MICROELEMENT CONTENT OF HERB VARIETIES ON A FLOODPLAIN PASTURE OF UPPER TISZA RIVER

Zoltán Győri[a]*, Péter Sipos[a], Diána Ungai[a] and Norbert Boros[b]

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In order to produce good quality products it is necessary to find out about the quality of pastures to be grazed. It is also important to know the element composition of grazed herbs and the demands of animals bred on pastures, especially where the environment may influence the feed safety conditions of plants – as in the case of floodplains. Our objective was to determine that what the element composition (Cu, Zn, Mn and Fe contents) of herbs grown on a floodplain which was subsided by a heavy metal contaminated sediment. Our results call an attention to the differences in the accumulation of herbs. *Bidens tripartitus*, *Lotus corniculatus* and *Vicia cracca* grown in the floodplain showed the higher amounts of Fe and Zn, but the effect of heavy metal contamination on the element contents of other examined plants cannot be proved.

* Corresponding Authors
Tel: +36 (30) 983 2880
E-Mail: z.gyori@hotmail.com
[a] Institute of Food Science, Quality Assurance and Microbiology, Faculty of Agricultural, Food Science and Environmental Management, University of Debrecen
[b] Environmental and Chemical Engineering Department, Faculty of Engineering, University of Debrecen

Introduction

At the beginning of year 2000, dams broke at two Romanian mining companies (at Baia Mare first and Baia Borsa second). The first one releasing 100 000 m^3 of contaminated water with cyanide to the river Tisza via its tributary Szamos. The heavy metal content of the polluted water was several times higher than the limits for heavily contaminated surface water (Ministry for Environment, 2000).[1] While the cyanide caused severe damage to organisms in the river, other heavy metals present in the water may also have been deposited in the sediments.

The second disaster sent about 20 000 tons of mud containing heavy metals into the river Tisza along with a simultaneous flood settling, forming a layer of approximately 5-10 cm in depth on the pre-existing soil (Fig. 1 and Fig. 2). As most of the affected areas were under agricultural use, and the economy of the region depends heavily on their continued productivity, it is important to study the heavy metal concentration within herbaceous plants in the floodplain.

The composition of herb varieties of a pasture is very important considering animal husbandry.[2] Mineral element composition is one of its most important quality parameters.[3] However, pastures are often that kinds of fields that are close to rivers and its alluvial deposits cover them yearly. The heavy metal contamination of the flood of Tisza river in the year 2001 caused considerable injuries for the ecosystem[4], and the long-term effects of the metals settled in the floodplain are not known.

Our objective was to determine the element composition (Cu, Zn, Mn and Fe contents) of herbs grown on this exhaustively examined (to 300 cm depth) soil. The results of in-depth soil analysis were presented by Győri et al.[5]

We present the sediment analysis data on the Fig. 1 and Fig. 2. The samples came from the banks of the river and the terraces of the holiday houses, at the altitudes of 112.750 mB.a.; 114.670 mB.a.; 108.940 mB.a. and 105.450 mB.a. in samples 1 to 4 respectively. For comparison this data with a chernozem soil data we can see on Fig. 3. We have to underline that in the most fertile soil Zn and Cu content was twofold lower than in floodplain soil.

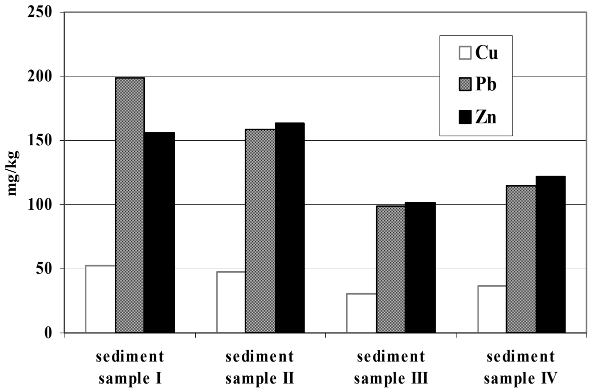

Figure 1 Total Cu, Pb and Zn content of sediment samples (Tivadar, 2001)

Considering that this 300 cm depth sediment of the floodplain subsided in the last 150 years, a control plot selection was almost impossible. This is the reason we used the results of Tölgyesi[6] and also Hungarian measurement[7] results by Leányvár for comparison.

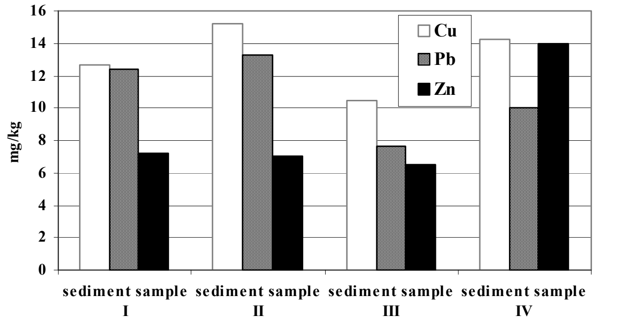

Figure 2. Lakanen-Erviö soluble Cu, Pb and Zn content of sediment samples (Tivadar, 2001)

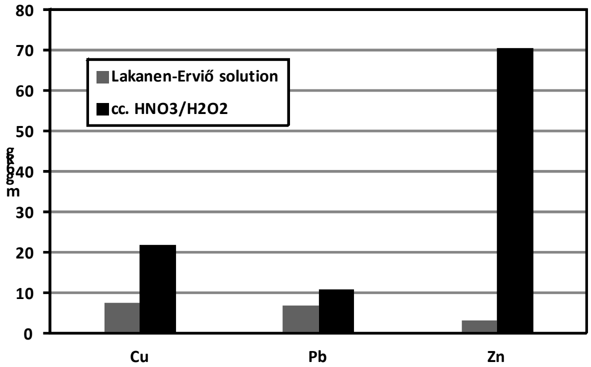

Figure 3. Lakanen-Erviö soluble and total Cu, Pb and Zn content of chernozem soil (Látókép, 1998)[8]

Materials and methods

Samples were taken in a floodplain meadow of upper the Tisza River near Tivadar and Gergelyiugornya in 2001-2003. Samples of 42 herb varieties from natural flora were collected from 1x1 m plots (ten times) near the boreholes in the floodplain.

