

Heavy metals in the common carp (*Cyprinus carpio* L.) from two reservoirs in the Czech Republic

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Abstract: Concentrations of heavy metals (cadmium, lead and mercury) in selected tissues of common carp (*Cyprinus carpio* L.) fished from two reservoirs in the Czech-Moravian Highland (Pilska and Domanin reservoirs) were measured during the period April - August 2013. A difference in the contents of heavy metals in fish samples from the two reservoirs (Pilska and Domanin reservoirs) was demonstrated. The content of all analyzed heavy metals in carp tissues was higher in the Domanin reservoir than in Pilska reservoir. The difference in mercury concentrations was also found; it was three times higher in tail muscles than in the liver. Cadmium concentration in the liver was higher than in the muscles. No difference was found in lead contents between muscles and the liver. The obtained data was in agreement with the standards except for cadmium contents in the liver. Therefore human consumption of the common carp from Czech-Moravian Highland does not pose any health risk concerning concentrations mercury and lead.

Key-Words: fish, mercury, cadmium, lead, atomic absorption spectrometry

Introduction

Fish is considered as an integral component of healthy diet, the source of high quality protein, vitamins, minerals, omega-3 fatty acids and a wide range of other important nutrients. On the other hand, fish generally accumulates contaminants from the aquatic environment and can transfer toxic metals to humans via the food chain. Fish are widely consumed and for this reason the contents of heavy metals in fish tissues is highly important for human health safety. Water pollution resulted in fish affection with toxic metals. This pollution has different causes and different sources e.g. accidental spillage of chemical wastes, periodic precipitation contaminated with airborne pollutants, discharge of industrial or sewerage effluents, agricultural drainage, domestic wastewater and gasoline from fishery boats [1,2].

Cadmium, mercury and lead are of particular interest for fisheries and consequently may pose health risk to humans [3]. Heavy metals enter the bodies of fish in three ways: through the body surface, the gills or the digestive tract [4]. In fish, the toxic effects of heavy metals may influence the physiological functions, individual growth rates, reproduction and mortality [5].

The *Cyprinus carpio* L. fish species, inhabiting the Pilska and Domanin reservoirs and being extensively consumed by the local population, were

selected for the analysis. The goal of the study is to evaluate health safety of fish for human consumption.

Material and Methods

Sampling and storage

Fish (*Cyprinus carpio* L.) were caught from April to August 2013 in two locations of Czech-Moravian highland, Czech Republic. First site – Pilska reservoir (Fig. 1) – is located 3.8 km north of Žďár nad Sázavou. The second place – Domanin reservoir (Fig. 1) – is located 6.8 km west of Bystřice nad Pernštejnem. Possible contamination of water system - major roads, inflows to the reservoirs and the near uranium mines.

Fish were caught on bait containing bread and potatoes. Caught fish were killed, and samples tail muscle and liver were collected. Samples were kept in a plastic bag at -20°C in the freezer. For each fish was recorded: weight and length of the fish, sex and sampling location.

Determination of mercury

For the determination of total mercury in the samples was used atomic absorption spectrometer AMA 254 (Altec, Czech Republic). The samples were directly weighted (100 mg ± 0.1 mg) into pre-cleaned combustion boats, and inserted into the AMA 254 analyser.

Fig. 1 Designation locations on the map



The samples were dried at 120°C for 60 s and thermally decomposed at 550°C for 150s. The limit of detection for the determination of mercury is 0.01 ng Hg.

Determination of cadmium and lead

Before analysis the fish samples were lyophilized (Power Dry LL 3000, Thermo Scientific, USA) for 7 days and subsequently mineralized in microwave oven for 20 min. For mineralization was used 0.4 mg and 8 ml nitric acid (1:1). Cadmium and lead were determined by electrothermal atomic absorption spectrometry (CONTRAA 700, Analytik Jena, Germany). Cadmium was measured at the wavelength 228.8 nm and lead was measured at the wavelength 283.3 nm.

Table 1 Limits of detection

	Tissue	$\mu\text{g}\cdot\text{kg}^{-1}$ FW
LOD cadmium	Muscle	0.51
	Liver	0.62
LOD lead	Muscle	4.93
	Liver	5.96

*FW – fresh weight

Statistical analyses

Statistical analyses of metal content in tissues were made using one-way analysis of variance (ANOVA) in program STATISTICA. Statistical significance was declared when p value was equal to or less than 0.05.

