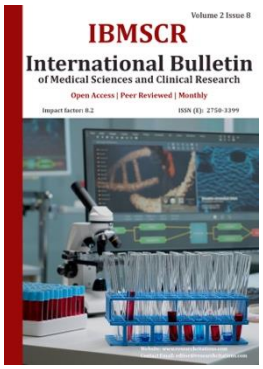

LITERATURE INTERPRETATION ON THE EFFECT OF XENOBIOTICS ON CERTAIN PHYSIOLOGICAL INDICATORS OF FISH

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Annotation

As a result of the increased concentration of xenobiotics in water, it has a negative effect on the reproductive systems of fish. Since heavy metals accumulate in the body of fish, they can easily enter the human body and cause negative consequences. They cause disturbances in the endocrine system of adult female fish, and metal in the amount of 0.52 mg/l inhibits the growth of fish. In general, it has a negative effect on blood circulation, immune, respiratory and hematological systems. Excess copper accumulates mainly in the liver of fish. When examining the morphological and histological parameters of the fish liver (*Cyprinus carpio*), we can see that it caused liver discoloration and necrosis. High levels of copper block catalase enzymes in the liver, muscles, and wounds within 24 hours. Lead blocks the conduction of impulses in fish by reducing the activity of monoamine oxidase and acetylcholine esterase. Lead weakens the immune system and increases susceptibility to infections.

Introduction

According to the literature, when the composition of fish and dairy products sold in some regions of several countries was studied, it was known that the amount of heavy metal salts in their composition increased several times [*Дячук 2002*]. As a result of the increase of such chemical hazardous substances, the observation of various pathological conditions is becoming one of the main medical problems [*Курляндский 2001*]. A number of ongoing studies provide brief reports on the harmful effects of heavy metals accumulating in the body of fish. Among the heavy metals, lead, mercury, copper, cadmium and zinc are the main pollutant and do not affect the ecosystem of water bodies and fish. These metals have a negative effect on the reproductive systems of fish [*Authman 2015*]. Fish have the characteristic of receiving heavy metals in two different ways, the first is directly through the water passing through their wounds and skin, and the second is indirectly through the consumption of water animals that have taken in heavy metals. These metals are mainly accumulated in fatty tissues of fish [2;3]. If dead fish are found in water bodies polluted with high levels of heavy metals, the probability of fish disease in ecosystems with an average level of damage is high [4].

The excess of heavy metal compounds in the environment, considered as adverse environmental factors, can lead to the development of various pathological conditions not only in the digestive system, but also in the whole organism [*Ревич 2002*]. Lead accumulates

in kidney, liver, and bone tissue. It settles in blood cells - erythrocytes and spreads to other tissues [*Луговський 2001*]. In Uzbekistan, it is found a lot in some industrially developed regions and has a negative effect on living organisms [*Гражданкина 2001*].

Also, the production sectors are developing day by day, which in turn is explained by the use of a large amount of fuel products and the direct pollution of water and soil by the resulting secondary products [1]. Heavy metals are formed as a result of natural and anthropogenic factors. Water bodies and organisms living in them are the last receivers of these heavy metals. Heavy metals have a negative effect on the normal physiology of aquatic animals. Especially fish are very sensitive to such factors [*Lakra et.all*]. Fish are mainly considered as bioindicators of heavy metal pollution in water bodies. They affect the ecosystem of water bodies and fish directly or indirectly by affecting the food chain [*Capillo et.all*]. The biological activity of heavy metals and their uptake by living organisms depends on various factors, for example, their concentration, water temperature, pH, interaction with other metals, fish metabolism, feeding behavior, age and size, as well as the physico-chemical properties of the environment [*Delahaut et. all*]. Fish products are a rich source of protein and fatty acids for humans. Due to the fact that heavy metals accumulate in the body of fish, they can easily enter the human body and cause negative consequences [*Yilmaz et.all*]. Heavy metals in the body connect with other biological structures, i.e. nitrogen, oxygen and sulfur, and cause changes in the structure of a number of biological substances, enzymes, proteins and hormones [*Bandai et.all*]. This article discusses a number of heavy metals of current importance and their effects.

Aluminum is the third most abundant element on earth after oxygen and silicon [5]. In the ionic state, it is a highly soluble toxic substance [6]. The toxic nature of aluminum depends on the physical and chemical properties of water, especially pH. If the pH of water is lower than 6.0, aluminum dissolves well and toxicity increases [7]. Aluminum is found in high amounts in the air of well-developed cities [8]. Molting occurred in the fins and fins of aluminum-infected fish. In addition, it causes disturbances in the endocrine system of adult female fish. A metal in the amount of 0.52 mg/l inhibits the growth of fish. In general, it has a negative effect on blood circulation, immune, respiratory and hematological systems [9].

