7th Workshop

SPECIFIC METHODS FOR FOOD SAFETY AND QUALITY

September 22nd 2021, Vinča Institute of Nuclear Sciences - National Institute of the Republic of Serbia, University of Belgrade, Belgrade, Serbia

PROCEEDINGS

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IL B5

TOXIC METALS CONTENT IN MUSCLE TISSUE OF COMMON CARP FROM LOCATIONS NEAR BELGRADE

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ABSTRACT

The aim of this study was to determine the contamination of some toxic metals (Pb, Cd, Hg and As) in muscle tissue of Common carp (*Cyprinus carpio*) from four different localities (Veliko Blato, Grabovac, Mokri Sebeš and Bečmen) near Belgrade. Generally, the highest average content of lead, cadmium, mercury and arsenic was found in fish muscle tissue from lake Veliko Blato. Concentrations of Pb, Hg and As were under the maximum residual levels prescribed by the European Union (EU) and the maximum allowed concentrations (MAC) for Serbia. In all investigated samples, levels of Cd exceeded MAC values. Data on the finding of toxic metals in fish at the same time speak about the safety of fish as food and can be an indicator of environmental pollution.

INTRODUCTION

In the diet of people, fish occupy a significant place as a biologically valuable food. Due to its nutritional value, which is reflected primarily in easily digestible proteins, as well as due to the high content of ω-3 polyunsaturated fatty acids (PUFA), fish meat is a highly valuable food that is important for proper nutrition and health protection for all categories of people [1]. However, fish, like other foods, can sometimes endanger the health of consumers. Potential foods, including fish, can contain chemical compounds that can harm human health. Imbalances in industrial development and inadequate environmental protection measures lead to an increasing presence of toxic metals in the environment [2]. As a consequence, the pollution of ecosystems, *i.e.* water, sediments and sludge, has increased, which directly affects the quality of aquaculture products. It is assumed that a direct transfer of pollutants from sediment to aquatic organisms is the main route, *i.e.* the way in which pollutants are transferred to many aquatic species, and thus to fish. In this way, fish are significantly susceptible to chemical contamination by ubiquitous

pollutants such as toxic metals, which are further accumulated in their tissues [3]. The high content of toxic metals in fish can reduce the positive effect of taking fish and they are associated with serious adverse effects on the health of children and adults [4].

The aim of this paper is to determine the content of toxic metals in the muscle tissue of the Common carp caught from around Belgrade and to determine whether the fish is safe as a food for human consumption, but also to determine the state of the ecosystem and the level of pollution.

EXPERIMENTAL

For this study, seven fish samples were taken from each locality (Veliko Blato, Grabovac, Mokri Sebeš and Bečmen) near Belgrade. The samples were caught by professional fishermen at the end of 2018. The locations of sampling sites are shown in Figure 1.

Figure 1. Map of fish sampling sites.

In order to determine toxic metals in 28 samples of muscle tissue of Common carp (*Cyprinus carpio*), all individuals were identified to species level. Fish samples were quickly frozen and stored at −20 °C. The samples were defrosted in a laboratory at room temperature and mechanically homogenized. For the determination of toxic metals, fish muscle portions of 1 ± 0.001 g were weighed out. Fish samples were digested using a microwave closed system MW 3000 (Anton Paar, Graz, Austria) with a mixture of HNO_3-H_2O_2 (1:1 v/v). The content of Pb and Cd was determined by atomic absorption spectrometer (Perkin Elmer Analyst 700, USA) using graphite furnace (GFAAS-800). According to the manufacturer's instructions, various modifiers were used for the determination of Pb (primary ammonium phosphate) and Cd (mixture of

magnesium nitrate and palladium chloride). Determination of Hg was analyzed with cold vapour techniques (CVAAS) using a hydride system (MHS 15) after reduction by $NaBH_4$ and As was measured as volatile hydrides (HGAAS) after treatment with $NaBH_4$ (MHS 15). All collected samples were analyzed in duplicate, and the results are expressed as mean ± standard deviation.

