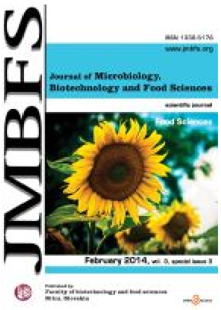

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THE LEVEL OF CROP PLANTS CONTAMINATION BY HEAVY METALS FROM THE HISTORICAL MINES AREA

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ABSTRACT

In the present work, we focused on monitoring the total content of heavy metals (Cd , Pb , Cu , Cr) in selected crops (spring barley, wheat, oilseed rape, maize and oats), grown on contaminated land in an iron-ore mining company in Spišská Nová Ves, plant Rudňany. Samples of plant material were collected at the stage of technological maturity with well-defined sampling points using the GPS. In mineralized samples we used the F - AAS on a VARIAN 240 FS performed analyzes to determine the content of heavy metals monitored. The results observed contents of risk elements point to a relatively high level of contamination of harvested agricultural production, which is used for food purposes. Exceeding the maximum levels was recorded fot Cd, Pb and Cr using the Codex Alimentarius. In the case of Cu, we exceeded HPL for each crop group recorded.

Keywords: soil, crop plants, heavy metals, contamination

INTRODUCTION

Environmental accumulation of risk elements represents a serious problem due to their persistence, especially in the soil. Around 250 000 grounds, where the limits for the risk elements have been exceeded significantly, are located in the European Union alone **(European Environmental Agency, 2007)**. Therefore, the EU environmental politics is oriented towards an effective reduction in releasing solid contaminants containing risky elements from defined emission sources as well as the implementation of effective remedial measures for the soil protection. Evaluation of the sanitary state of soils includes two basic approaches: the assessment of the incoming risk elements based on their required soil contents, together with taking in account the risks resulting from their presence within the biological cycle, including the food chain and the potential hazard to the health status of the EU population.
Heavy metals are ubiquitous part of the environment as a result of natural and anthropogenic activities causing increased exposure of human populations to their effects through various channels **(Wilson - Pyatt, 2007, Poty et al., 2012)**. Increasing concentrations of certain trace elements, especially their mobile forms can cause serious environmental concern about contamination and accumulation in soil, vegetation, animals, respectively, surface and ground waters **(Chopin - Alloway, 2007)**.
Soil contamination reveals itself as overreaching the limit value of at least one risky substance. In case of the risk elements we talk about their overall content. The available data regarding the total content (after the soil decomposition using potent mineral acids, especially the Aqua regia has been in the Slovak Republic since 2004) may give us the necessary information in accordance with the valid legislation (including the approved maximum content of risk elements and the level of contamination). Relationships between the risk element contents in the soil and their concentrations in plants have been observed only in case of overreaching their established total concentrations in soils. Analyzing the transport of the risk elements to the plants, the interactions soil-plant are especially crucial and studied by a variety of authors **(Castaldi et al., 2009; Xiangy-Ang et al., 2009)**. On the other hand, low concentrations of risk elements in soils, e.g. in acid soils, are related to their exceeded limits in plants **(Linkeš, 1997; Kobza et al., 2007)**.
Heavy metals are the primary source of environmental contamination. The most common heavy metal are lead, zinc or copper, in addition, antimony, arsenic, mercury, cadmium, thallium, gallium, and others. Additionally, the production of metals is a very important source of environmental contamination by metals and burning of fossil fuels, especially coal. Fly ash from the incineration of atmospheric leakage through contaminated soil **(Steinnes et al., 2005)**. An increasingly important source of environmental pollution with heavy metals is becoming a burning municipal waste streams and pollution effluents containing elevated levels of toxic metals **(Bencko et al., 1995)**.

MATERIAL AND METHODS

In the present work we aimed to monitor contamination levels of harvested crop in the middle of Spiš. A leisure site is located in the Spišská Nová Ves district at different distances from the emission source in Rudňany. All samples were taken from technologically exploited parts of crops (n = 16) representing the cultural ecosystem located in the catchment area imission source (EZ) – the Iron-ore processing plant mines Rudňany, which until year 1993 emitted between 4.64 to 6.5 t of elemental mercury in the gaseous into the environment **(Hronec et al, 1992)**. Graphical representation of sampling sites and their location in the Spišská Nová Ves districts are shown in Figure 1.
Samples of plant material after we withdraw offsite in paper bags to pre-analytical adjustments. After drying to constant weight are separated from the rest of the generative biomass. A technology used parts are then homogenized and done we mineralization by microwave digestion device in MARS X-press in a mixture of HNO_3 and H_2O in a 2:1 ratio. After mineralization, we digest filtered through filter paper and the filtrate 390 Filtrak we added the 50 cm^3. Analytical ending was FAAS on a Varian 240 FS. All the data obtained were compared with the limits for individual commodities, which defines the Codex Allimentarius of the Slovak Republic.