Copper is the main metal and micronutrient for cell metabolism, and it is important in the metabolism of enzymes. If taken in high amounts, it causes misunderstandings in the internal intercellular physiological mechanisms. Copper contamination is mainly caused by substances used against insects, fungi and molluscs in water bodies [10]. For example, copper sulfate ($CuSO_4$) is used not only to control the growth of phytoplankton and algae in water bodies, but also to prevent diseases spread among certain fish [11]. Excess copper accumulates mainly in the liver of fish [12]. When examining the morphological and histological parameters of fish liver (*Cyprinus carpio*), we can see that it caused liver discoloration and necrosis [13]. High amounts of copper block catalase enzymes in the liver, muscles, and wounds within 24 hours [14]. It was known that both hemoglobin and hematocrit increased in the blood of fish under copper-contaminated conditions. Also, this phenomenon is explained by the release or breakdown of erythrocytes in a high amount from the spleen [15]. A reduction in body weight was observed in growing tilapia fish fed 20 mg/kg of copper [16].

Iron is the main part of industry and mining, and its products are constantly released into water bodies. Fe^{+2} ion is more toxic than Fe^{+3} [17]. A high concentration of iron was found

in the liver of fish. Since the surface of fish gills is alkaline, soluble Fe^{+2} is oxidized to insoluble iron oxide and covers the surface of the gills, which prevents oxygen absorption in the gills [18]. Dysfunction in the joint blocks diffusion between water and blood vessels. In addition, iron compounds cover the surface of fish eggs and prevent the supply of oxygen, causing the eggs to die [7].

Lead can enter the body up to 44-100 % through alimentary factors. So, the main indicator of toxicant entering the body is through food. As a result of the influence of various abiotic and biotic factors on food products, it causes the development of various pathological conditions in the organism [*Джатдоева 2001*]. Organisms living in water accumulate lead mainly through water. It is not paid in large amounts through nutrition [19]. Lead accumulates in fish liver, spleen, kidneys, digestive system and wounds [12]. When *C. batrachus* was exposed to lead nitrate for 150 days, a decrease in the amount of lipid and cholesterol in the fish brain was observed, while their amount in the liver increased [20]. Also, lead blocks the conduction of impulses by reducing the activity of monoamine oxidase and acetylcholine esterase [21]. Lead weakens the immune system and increases susceptibility to infections. In the studies conducted on lead, when the effect on the digestive system was studied, it was observed that it blocks the activity of enzymes involved in cavity and membrane digestion, and derails the connection between the enzyme and the substrate [*Садиков 2012*]. In addition, it increases the free radicals in liver mitochondria and destroys oxidation and phosphorylation processes [*Karimova 2017, Karimova 2018*]. Household wastewater, sewage, ash from burnt plants, phosphate and metal ore deposits are the main sources of selenium polluting water bodies. Excess selenium causes stunted growth, tissue damage, disruption of many biomolecules (DNA, protein, and lipid) and reproductive defects in fish [22].

Zinc is the second most important element for living organisms after iron. It is found in almost every cell, in the synthesis of nucleic acids and in many enzymes [23]. Fisheries are mainly affected by zinc alone or by other metals with zinc [24]. Fish kidneys are the organ where zinc accumulates the most [9]. Zinc causes fish mortality, growth retardation, and respiratory and cardiac changes. In addition, it damages the kidneys, liver, skeletal muscles and injuries [24].

The blood of fish is the most important diagnostic element. By examining a number of hematological and biochemical parameters in the blood, we can understand the mechanisms of action of heavy metals. Under the influence of a number of heavy metals, the amount of red blood cells, hemoglobin, leukocytes and lymphocytes significantly decreased. Erythrocytes are considered a very effective parameter in relation to environmental changes. Various heavy metals affect the membrane of erythrocytes and lead to damage. Neutrophils increase to a certain extent mainly under the influence of heavy metals. We can see the results from the fish *Pangasianodon hypophthalmus* that the number of white blood cells increased to a certain extent under the influence of chromium. Although the increase of white blood cells is considered as a normal protective function, under their influence, a significant decrease in the number of white blood cells of carp fish was observed. Due to the fact that heavy metals accumulate mainly in the kidneys and liver, they resist lymphopoiesis and granulopoiesis. As a result, leukocytes decrease. In addition, biochemical indicators of blood (glucose, glycogen, cholesterol and proteins) also show specific changes. Sometimes it was said that under the influence of zinc, cadmium and chromium, the amount of glucose in the blood decreased. This

can be explained by the large amount of energy required to prevent oxidative stress and glycolysis processes. On the other hand, due to the formation of glucose from glycogen through glycogenolysis in some fish species (*Clarias gariepinus, Mastacembelus armatus*) under the influence of copper and iron, the amount of glucose in the blood increases. Due to the effect of metals, the amount of glycogen in the blood decreases due to the blocking of the hormone necessary for glycogenolysis and glycogen synthesis. Under the influence of iron, manganese, zinc, and cobalt, the total protein, lipid, cholesterol, and low density of lipoproteins relatively increase.

Cortisol is stress hormone released by the hypothalamo-pituitary part. This hormone is released especially when fish are damaged by heavy metals. The level of cortisol is related to the amount of glucose in the blood. If this hormone increases in the blood, it increases the processes of glucogenolysis and gluconeogenesis, which in turn increases the amount of glucose in the blood.

The number of blood enzymes (ALT, AST and ALP) increased in fish contaminated with heavy metals. Heavy metals indirectly affect the formation of free radicals in the cells and tissues of fish. Free radicals damage cell membranes and damage DNA. For example, when the fish *Pangasianodon hypophthalmus* was contaminated with Cr metal, the amount of DNA in important organs such as the liver, kidney and liver decreased dramatically.

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