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POTENTIALLY TOXIC ELEMENTS IN LOWLAND GREAT MORAVA RIVER – BIOINDICATION WITH BLEAK (*ALBURNUS ALBURNUS*)

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Abstract

The utilization of fish bioindicators has become of crucial importance for ecosystem contamination assessment. Bleak (*Alburnus alburnus*) is a widely distributed epipelagic fish species characterized as very active with fast metabolism which can lead to a high accumulation of pollutants in tissues. Bleak is easy to sample, identify in the field by morphological characteristics, and easy to work within the laboratory. This study deals with the bleak sensitivity in detecting the pressure of the potentially toxic elements (PTEs) in the large lowland Great Morava River. The Al, As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Se, Sn, and Zn were estimated in whole body composite (wbc) of bleak. The study was conducted at Great Morava River, near the city of Paraćin in Serbia. The highest concentrations of essential elements Zn and Fe were detected. The most toxic elements As and Hg were below detection limits. The metal pollution index (MPI) was 0.39. In large lowland rivers, point sources of pollution such as municipal wastewaters of smaller settlements usually have only local impact due to high dilution by the main watercourse. Since bleak is a site-specific species, results in this study indicated that this stretch of the Great Morava River is slightly affected by PTEs. None of the elements above the maximum permitted concentrations (MPC) in fish meat for use in the human diet, prescribed by the Official Gazette and European Commission Regulation, were not recorded.

Key words: whole body composite, bioindicator, metal pollution index, Serbia

1. Introduction

Potentially toxic elements (PTEs) are, among different xenobiotics from multiple anthropogenic stressors, particularly important environmental pollutants since they are not degraded or eliminated from the ecosystem [1, 2].

Bioindication with the employment of bioindicators has become of crucial importance for potentially toxic elements (PTEs) assessment. Fish normally occupy high positions in aquatic trophic webs, accumulating several kinds of contaminants in their tissues, including PTEs [3,4]. In Serbia, numerous fish species have been widely employed in studies dealing with PTEs in freshwater ecosystems, but only two studies deal with common bleak sensitivity in detecting the pressure with PTEs in large lowland rivers [5, 6]. The assessment of PTEs in water based on PTEs in fish as bioindicators can be challenging depending on the feeding strategy of selected species and migratory behavior. Common bleak (*Alburnus alburnus*) is an epipelagic, planctivorius fish species, widespread from medium to large rivers, and lakes across Europe and Asia [7, 8]. Very active and fast metabolism of common bleak can lead to a high accumulation of pollutants in tissues [9]. Characteristics such as

being easy to catch, handle, identify onsite, and work with make this species interesting for bioindication of water pollution with PTEs. Jovanović Marić [5] indicated that pollution of common bleak can be characterized as site-specific.

The objective of this study was to estimate PTEs in common bleak sampled from the Great Morava River in Serbia. To avoid any differences in the concentrations of elements between different organs of the fish, we chose to analyze the whole-body composite (wbc) of the fish for elements. The response of common bleak on pollution was evaluated via condition factor (CF) and metal pollution index (MPI). The major objective was to estimate water pollution with PTEs of the Great Morava River based on bioindication with common bleak.

2. Material and methods

The Great Morava, as a typical lowland river, flows through the most densely populated area of Central Serbia, the Morava River valley, receiving untreated or incompletely treated wastewater from urban areas and animal farms, which leads to serious degradation of the water quality. Common bleaks were sampled at village Čepure, near the city of Paraćin in August 2016. Fishing was carried out using netting tools (gill nets with mesh size 0.5, 10–12, and 14–16 mm), and sampled common bleaks were transferred on ice in a hand-held refrigerator to the laboratory (17 specimens in total).

In the laboratory, the fish were measured for their total body length (to the nearest cm) and weighed (to the nearest g). For each specimen, the CF was calculated using the formula [3]:

$$CF = WL^{-3} \times 100 \quad (1)$$

where W represents the weight (g) and L is the total length of the fish (cm).