RESULTS AND DISCUSSION

Toxic metals among environmental pollutants have a particularly important place. The content of toxic metals in fish muscle is given in Table 1. The concentrations in fish meat (*i.e.,* muscle samples) were compared with the maximum allowed concentrations (MAC) in fish meat for the utilization in the human diet, as established by the European Union [5] and the Official Gazette of the Republic of Serbia [6]. According to the legislation [5, 6], the MAC for Pb, Cd, Hg and As are 0.30, 0.05, 0.50 and 2.0 mg kg^{-1} w/w, respectively.

Table 1. Average content (mg kg^{-1}; $\overline{X}$ ±Sd) of toxic metals in the muscle tissue of the Common carp.

Locations	Toxic metals			
	Pb	Cd	Hg	As
Veliko Blato	0.038^{ABC}±0.003	0.077^{A}±0.004	0.413^{A}±0.012	0.397^{AB}±0.013
Grabovac	0.030^{A}±0.004	0.067±0.010	0.385±0.022	0.337^{A}±0.021
Mokri Sebeš	0.031^{B}±0.005	0.063^{A}±0.003	0.332^{A}±0.015	0.370±0.004
Bečmen	0.032^{C}±0.006	0.067±0.007	0.375±0.012	0.278^{B} ±0.004

Legend: Same letters A, B, C – $p < 0.01$

The obtained results of Pb showed the least variation in absolute values in relation to all other tested toxic metals and ranged from 0.030 ± 0.004 mg kg^{-1} (Grabovac) to 0.038 ± 0.003 mg kg^{-1} (Veliko Blato). The lower results of Pb content (0.0189 – 0.0301 mg kg^{-1}) in relation to ours were found in the muscle tissue of omnivorous fish in fishpond near Belgrade [7]. In the location of the Danube near Belgrade, the results of Pb in muscle tissue of Common carp were similar and ranged from 0.030 mg kg^{-1} to 0.040 mg kg^{-1} [8]. Compared to our results, a higher lead content (0.95 – 1.30 mg kg^{-1}) was observed in the muscle tissue of Common carp caught from Buško Blato, a lake in Bosnia and Herzegovina [9]. Increased Pb levels in the environment are most often derived

from metallurgical combiners and such high levels indicate that the living world in lakes can be a good indicator of the state of the environment. All obtained results of Pb in muscle tissue of Common carp are significantly below the maximum allowed values of 0.30 mg kg^{-1} [5, 6].

The highest content of Cd was determined in the Common carp caught from the lake Veliko Blato and was significantly ($p < 0.01$) higher, from location Mokri Sebeš. All obtained results in muscle tissue of Common carp are above the maximum allowed values of 0.050 mg kg^{-1} [5, 6]. Almost identical results (0.058 to 0.067 mg kg^{-1}) to our were determined in the muscle tissue of omnivorous fish species in fishponds around Belgrade [7]. Also, similar values of Cd ranged from 0.051 to 0.057 mg kg^{-1} were found in the muscle tissue of Prussian carp caught from the river Danube near Belgrade [8]. As in recent years was probably enlarged use of Cd in industrial processes, which has resulted in an increased concentration of this toxic metal in the environment [10]. On the other hand, the obtained results indicate that this may be the current increased concentration of this element, and it would be useful to introduce monitoring the level of Cd in fish and rivers around Belgrade.

In the tested samples, determined Hg contents showed a slight variation. The smallest content (0.332 ± 0.015 mg kg^{-1}) was found in the muscle tissue of the Common carp peaked from Mokri Sebeš which were significantly ($p < 0.01$) lower in relation to the highest results (0.413 ± 0.012 mg kg^{-1}) found in samples taken from Lake Veliko Blato. In the region of Belgrade, different values of Hg in the muscle tissue of the fish were found in the near-term. Lower mercury content (0.077 – 0.095 mg kg^{-1}) compared to our results was confirmed in the muscle tissue of omnivorous fish (Prussian carp) from the Danube upstream from Belgrade [11]. Recorded values were in the range of 0.387 mg kg^{-1} to 0.485 mg kg^{-1} and the Hg content was close to the MAC prescribed by the Rules [5, 6]. This can be interpreted as the ability of Hg to concentrate in fish flesh. The regulation of the mercury in the fish and its detoxification is such that the content of Hg in the fish grows mainly with age so that the meat of older fish tends to accumulate larger amounts of Hg.