Table 1 Basic characteristic of sample points and samples of plant material

Sampling points	VGS 84 coordinates	Distance from EZ (km)	Soil - parcel		
			Soil character	Cadaster	Orientation by EZ
Spiš 03	48°54,113 20°40,105	3	Oil rape	Odorín	N
Spiš 04	48°54,142 20°40,924	4	Wheat	Odorín	N
Spiš 05	48°54,171 20°41,742	5	Oil rape	Jamník	N
Spiš 12	48°54,201 20°42,556	6	Barley	Spišský Hrušov	NNE
Spiš 22	48°54,229 20°43,377	12	Oil rape	Žehra	NE
Spiš 23	48°54,258 20°44,194	10	Wheat	Bystrany	NE
Spiš 32	48°54,315 20°45,826	10	Oil rape	Spišské Vlachy	ENE
Spiš 93	48°54,373 20°47,461	1	Barley	Markušovce	W
Spiš 108	48°54,429 20°49,091	1	Barley	Markušovce	WNW
Spiš 109	48°54,485 20°50,726	2	Oat	Markušovce	WNW
Spiš 122	48°54,438 20°51,756	10	Maize	Spišská Nová Ves	NW
Spiš 124	48°54,286 20°48,721	1	Barley	Markušovce	NW
Spiš 127	48°54,188 20°50,758	4	Barley	Markušovce	NW
Spiš 128	48°54,985 20°51,556	5	Oil rape	Lieskovany	NW
Spiš 129	48°54,558 20°50,759	6	Wheat	Spišská Nová Ves	NW
Spiš 136	48°54,158 20°47,789	2	Barley	Markušovce	NNW

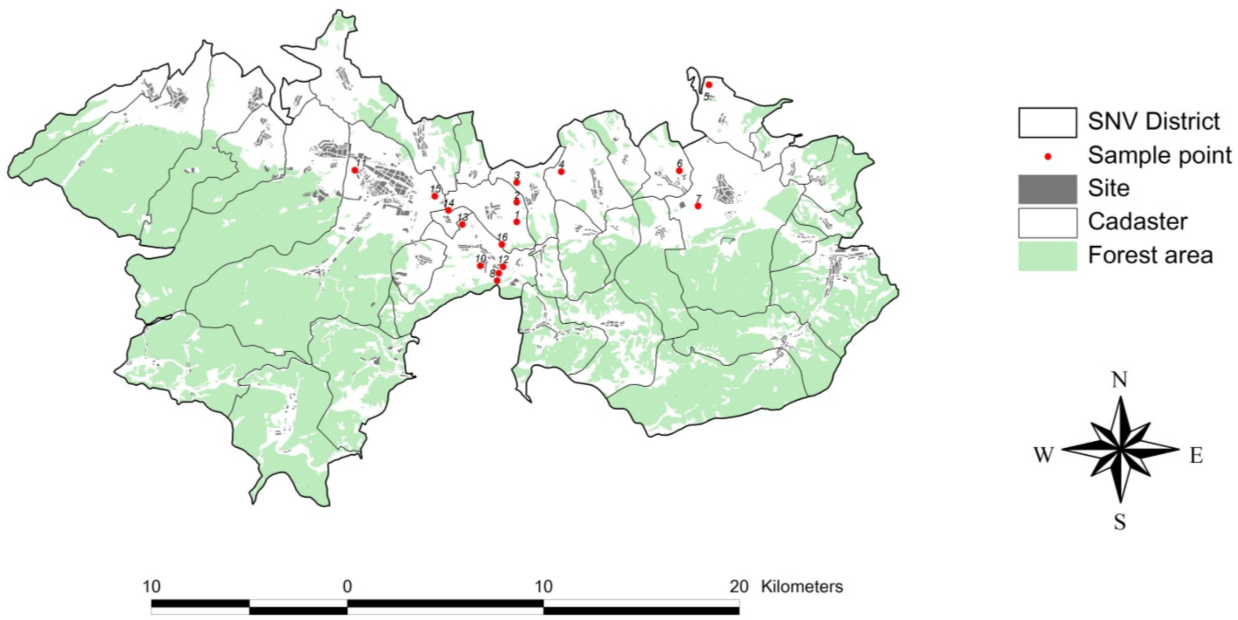

Figure 1 Graphical presentation of sampling sites and their location in the Spišská Nová Ves district

