 2.596	0.032 *	3.640 ± 2.527	0.002 *

The muscle tissues of Tilapia mossambikawere tested for the presence of As, Cd, Cu, Fe, Pb, and Zn using FAAS of single Trematoda (T), Cestoda (C), and Nematoda (N), double Trematoda+ Cestoda (T+C), Trematoda+ Nematoda (T+N), and Cestoda+ Nematoda. Analysis showed that the amount of arsenic in each fish that had been infected with T and N had gone up by a lot. The amount of Cd and Cu in the affected fish went down by a lot. Compared to healthy fish, the amount of iron in single fish with C decreased significantly and the amount of iron in fish with T increased significantly. Lead levels went up a lot in one fish tissue (C and N).

CONCLUSION

Heavy metals have been looked at all over the world, and it has been found that they are bad for aquatic life and, in turn, for human health. There are many pollutants in the water, such as zinc, nickel, lead, cadmium, etc. These pollutants come from both point and non-point sources, such as industrial waste, agricultural waste, and household waste, and they cause damage. This pollutant efflux should be stopped by filtering the waste to reduce water pollution and keep the ecosystem in balance. Chemical and biological indicators should be used to find out if water is polluted. This is the most important step toward making the environment better.

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