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House sparrow (*Passer domesticus*) as bioindicator of heavy metals pollution

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ABSTRACT

The aim of the present study was to determine the concentrations of heavy metals (Pb, Cd, Cu, Ni and Zn) in tissues (lungs and heart) of the house sparrow (*Passer domesticus*) grown in Mitrovica and Drenas towns (polluted area) and reference site (Ujmir village). A total of 30 house sparrows, only male (10 from each locality) were analyzed. The concentrations of heavy metals were measured using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). Results showed different affinities of heavy metals to tissues. The concentrations of lead, cadmium and nickel in lungs tissue (Pb – 21.764 $\mu\text{g/g}^{-1}$; Cd – 2.519 $\mu\text{g/g}^{-1}$; Ni – 12.784 $\mu\text{g/g}^{-1}$) were significantly higher ($P < 0.001$; 0.01) in sparrows from the polluted area (Mitrovica and Drenas) compared with reference site (Ujmir village). While concentrations of copper and zinc in heart tissue (Cu – 23.213 $\mu\text{g/g}^{-1}$; Zn – 91.720 $\mu\text{g/g}^{-1}$) were significantly higher ($P < 0.001$; 0.01) in sparrows from the polluted area (Mitrovica and Drenas) compared with reference site (Ujmir village). Considering the high concentrations of heavy metals in tissues of sparrows from Mitrovica and Drenas towns (polluted localities), we can say that there is still a danger for biota.

Key words: Heavy metals, house sparrow, lung, heart, ICP-OES.

INTRODUCTION

Contamination by heavy metals is a major concern worldwide, regional and local level and influences the functional and structural integrity of an ecosystem. The metals present in an animal may result in various interactions: some are essential for life, others can be harm-full. A serious group of pollutants are heavy metals that pose a threat to all living organisms, with lead being especially considered as highly toxic [1], [2]. The sources of heavy metal pollution include natural sources [3], mining or metal smelting [4], municipal waste, industrial effluents, application of sewage sludge and animal manure on agricultural land [5]. Heavy metals are naturally present in various natural segments. However, human activity exerted for stimulus provided by industrial development, has changed the biogeochemical cycles influencing the transfer of these elements [6]. A number of metal ions are essential but some other metals are non essential such as Pb, Cd, [7]. Quantification of trace element levels in different tissues of the organism is an indicator of the bioavailable fraction of the element in the environment [8].

Recently biological indicators have become very common and have been found very useful. This is because living organisms have high sensitivity to changes in environmental components and conditions that constitute their living.

However, different organisms respond at different degree to changes in some environmental parameters. Therefore, the biodiversity needs to be well understood when considering biomarkers of environmental pollution.

The use of living organisms to monitor heavy metal pollution provides more promising results than chemical and physical analysis. This results from the fact that we obtain accurate data of bioavailability and bio transference of contaminants as well as observe some physiological and behavioral symptoms of induced toxicity. Birds are traditional objects for biological monitoring in polluted ecosystems. Birds can be exposed to heavy metals both externally, by physical contact, and internally, by consumption of contaminated food.

Birds are easy to identify and their classification and systematic are well established. They are particularly well known organisms, with much research carried out on their ecology and behavior, and this background knowledge of biology enhances their usefulness as biomonitors. It is very important to keep several criteria when selecting the bird species for biomonitoring. Among them common occurrence, easy capturing, clearly identified individual territory size, homogeneity of the material, well known biology of the species and bioaccumulation capacity should be taken into account.

Bioaccumulation of heavy metals in tissues of birds has received attention because of the lethal and sub-lethal effect of their accumulation, apart from the fact that birds are often located in high levels in the food chain which makes them suitable for use in bioaccumulation studies [9]. Studies on lead contamination in birds conducted in industrial areas showed a definite influence of environmental pollution on the levels of metals accumulated by birds [10]. Extensive studies on heavy metals concentration in birds have been conducted in many polluted regions. Recently, some researchers explored the potential of monitoring metals pollution using wild species such as doves (e.g. *Columba livia*), house sparrow (*Passer domesticus*), pigeons, and great tits (*Parus major*) [11], [12], [13], [14], [15]. These species are ideal bioindicators because they are common and widely distributed and have fast metabolic rates.

