

## CONTENT AND DISTRIBUTION OF HEAVY METALS IN ORGANS AND TISSUES OF FRESHWATER FISH IN THE ZAPADNA MORAVA RIVER

SAŠA OBRADOVIĆ<sup>1</sup>, ALEKSANDAR IVANČ<sup>2</sup>, VERA ĐEKIĆ<sup>3</sup>,  
MILANKO ŠEKLER<sup>4</sup>, MILICA ŽIVKOV-BALOŠ<sup>5</sup>, NENAD VELJOVIĆ<sup>6</sup>,  
BRANISLAV ŠARČEVIĆ<sup>7</sup>

<sup>1</sup>*Faculty of Economics and Engineering Management, 2 Cvecarska Street,  
21000 Novi Sad, Serbia*

<sup>2</sup>*State University of Novi Pazar, Vuka Karadžića Street, 36300 Novi Pazar, Serbia*

<sup>3</sup>*Center for Small Grains, 31 Save Kovačevića Street, 34000 Kragujevac, Serbia*

<sup>4</sup>*Veterinary Specialist Institute, 34 Žička Street, 36000 Kraljevo, Serbia*

<sup>5</sup>*Scientific Institute of Veterinary Medicine, 20 Rumenački put Street,  
21000 Novi Sad, Serbia*

<sup>6</sup>*Faculty of Industrial Management Business, 2 Ive Andrića Street,  
11400 Mladenovac, Serbia*

<sup>7</sup>*Ministry of Agriculture, Forestry and Water Management, 1 Omladinskih brigada  
Street, 11070 Belgrade, Serbia*

### SADRŽAJ I DISTRIBUCIJA TEŠKIH METALA U ORGANIMA I TKIVIMA SLATKOVODNIH RIBA ZAPADNE MORAVE

#### *Apstrakt*

Uzimajući u obzir da se u vodenoj sredini ribe nalaze na vrhu lanca ishrane, česta je pojava da u svom organizmu akumuliraju određene količine teških metala zbog čega se smatraju jednim od najosetljivijih akvatičnih organizama na prisustvo toksičnih materija. Pošto meso ribe predstavlja jednu od značajnih komponenti ljudske ishrane, prekomerna akumulacija teških metala u muskulaturi riba čini ovu namirnicu zdravstveno nebezbednom za ishranu ljudi.

U radu su analizirane koncentracije teških metala kadmijuma (Cd), olova (Pb), žive (Hg) i cinka (Zn) u mišićnom tkivu i jetri bentosnih i omnivornih vrsta riba, uzorkovanih u ekosistemu Zapadna Morava. Cilj rada bio je dobijanje potpunijeg uvida u stepen akumulativnosti ili opterećenosti teškim metalima, kako vode kao ambijenta u kojoj ribe žive, tako i ribljeg mesa kao namirnice.

Na osnovu ispitivanja prisustva teških metala u srebrnom karašu (*Carassius gibelio*) i deverici (*Abramis brama*) utvrđeno je prisustvo sva četiri analizirana metala, ali u

koncentracijama ispod maksimalno dozvoljenih količina (MDK). Na osnovu utvrđenih rezultata može se konstatovati da ekosistem Zapadne Morave pokazuje trend poboljšanja kvaliteta u pogledu opterećenosti antropogenim zagađenjem i da je meso ispitivanih vrsta riba zdravstveno bezbedno i higijenski ispravno za ishranu ljudi. Takođe, relativno niski sadržaji teških metala u jetri riba jasno ukazuju da je u ovom ekosistemu došlo do znatnog sniženja stepena zagađenosti vode i sedimenta u odnosu na ranije periode ispitivanja.

*Ključne reči: teški metali, reka Zapadna Morava, deverika, srebrni karaš*  
*Keywords: heavy metals, Zapadna Morava River, bream, silver carp*

## INTRODUCTION

Fish meat is highly appreciated food in human diet. Besides nutritional value in terms of consumer, its hygienic and health safety is also significant. It is well known that the fish population from land waters (open and closed) is important as natural biological resource of animal proteins needed in human diet. Although man usually use fish meat supplies from the sea and aquaculture, it is not insignificant amount of fish which we got by commercial and recreational fishing in freshwaters.

Most of freshwater ecosystems are, due to urbanization, industrialization and other forms of human activity, permanently exposed to the influence of various forms of water pollution. Because of that, biota representatives in it, and especially fish populations, suffers serious consequences, but also a man as their consumer. Fish come to contact with these pollutants through skin or gills and by feeding (plankton, benthic fauna, detritus, plant material), while predatory fish species intake metals into the body through other fish with which they are fed. This way, metals enter directly through bloodstream into the liver, kidneys and muscle tissue, where they are, more or less, accumulated (Has-Schön et al. 2006).

According to available literature data, fish population of The Zapadna Morava River ecosystem are systematically exposed to influence of numerous pollutants, especially toxicants of anthropogenic origin, generally known as POPs - *Persistent organic pollutants* (Veljović and Spasojević, 1992; Lazić et al., 2003; Marković and Lenhardt, 2007).

The main goal of this research is to determine accumulation level of heavy metals (lead, cadmium, mercury and zinc) in muscle tissue and liver of Prussian carp (*Carassius gibelio*) and bream (*Abramis brama*). Thus we would be able to estimate possibility of using different fish tissue and organs as heavy metals pollution indicator, as well as assessment of health safety of their meat in human diet. At the same time information about concentration of metals stored in the fish liver would indicate the degree of water and sediment pollution in the ecosystem of The Zapadna Morava River.