The highest concentrations of As were found in the muscle tissue of Common carp from lake Veliko Blato and were significantly ($p < 0.01$) higher than the results of fish samples from the lake Grabovac and Bečmen. Lower content of the As was determined in the muscle tissue of the Common carp (0.139 ± 0.006 mg kg^{-1}) in the Danube [8]. On the other hand, the muscle tissue of Common carp from a fishpond near Belgrade contains an approximate level of As (0.252 to 0.378 mg kg^{-1}) compared to our results [7]. Arsenic in water is mostly due to industrial plants, natural deposits in the country, and the use of artificial fertilizers and insecticides [12]. In all the examined samples of

Common carp muscle tissue from the region near Belgrade, established values did not exceed 2 mg kg^{-1}, prescribed by Rules [5, 6].

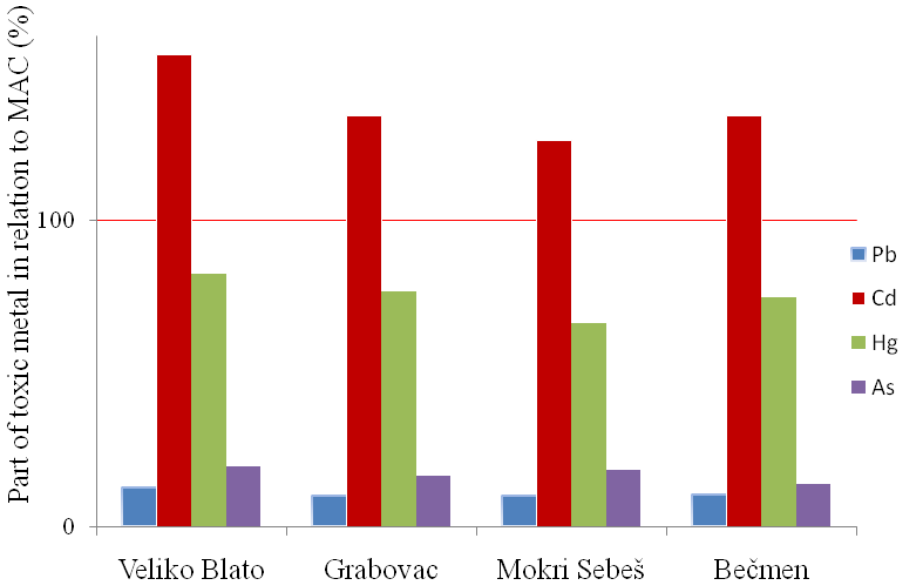

Figure 2. Toxic metal content in relation to the maximum allowed concentration.

The highest concentration of all examined toxic metals in relation to MAC was recorded for cadmium, which is above the legal limit. Cadmium concentrations in samples of Common carp were 26% (Mokri Sebeš), 34% (Grabovac and Bečmen) and 54% (Veliko Blato) above the MAC (Figure 2). The second most represented metal in relation to MAC was mercury, but it did not exceed the allowable value (66.4 – 82.6% in MAC), while the part of As and Pb in MAC was below 20%. The obtained results showed that the highest content of all examined toxic metals was recorded at the lake Veliko Blato which is located in the immediate vicinity of the industrial zone. It is obvious that the industry largely contributes to the increased concentration of toxic elements in water and thus in fish.

CONCLUSION

The study of toxic metals in the muscle tissue of the Common carp from locations near Belgrade revealed statistically significant differences in their content. In all tested samples, the content of Pb, Cd, Hg and As was highest in fish caught from lake Veliko Blato. The content of Pb, Hg and As in fish muscle was below the MAC in the Republic of Serbia and EU Regulations. In all examined samples, a higher amount of Cd was recorded than is prescribed

by Serbian and European regulations. Higher concentrations of Cd can be explained by anthropological influence, the development of the industry and wastewater discharge. Finally, the results of this study show that it is necessary to introduce control of potential industrial pollutants with continuous monitoring of aquatic ecosystems.

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