The main objective of the present study was to provide the information on the concentration and distribution of Lead (Pb), Cadmium (Cd), Copper (Cu), Nickel (Ni) and Zinc (Zn) in different tissues of house sparrow (*Passer domesticus*), including consumption organs (lungs, heart).

MATERIALS AND METHODS

Study areas:

The pollution of living environment in Mitrovica still presents an ecological problem (the area near foundry "Trepqa" closed since 2000). The main recourses of pollution in Mitrovica, in the past had as starting point different technological departures (metals foundry, refinery, flotation, factory of accumulations and sulfuric acid battery) of "Trepqa" combine and also superphosphates fertilizer factory. The work of these departments has made Mitrovica of the most polluted cities in Europe. The pollution level can be illustrated from some information's by Popovac [16], who find that the quantity of the emitted lead dust everyday from the Trepça foundry in 1979 was 5 to 6 tons. The concentration of lead in air in Mitrovica from the same period was 20-30 $\mu\text{g}/\text{m}^3$. Trepça Foundry was closed in August 14th 2000 from the United States Forces. The research that was done from Shehu's [17], analysis of soil taken in the location around Mitrovica had notice high concentration. More than 13 years have passed by but the pollution left from Trepça's activities, threatens seriously the local environment and people's health.

Drenas town is located 20 kilometers far from Pristine (capital of Republic of Kosovo) in the West. The smelter (Ferronickel) has operated since 1982. Ferronickel has three open pit mines: the Dushkaja mine with estimated reserves of 6.2 million tons; the Suka mine-0.8 million tones and the Gllavica with 6.8 million tones. Ferronickel smelter is well-known for final production of Ferro- nickel. In metallurgical processing the mineral base is treated by an oxide mineral of nickel (two sources) with the following average chemical structure: Ni+Co=1.2%; Fe=26.0%; SiO₂=47.0%; CaO=2.5%; Cr₂O₃=1.2%; MgO=11.0%. The produced slag has the chemical structure as follow: Ni-0.08%; SiO₂ 55-57 %; MgO 10.0%; Fe total 20%; Ca) 4.0%. The capacity of the smelter in the technological lines (rotating furnace and electrical furnace) is about 12.000 t Ni/year [18]. In recent time, the smelter plant is active and it is known as "New CO Ferrocickel".

Sample collection and preparation:

Our research is done on the natural individuals of the population of house sparrow (*Passer domesticus*) who were caught in the city of Mitrovica (polluted area), the town of Drenas (area near the Ferronickel smelter, polluted area)

and in rural areas – reference site (Ujmirë village, not a polluted area). In May (2014), a total of 30 house sparrows (*Passer domesticus*) only male (10 from each locality) were caught. After dissection of birds, samples tissues (lungs and heart) were gathered and stored at -20°C for further analysis. The concentrations of Pb, Cd, Cu, Ni and Zn were determined using Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES).

The differences in metal concentrations were analyzed with Student's test (t). Significant differences were assumed at $p < 0.05$. For all statistical analyses, Sigma stat program were used.

RESULTS AND DISCUSSION

Concentrations of the heavy metals in tissues (lungs and heart) of house sparrow (*Passer domesticus*) are presented in Tables 1. All the results were performed in dry weight.

Table 1. Mean \pm SD values for heavy metals (Pb, Cd, Cu, Ni and Zn) in house sparrow (*Passer domesticus*) by tissues and site (in $\mu\text{g/g}$ d.w.)