## MATERIAL AND METHODS

Heavy metal contamination of muscle tissue and the liver of fish species were analyzed, for Prussian carp as allochthonous species and bream as autochthonous species in ecosystem of The Zapadna Morava River, profile site Stančići 9 km location downstream from Čačak.

In choosing this fish species it was taken care of its trophic level and their representativeness in aquatic ecosystem. Both examined species are benthic and omnivorous, as such they accumulate the highest concentration of examined heavy metals. As for the choice of heavy metals whose content was analyzed in fish muscles and liver, we chose cadmium and lead as highly toxic, zinc because of its competitive bond with cadmium and highly toxic mercury whose toxic effect on fish manifests at concentrations of 0,003 mg/l in water.

The fish were caught by using nets with different mesh size, so that there would be specimen representatives of different age and size in the sample. In total we caught 19 specimens, 11 individuals of Prussian carp and 8 individuals of bream. After dissection we took samples of muscle tissue (left dorsal muscle) and liver, by which the collective composite samples of muscle tissue and liver were prepared for each fish species separately. Analyses were conducted according to standard methodology for quantitative analysis for heavy metals, by which we used necessary instrumental techniques. By atomic absorption spectrometry method (flame technique - FAAS) we determined contents of Cd, Pb and Zn, while the content of Hg in tissues and organs was determined by HGAAS method (absorption spectrometry method - hydride technique). Determined concentrations of heavy metals in edible parts of the fish were compared to allowed values of maximum acceptable concentrations (MDK) provided by national regulation (Anonymous 2011 Gazette Republic of Serbia 25/2010, 28/2011).

## RESULTS AND DISCUSSION

Results of analyzed parameters in fish muscle and liver are shown in Table 1.

**Table 1.** Content of heavy metals in fish samples wet weight, mg/kg

Fish species	Organ	Cd	Pb	Hg	Zn
Prussian carp n = 11	muscle tissue	0,004	0,324	0,135	17,392
	liver	0,084	0,372	0,152	18,190
Bream n = 8	muscle tissue	0,005	0,193	0,098	19,286
	liver	0,012	0,231	0,112	32,152

Based on this table results, we can conclude that the concentration of heavy metals in examined fish muscle mass was lower in relation to their content in the liver. The lowest values of metal in muscle tissue were established for cadmium and they varied from the range of 0,004 mg/kg in Prussian carp to 0,005 mg/kg in bream. These are below the prescribed MDK.

Reference concentrations are determined in terms of the content of analyzed metals in fish muscles. Average value of lead was 0,324 mg/kg in Prussian carp, while it was 0,193 mg/kg in bream. Maximum acceptable lead concentration, according to regulations is 0,3mg/kg. Mercury concentration varied in range of 0,098 mg/kg in bream to 0,135 mg/kg in Prussian carp. Upper limit of MDK for this parameter in edible parts of the fish is 0,5 mg/kg. Content of zinc was also acceptable and it varied from 17,392 mg/kg in Prussian carp muscle mass to 19,286 mg/kg in bream. By the book of regulations, the allowed concentration for this metal was not determined, but according to the same legislation, maximum content of Zn in fish products and tin containers is up to 100 mg/kg.

Comparing the average values of content for examined metals in muscle tissue of Prussian carp and bream, to the data quoted by other researchers (Veljović et al., 1992;

Lazić et al., 2003; Marković and Lenhardt 2007), it can be concluded that accumulation of metals in fish from The Zapadna Morava River is decreased in comparison to previously determined values.

The part of the research related to metal content in liver of analyzed fish species clearly show that aquatic ecosystem of The Zapadna Morava River is not loaded with pollutants from industrial and communal waste, although this ecosystem is their main recipient. The reason for this is lower level of industrialization and closing of many factories.

Determined concentrations of heavy metals in Prussian carp and bream liver (Table 1) varied within normal physiological concentrations for all four chemical elements and were below the level of tolerance for human consumption (Biro et al., 1991). This means that the water flow of The Zapadna Morava River on examined profile, can be considered relatively pollution free in terms of loading with heavy metals (Cd, Pb, Hg and Zn). According to Oloj et al., (2005) because of biological degradability, and ability to accumulate along the food chain, heavy metals are considered to be one of the main pollutants of internal fish organs and entire aquatic system.

The results of this research point to the necessity of continuous sampling and analyzing this water flow in order to prevent accidental situations and maintaining health safety of fish meat in this water flow. To be able to make the final assessment of the hygienic quality of fish meat for human consumption and the ecological status of this ecosystem, it is necessary to conduct complex analyses, which would consider: determination of heavy metals content in water, sediment and commercially important fish species from ichthyofauna of the Zapadna Morava River. The necessity of this type of research suggest some other authors as well (Đukić et al., 1998., Teodorović et al. 1999., Farkas et al., 2002).

## CONCLUSIONS

Considering that the fish are usually at the top of the food chain, they often accumulate huge amounts of certain heavy metals, so they are considered to be one of the most sensitive aquatic organisms to presence of toxic substances. Since the fish meat presents one of the essential components of human nutrition, excessive accumulation of heavy metals in fish muscles make this food unsafe for human consumption.

The content of heavy metals (Cd, Pb, Hg and Zn) in muscle tissue of benthic and omnivorous fish species of Prussian carp and bream from The Zapadna Morava River, was within MDK limits and in accordance with established legal acts on the contents of metals and other toxic substances that can be found in food.

Based on conducted research, we can conclude that the ecosystem of The Zapadna Morava River shows the trend of improvement in the quality of the load in terms of anthropogenic pollution, for the registered amounts of heavy metals stored in the liver of silver carp and bream varied in the range of normal physiological concentrations.

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