Each sample was grinded in a Sterilmixer Laboratory homogenizer (International P.B.I. S.p.A.) and the wbc samples were again weighed using an electronic balance (±0.1 g) and stored at −20 °C prior to analysis. Before digestion in microwave Christ Alpha 2-4 LD, Harz, Germany, samples are dried in a lyophilizer Christ Alpha 2-4 LD, Harz, Germany and measured one more time. The Al, As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Se, Sn, and Zn concentrations were determined by inductively coupled plasma optical emission spectrometry (ICP-OES), using a Thermo Fisher Scientific iCAP 6500 Duo ICP (Cambridge, United Kingdom). The analytical procedure was performed according to Milošković et al. [10]. The muscle standard reference material (DORM-4; National Research Council of Canada) was digested in triplicate and analyzed to support quality assurance and control. Recovery ranged from 89.8% to 106.3% for all of the elements investigated. The mean values and standard deviations were calculated for each group and the element concentrations were expressed as mg kg^{-1} wet weight (ww).

The resulting concentrations of the PTEs were compared with the maximum permitted concentrations (MPCs) in fish meat for utilization in the human diet, established by the European Union and national legislation. According to EU legislation [11], the MPCs for Cd, Hg, and Pb are 0.05, 0.50, and 0.30 mg kg^{-1} ww, respectively. The MPCs for As, Cd, Hg, Pb, Cu, Fe, and Zn in fish meat are 2.0, 0.1, 0.5, 1.0, 30.0, 30.0, and 100.0 mg kg^{-1} ww, respectively, as prescribed by national legislation [12].

The MPI was calculated to present the total PTEs content in the wbc of species, as well as in the sampling site using the following equation [13]:

$$MPI = \left(cf_1 + cf_2 + cf_3 + \ldots + cf_n \right)^{\frac{1}{n}} \quad (2)$$

where cfn = concentration of the element n in the sample (mg kg^{-1} ww).

3. Results and discussion

The average weight of the specimens examined was 12.43 ± 0.97 g while the average length was 13.67 ± 2.42 cm. The calculated CF was 0.056 ± 0.06. As Froese [14] stated, the condition factor is a measure of the general health of fish, and it reflects the recent feeding conditions and environmental quality. Since the CF decline was observed at highly contaminated locations and in our study value was 0.56 (lower than one), it can be concluded that the general health of fish was poor.

In Table 1 concentrations of PTEs in common bleak are shown. Prosi [15] stated that the type of chemical, metabolic properties of the tissues, and the degree of environmental pollution affect the bioaccumulation levels in fish. The highest concentrations of Zn, Fe, Mn, Al, and Cu were recorded.

Goyer [16] stated that the involvement of Zn and Fe in the regulation of key enzymatic detoxification processes may be the reason for the high concentrations of these elements in fish tissues. Bervoets and Blust [3] emphasized that the levels of Zn and Fe in the tissue were influenced by several chemical and physiological processes in addition to the environmental concentrations. On the other hand, the most carcinogenic As and Hg were below detection limits. The MPI (0.39) was affected with concentrations of PTEs, and the calculated value indicates that the Great Morava River is, according to Milošković et al. [10], slightly affected by PTEs.

In large lowland rivers, point sources of pollution such as municipal wastewaters of smaller settlements usually have only a local impact due to high dilution by the main watercourse. Since bleak is a site-specific species [5], results in this study indicated that this stretch of the Great Morava River is slightly affected by PTEs.

Table 1. The average PTEs concentrations and standard deviation in the wbc of common bleak from Great Morava River in mg kg^{-1}ww

Al	As	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Se	Sn	Zn
5.34 ± 3.63	nd	0.008 ±0.006	0.001 ± 0.001	0.312 ± 0.153	2.33 ± 1.72	15.75 ± 9.5	nd*	5.49 ± 3.38	0.021 ± 0.020	0.015 ± 0.013	0.52 ± 0.12	0.53 ±0.45	50.5 ± 32.88

*nd – not detected

Fish samples examined had no concentrations of PTEs above the MPC prescribed by the EU [11] and national legislation [12]. This information is useful but often very restricted because it does not consider the effect of intraspecific variations in the human population (exposure rate, human weight, meal size, etc.) or long-term exposure to pollutants [17], but it can be an early warning and the basis for future research.

4. Conclusions

The bleak is a site-specific species and results in this study indicated that this stretch of the Great Morava River is slightly affected by PTEs. Fish meat is safe for utilization in human diet.

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