Tissues	Metals	Reference site		Polluted site			
		Ujmir (n=10)		Drenas (n=10)		Mitrovicë (n=10)	
Lungs	Pb	3.87	± 3.843	14.611**	± 5.92	21.764**	± 2.309
	Cd	0.609	± 0.45	2.113**	± 0.82	2.519**	± 0.758
	Cu	3.852	± 0.906	8.264*	± 5.815	8.574*	± 5.258
	Ni	1.74	± 0.539	12.784*	± 12.338	10.386*	± 12.981
	Zn	21.016	± 5.89	69.801**	± 39.356	83.832**	± 94.029
Heart	Pb	2.5	± 0.901	5.967**	± 2.747	11.09**	± 6.479
	Cd	0.228	± 0.179	0.918**	± 0.299	1.214**	± 0.617
	Cu	8.878	± 5.22	19.345**	± 5.156	23.213**	± 4.47
	Ni	0.8	± 0.355	2.481*	± 2.289	1.289*	± 0.602
	Zn	30.444	± 8.92	77.306**	± 25.99	91.72**	± 53.903

Note: Significance level: $p < 0.01$ *; $p < 0.001$ **

It observed that the different tissues in house sparrow had disparity in the mean metal concentrations, in general, the concentrations of the heavy metals, such as Pb, Cd, Cu, Ni and Zn were higher in tissues of house sparrow from polluted site (Mitrovica and Drenas city) in comparison with reference site (Ujmir village). In the lungs of sparrows from polluted site, the highest values of heavy metals were, Pb concentration $21.764 \pm 2.309 \mu\text{g/g}$ d.w.; Cd concentration were $2.519 \pm 0.758 \mu\text{g/g}$ d.w.; Cu concentration were $8.574 \pm 5.258 \mu\text{g/g}$ d.w.; Ni concentration were $12.784 \pm 12.338 \mu\text{g/g}$ d.w.; Zn concentration were $83.832 \pm 94.029 \mu\text{g/g}$ d.w. In the heart of sparrows from polluted site, the highest values of heavy metals were, Pb concentration $11.09 \pm 6.479 \mu\text{g/g}$ d.w.; Cd concentration were $1.214 \pm 0.617 \mu\text{g/g}$ d.w.; Cu concentration were $23.213 \pm 4.47 \mu\text{g/g}$ d.w.; Ni concentration were $2.481 \pm 2.289 \mu\text{g/g}$ d.w.; Zn concentration were $91.72 \pm 53.903 \mu\text{g/g}$ d.w. The lowest Pb concentrations were $2.5 \pm 0.901 \mu\text{g/g}$ d.w. in heart of house sparrows from reference site. The lowest Cd concentrations were $0.228 \pm 0.179 \mu\text{g/g}$ d.w. in heart of house sparrow from reference site. The lowest Cu concentrations were $3.852 \pm 0.906 \mu\text{g/g}$ d.w. in lungs of house sparrows from reference site. The lowest Ni concentrations were $0.8 \pm 0.355 \mu\text{g/g}$ d.w. in heart of house sparrow from reference site. The lowest Zn concentrations were $21.016 \pm 5.89 \mu\text{g/g}$ d.w. in lungs of sparrows from reference site.

In lungs Pb, Cd and Zn concentration averages were significantly different ($p < 0.001$) between polluted site and reference site, while Cu and Ni concentration averages were significantly ($p < 0.01$) between polluted site and reference site. In heart Pb, Cd, Cu and Zn concentration averages were significantly different ($p < 0.001$) between polluted site and reference site, while Ni concentration averages were significantly ($p < 0.01$) between polluted site and reference site.

The results of higher concentrations of heavy metals to house sparrow from Mitrovica and Drenas city are in accordance with results of Elezaj [19], who showed very higher concentration of Pb, Cd, Cu, Ni and Zn in many of tissues of feral pigeons (*Columba livia*) from Mitrovica. The higher concentrations of Pb recorded in house sparrows from Mitrovica is in accordance with results of Huton's [20] who in feral pigeons from London area recorded very higher lead concentrations.

For example, several studies have shown that urban populations of house sparrows, starlings, pigeons tend to have higher heavy metals concentration than rural populations [21]. Our data are compatible with data of Swaileh [1],

who used house sparrow as object of research for the determination of heavy metals in the environment.

CONCLUSION

Research has shown that house sparrows (*Passer domesticus*) have great capabilities to accumulate heavy metals in their tissues. Considering the high concentrations of heavy metals in tissues of sparrows from Mitrovica and Drenas towns (polluted sites), we can say that there is still a danger for biota.

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