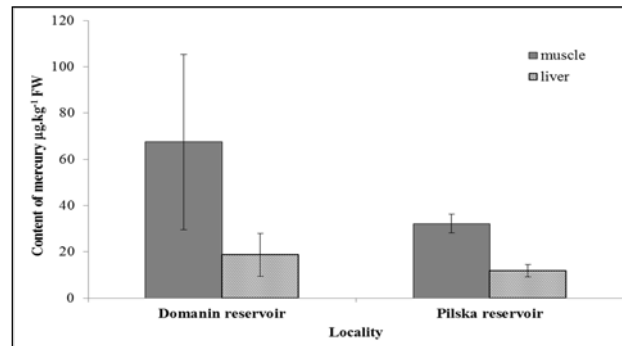
Results and Discussion

Carp (*Cyprinus carpio* L.) was selected for monitoring bioaccumulation of mercury, cadmium and lead in selected water ecosystems. Carp is omnivorous fish with the widest food web (aquatic plants, aquatic worms, protozoa,...) and is one of the most consumed fish in the Czech Republic.

In Pilska reservoir were analyzed 12 samples (3 female and 3 male, in length range 46 – 52 cm, in the range of weight 1.0 – 3.1 kg), in Domanin reservoir were analyzed total 18 samples (4 female and 5 male, in length range 42 – 52cm, in the range of weight 1.7 – 3.1 kg).

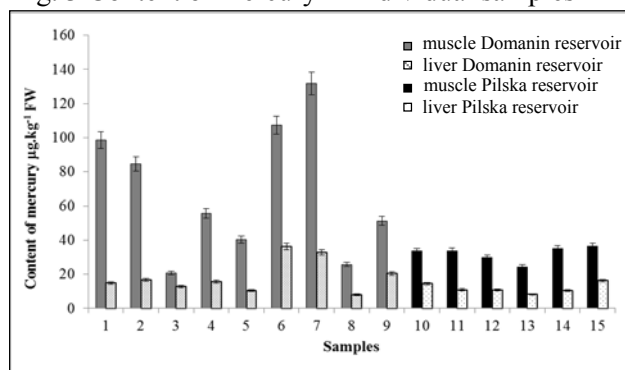
The average mercury content was in Domanin reservoir statistically higher than in Pilska reservoir in both tested tissues ($p < 0.05$) (Fig. 2).

Fig. 2 Content of mercury in tail muscle and liver fish of both locations



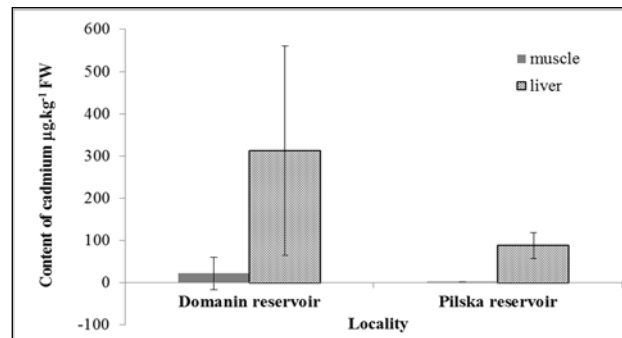
Content of mercury was statistically significant higher in tail muscle than in the liver ($p < 0.05$) (Fig. 3). Svobodová et al. [3] presents that higher mercury content in muscle than in the liver shows low or no contamination of the locations. On the basis of this argument, is possible to consider both reservoirs (Domanin, Pilska) as uncontaminated.

Fig. 3 Content of mercury in individual samples



Content of cadmium in Domanin reservoir was significantly higher ($p < 0.05$) than in Pilska reservoir (Fig. 4).

Fig. 4 Content of cadmium in tail muscle and liver fish of both locations

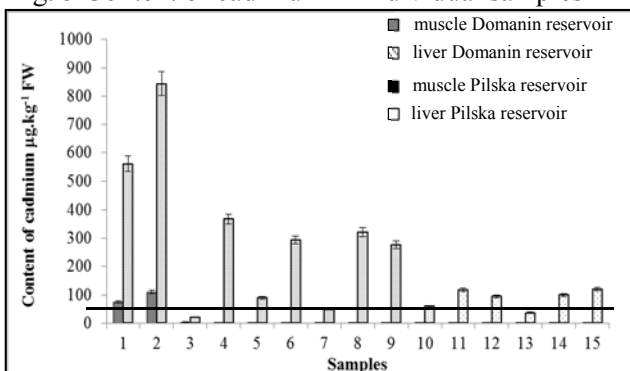


Cadmium content was significantly higher in the liver than in the muscle samples (Fig. 5). Visnjic-Jeftic et al. [6] presented very similar conclusions. They studied heavy metal and trace element accumulation in muscle, liver and gills of the Pontic shad (*Alosa immaculata* Bennet 1835) from the Danube River (Serbia). They found the highest concentration of cadmium in liver ($0.714 \pm 0.323 \mu\text{g/g}$ dry weight) and approximately half the amount in muscle ($0.433a \pm 0.181 \mu\text{g/g}$ dry weight). Cadmium is metabolized in the liver, what caused the higher content in this tissue [7].