RESULTS AND DISCUSSION

In the present work, we focused on monitoring the level of contamination of agricultural produce harvested in pollution in the plant, which used to process the raw material has pursued containing heavy metals. The results observed contents of risk elements confirmed the assumptions that the crops grown in pollution areas may pose a potential transfer of heavy metals into the human food chain.

Cadmium content of harvested production ranged from 0.03 to 0.83 mg.kg^{-1}, depending on the crop. The highest content was recorded in oilseed rape, in which the content ranged from 0.53 to 0.83 mg.kg^{-1}, which means that in all cases, we observed excess HPL for oilseeds (0.50 mg.kg^{-1}). For other crops we had excess HPL for barley in four cases. For other crops we HPL excess of Cd recorded.

The situation concerning the lead was similar to that for cadmium. Exceeding the HPL was observed in ten cases, the highest risk group were right oilseed rape and spring barley. In these cases, we observed excess HPL for oilseeds by up to 78% for cereals and by 450% (barley - SP Spiš 12).

The last element, which saw crossing the HPL was chrome. The HPL amount of this element (4.0 mg.kg^{-1}) was observed in two cases. It was a sample of spring barley (SP Spiš 93 and Spiš 124), where the excess representing 5% respectively, 35% in the grain. For the latter, the reference element we exceeded HPL for other foods (25.0 mg.kg^{-1}) recorded. Closest to this value approaching barley sample delivery point Spiš 12, in which the copper content was around 8.40 mg.kg^{-1}.

Table 2 The contents of monitored heavy metals in plant material

Sampling points	Crop	Heavy metals contents mg.kg^{-1}			
		Cd	Pb	Cu	Cr
Spiš 03	Oil rape	0,83	1,19	3,66	1,09
Spiš 04	Wheat	0,03	0,10	3,75	3,06
Spiš 05	Oil rape	0,53	1,47	3,52	1,17
Spiš 12	Barley	0,42	1,10	8,40	2,10
Spiš 22	Oil rape	0,68	1,78	3,56	0,89
Spiš 23	Wheat	0,18	0,10	5,30	1,50
Spiš 32	Oil rape	0,78	1,30	3,30	2,20
Spiš 93	Barley	0,17	0,49	5,08	4,20
Spiš 108	Barley	0,23	0,70	4,90	1,50
Spiš 109	Oat	0,33	0,80	6,40	1,60
Spiš 122	Maize	0,61	1,40	7,30	2,10
Spiš 124	Barley	0,14	0,49	4,52	5,40
Spiš 127	Barley	0,05	0,59	5,84	3,56
Spiš 128	Oil rape	0,54	0,99	3,55	0,49
Spiš 129	Wheat	0,04	0,20	3,88	2,49
Spiš 136	Barley	0,16	0,10	5,80	1,20
HPL for sample materials					
HPL – oil seed		0,50	1,00	x	x
HPL – cereal		0,10	0,20	x	x
HPL - wheat		0,20	x	x	x
HPL – other foodstuffs		x	x	25,0	4,0
Descriptive statistics derived indicators					
Minimum		0,03	0,10	3,30	0,49
Maximum		0,83	1,78	8,40	5,40
Mean		0,36	0,80	4,92	2,16
Median		0,28	0,75	4,71	1,85
Standard deviation		0,27	0,54	1,51	1,32

CONCLUSION

In the present work, we focused on monitoring the level of contamination of agricultural produce harvested in pollution in Iron Ore mines in Spišská Nová Ves, Rudňany plant, which is used for food purposes. The results of chemical analyzes indicate the riskiness of crops in their use for food purposes. Maximum limits defined by legislation in force in Slovakia and the European Union have been exceeded for Cd in 12 samples for lead in 10 samples and excess chromium content in the case of two samples. For more monitored risk immission area would need to undertake more detailed analysis that would be able to provide a more comprehensive view of the quality of the environment.

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