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Determination of Cadmium and Mercury Contamination Level in the Fish of the River Mtkvari

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Abstract

The Mtkvari is the biggest transboundary river in Transcaucasia,originating in Turkey and flowing through Georgia to Azerbaijan. The river is antropogenically polluted and our research aimed to assess the Hg and Cd contamination threat in its water. These heavy metals are significant environmental contaminants and therefore, even their low concentrationsmight are lethal for fish and other water entities.

The research findings showed that there were no Hg and Cd concentrations even in the most antropogenically impacted areas (Zahesi, Vakhushti bridge, Ortachala, Gachiani) of Tbilisi city. Although, small concentrations of these heavy metals were detected in the samples of the fish tissues, taken from the same sample sites, which is caused by the cumulative effect, characteristic of fish. Based on the findings, even in the most anthropogenically impacted regions of the river Mtkvari, there was no concentration of cadmium and mercury detected. There were various fish species that were not contaminated, however it should be mentioned that the cadmium and mercury bioaccumulation process in fish may take place easily and quickly. Fortunately, there are not many industrial processes in Georgia which could cause further ecosystems contamination with cadmium and mercury. Thus, contamination with heavy metals is almost impossible in the Georgian rivers, water ecosystems, hydrobionts and their populations, and the reservoir's bio-communities.

Keywords: the river Mtkvari, cadmium, mercury.

1. Introduction

The irreversible process of technological progress and urbanization increases pollution in man-made water reservoirs and the contaminants from widespread use of chemicals and heavy metals in agriculture, then damage the ecosystems of the rivers. Among the most hazardous of heavy metals are cadmium and mercury, which will be discussed in this study.

In the environment, inorganic mercury can be converted to metal organic compounds and among these compounds, toxic methyl silver is one of the most toxic. It is produced in water due to the biological processes there and through trophic chain transfers from the fish and other water entities to human organisms. As soon as Hg appears in the water, contaminated with organic pollutants, its methylation process starts and it is converted to methyl or dimethyl mercury (CH_3Hg, CH_3HgCH_3), which are the most toxic forms of elemental mercury. Hg contamination of

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rivers is extremely harmful for the fish and other life forms in the water. Moreover, due to its easily soluble nature in fish oil, it is lethal for other living organisms when consumed. It should be mentioned that Hg poisoning is not a rare occurence. The best-known instances of Hg poisoning were in Niigata and Minamata, Japan, when a highly toxic mercury compound was released into the Agano *River*, resulting in the death of thousands of people.

It should be noted that soon Georgia will sign the Minamata Convention and will be obligated to perform the requirements from the convention and create a detailed report regarding the potential threats of Hg contamination in the country. Therefore, to conduct these water contaminant studies in Georgia is a matter of great importance.

Cd is a significant environment pollutant and toxic for hydrobionts and human beings. Even in low concentrations, Cd can still be lethal for fish and entities in the contaminated water. Furthermore, low concentrations of Hg and Cd can have serious toxic effect. Their bioaccumulation and biomagnifications are dangerous to human health and under the influence of natural processes they can become even more hazardous. Due to their persistent nature, they can also have a destructive impact on the environment and cause poisoning of water ecosystems, kill fish, pollute and deteriorate local landscapes.

Our research, conducted at several of the most polluted regions of the river Mtkvari in Georgia, aimed to assess Hg and Cd accumulation level in the fish of the river Mtkvari.

2. Discussion

Research method Colorimetric method (GOST 26927-86) for determination of mercury in the fish samples and atomic absorption method (GOST 30178-96) for determination of cadmium concentration.

The research findings and review: The research was conducted in October, 2017 and the water and fish samples were taken from several sample sites for the purpose of chemical analysis to determine Hg and Cd contamination. The following sites were selected for conducting the research: Zahesi bridge; Vakhushti bridge; Ortachala area; Gachiani.