Two fish samples contained statistically significantly higher cadmium contents in both tested tissues ($p < 0.05$). This fish were caught in the spring, when the *Cyprinus carpio L.* are still living at the bottom of reservoir and in the sediment.

Cadmium concentration in fifteen liver samples exceeded the Czech standards ($50 \mu\text{g.kg}^{-1}$), see the bold line in the Fig. 6. The livers are not normally consumed by humans, so there is no recommendation for limit concentration.

Fig. 5 Content of cadmium in individual samples



The lead content in carp tissues in Domanin reservoir was statistically higher than in Pilska reservoir ($p < 0.05$) and no difference in lead concentration was found between muscles and liver (Fig. 6, 7).

Fig. 6 Content of lead in tail muscle and liver fish of both locations

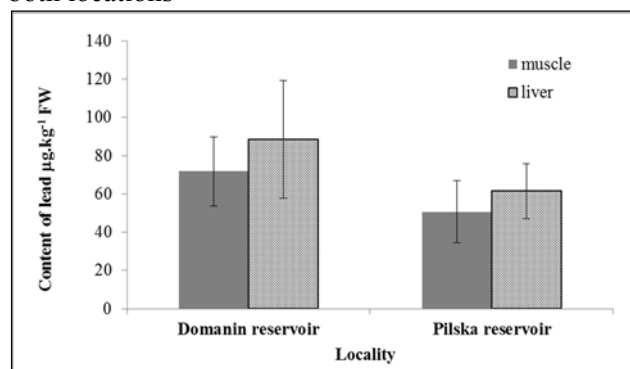
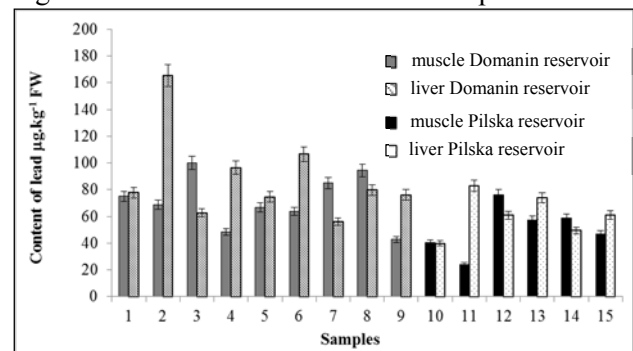


Fig. 7 Content of lead in individual samples



Conclusion

The results obtained in this work showed the differences in the contents of heavy metals between the two locations (Pilska and Domanin reservoirs). The contents of all the metals under analysis were higher in samples from the Domanin reservoir than from the Pilska reservoir. The major cause may be a recent clearing of the Skalsky reservoir, which is the main tributary of the Domanin reservoir. Another cause may be the vicinity of major routes. The difference in mercury concentrations in the analyzed tissues was also found; the concentrations in tail muscles were three times higher than in the liver. Cadmium content in the liver was higher than in the muscles. Lead concentrations did not differ in the studied samples.

The total mercury concentration in muscle tissues ranged from 20 to $132 \mu\text{g.kg}^{-1}$ and in the liver from 8 to $36 \mu\text{g.kg}^{-1}$ in both reservoirs. Cadmium concentrations in tail muscles ranged from 1 to $110 \mu\text{g.kg}^{-1}$, in the liver from 19 to $844 \mu\text{g.kg}^{-1}$ from both reservoirs. Lead concentrations in muscle tissues ranged between 24 and $101 \mu\text{g.kg}^{-1}$ and in the liver between 39 and $166 \mu\text{g.kg}^{-1}$. The contents of individual elements in carp tissues from the two reservoirs were compared. The obtained data were in agreement with the standards except for cadmium contents in the liver. Therefore human consumption of the common carp does not pose any health risk concerning mercury and lead concentrations. In most liver samples, cadmium concentrations exceeded the health safety limit. With regard to the fact, that the liver is not massively consumed this does not represent a health risk. In two carps caught in the spring, increased content of cadmium was also found in the muscles, which could be caused by fish overwintering in the reservoir's sediments.

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