Table 1. Hg contamination in the fish tissue samples from the river Mtkvari

№	Place sample was taken	Time sample was taken	Finding. mg/kg	Maximum permisible concentration mg/kg	Comment	Method
1	The river Mtkvari (Zahesi bridge,Tbilisi)	16.10.2017	0.005	0.5	Weight of taken samples – 350 gr.	26927-86
2	The river Mtkvari, Tbilisi (Vakhushti bridge)	16.10.2017	0.004	0.5		
3	The river Mtkvari (Ortachala area)	16.10.2017	0.0065	0.5		
4	The river Mtkvari, Gachiani	16.10.2017	0.007	0.5		

Based on the findings, there is no cadmium and mercury concentration in the river Mtkvari. However, Hg concentration was detected in the fish tissue samples, taken at different sample sites in Tbilisi and there are few differences between the findings at both sites. On average, Hg concentration in the fish samples is 006 mg/kg, which is much lower that maximum permissible concentration of 0.5 mg/kg. The findings show, that the water sample from a certain site might not be Hg contaminated, but Hg traces can be detected in the fish tissue sample from the same site. Therefore, it can be concluded, that fish have the ability to absorb Hg quickly and accumulate it in their tissues. According to the data in diagram 1, Hg concentration in the fish increases as the stream of the river flow increases – Hg contamination level in the fish is increased in the greater city area of the river Mtkvari.

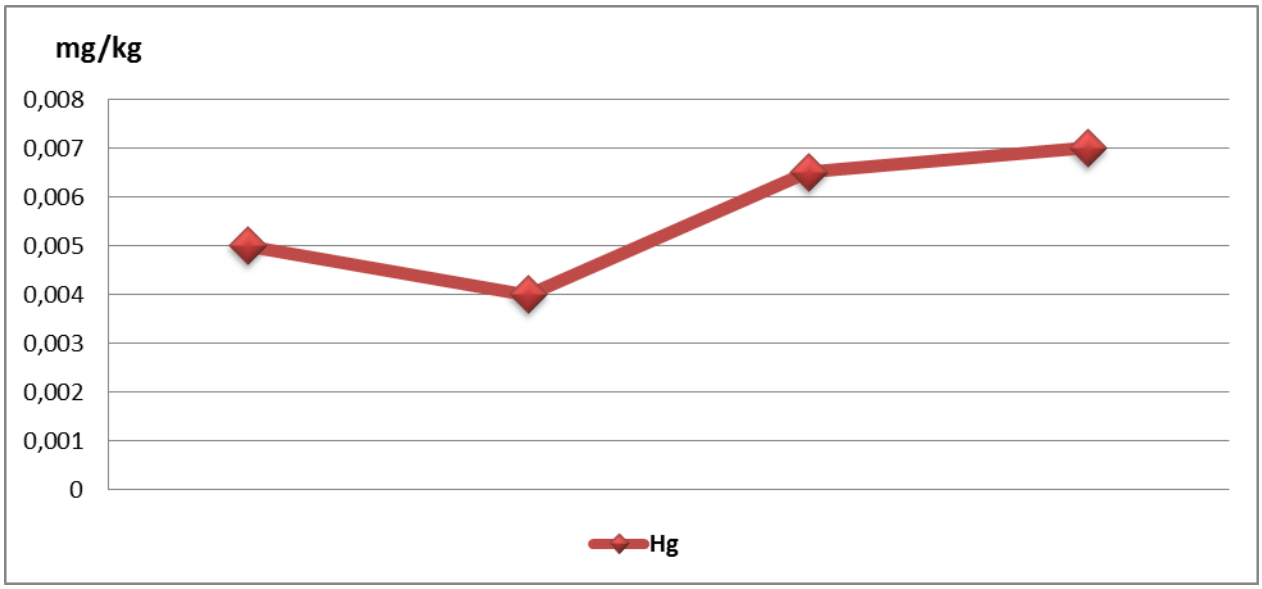

Fig. 1. Hg contamination in the fish tissue samples from the river Mtkvari

Our research findings are relevant and foundational in determining the levels of Hg contamination in the fish of the river Mtkvari, as well as fish in other bodies of water, because it has not previously been conducted in Georgia. Additionally, another research was conducted to determine Cd concentration in the fish from the river Mtkvari. See the findings in the Table 2.

Table 2. The findings

№	Place sample was taken	Time sample was taken	Finding. mg/kg	Maximum permisible concentration mg/kg	Comment	Method
1	The river Mtkvari (Zahesi bridge, Tbilisi)	16.10.2017	0.0110	0.05	Weight of taken samples – 350 gr.	30178-96
2	The river Mtkvari, Tbilisi (Vakhushti bridge)	16.10.2017	0.0112	0.05		
3	The river Mtkvari (Ortachala area)	16.10.2017	0.0116	0.05		
4	The river Mtkvari, Gachiani	16.10.2017	0.0118	0.05		

The highest concentration of Cd (0,0118 mg/kg) detected in the fish tissue, taken from Gachiani sample site, is much lower than maximum permissible concentration (0,05 mg/kg) and an even lower concentration (0,0110 mg/kg) was detected in the fish samples taken from the sample site near Zahesi bridge. The findings show that Cd concentration in the fish rises more sharply with the increased river flow than in case of Hg (Figure 2). It should also be noted, that once absorbed Cd displaces Ca, which is a vital element in the formation and maintenance of bones and can cause bone demineralization and other undesirable changes at the cellular level.Diagram shows the tendency of Cd contamination in the fish of the river Mtkvari.

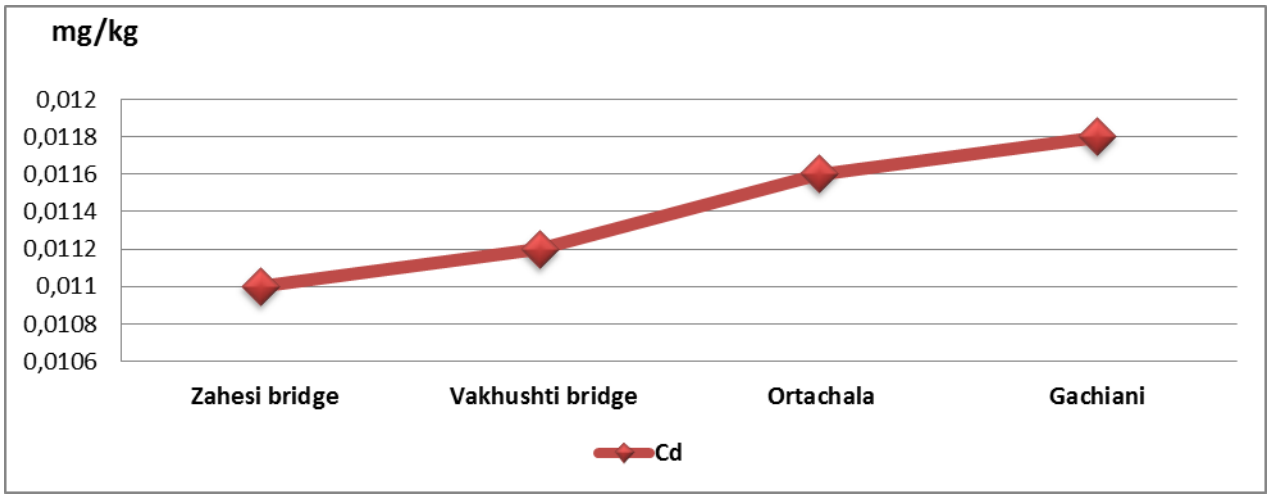

Fig. 2. Cd contamination in the fish tissue samples from the river Mtkvari

3. Conclusion

The research findings show that a cumulative action-accumulation of toxic substances – is characteristic of fish and the toxins, even when Cd and Hg concentration in the water is very low it still influences them. As hydrobionts concentrate toxins in the body, they become toxic to the host.

Based on the findings, even in the most anthropogenically impacted regions of the river Mtkvari, there was no concentration of cadmium and mercury detected. There were various fish species that were not contaminated, however it should be mentioned that the cadmium and mercury bioaccumulation process in fish may take place easily and quickly. Fortunately, there are not many industrial processes in Georgia which could cause further ecosystems contamination with cadmium and mercury. Thus, contamination with heavy metals is almost impossible in the Georgian rivers, water ecosystems, hydrobionts and their populations, and the reservoir's bio-communities.

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