Figure 4. Sampling sites on the river Tisza, Hungary

Plant samples were dried at 60°C and grounded by Retsch SK-1 hammer mill with 1 mm sieve. The chemical analysis was carried out with analytical grade HNO_3-H_2O_2 (E. Merck, Darmstadt, Germany) digestion by the method of Kovács et al.[9,10] by PERKIN-ELMER OPTIMA 3300 DV type ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry). Ultrapure water was use to prepare the solutions (Millipore, Paris, France). The easily available element contents extracted according to the Lakanen-Erviö method.[11]

Table 1. Geographical data of sampling sites

Sampling site	Geographical coordinates	River kilometers
Tivadar	N 48° 04' 00.6" E 22° 31' 04.8"	708.7
Gergelyugornya	N 48° 07' 46.5" E 22° 19' 39.5"	683.0

We determined the following elements: Al, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, La, Li, Mg, Mn, Mo, Na, Ni, P, S, and Zn. Out of the 20 elements examined, Cu, Fe, Mn, and Zn are discussed in detail in the present study. We used the SPSS 17.0 for Windows and Microsoft Excel 2007 programs for statistical analysis of data. Results are mean values of two replications.

Results and discussion

Previously Tölgyesi[5] analyzed seventeen varieties in 1969, so this was the base of our comparison. We found that the newly measured Mn values representing the herb samples collected at Tivadar were lower than the previous findings at Leányvár exception of Salvia nemorosa, while the Zn content of new samples were higher in the case of most of the examined herbs.

These systematic differences are taken into account for the differences in the basic of soil properties or analytical methods. The differences in Cu and Fe content were varied by herb to herb (Table 1).

Comparing our results to the previous findings, we found significant differences in several cases. Tölgyesi[5] found that *Solanum dulcamara, Symphytum officinale* and *Taraxacum officinale* accumulate Cu in high degree.

We confirmed these results and recommend that the list of Cu accumulating herbs can be complement by *Salvia nemorosa* and *Bidens tripartitus*. We found high Fe content in the case of *Salvia nemorosa*, *Althea officinalis, Rumex acetosa* and *Solanum dulcamara* (above 500 mg kg^{-1}). The highest Mn contents were measured in the case of *Salvia nemorosa, Althea officinalis* and *Equisetum arvense* (in descending order). *Lotus corniculatus, Salvia nemorosa* and *Bidens tripartitus* contained the highest concentrations of Zn.

As we mentioned above we analyzed more than forty herb varieties from the floodplain of upper Tisza. The microelement contents of additional 21 herb varieties are summarized in Table 2.

The copper content in case of *Convolvulus arvensis* and *Ranunculus repens* were more than 25 mg kg^{-1}. These values were the maximum among the studied herb varieties. Two high iron contents (more than 600 mg kg^{-1}) were determined in case of *Cephalaria transsilvanica* and *Xanthium strumarium*.

Table 1 Mineral element content of different herbs Legend: L = Leányvár, 1963., T = Tivadar, 2001.

Herbs	Mineral elements mg kg^{-1} in dry matter							
	Cu		Fe		Mn		Zn	
	L	T	L	T	L	T	L	T
Althea officinalis	6.9	8.4	494	732	98	41.5	28	32.5
Bidens tripartitus	24.2	18.7	278	86.8	118	24.4	31	59.0
Cichorium intybus	12.1	11.3	209	296	35	18.5	35	44.4
Equisetum arvense	7.7	6.0	253	177	117	41	27	37.9
Galium verum	6.6	11.4	200	63.5	40	33.6	21	45.0
Lotus corniculatus	7.0	10.2	83	226	-	38.8	22	66.1
Lathyrus tuberosus	9.0	4.8	170	121	46	14.5	19	39.5
Poa pratensis	6.1	8.0	143	74	43	29.8	22	15.8
Potentilla argentea	5.4	7.12	362	171	96	38.9	22	29.6
Ranunculus acris	8.3	7.8	138	163	65	37.6	25	26
Rumex acetosa	4.7	8.7	145	572	37	26.3	25	23.1
Salvia nemorosa	9.2	17.5	369	869	56	67.1	44	61.8
Solanum dulcamara	15.4	14.8	315	509	91	33.1	20	31.7
Sonchus arvensis	15.7	10.2	754	154	49	25.6	63	55.4
Symphytum officinale	14.8	15.7	405	301	55	19.4	34	26.9
Taraxacum officinale	14.6	12.4	286	401	44	33.9	40	33.6
Vicia cracca	12.5	11.8	412	136	59	36.7	33	52.4

The manganese content of these varieties group was higher than in the recorded in previous table. Compare with the *Salvia nemarosa*'s manganese content we found that *Plantago major, Potentilla reptans, Trifolium repens*, and *Gleochoma hederacum* are near 60 mg kg^{-1} manganese.

Table 2 Microelement content of other herbs

Herbs	Mineral content [mg kg^{-1}]			
	Cu	Fe	Mn	Zn
Agrostis alba	8.6	137	36.1	49.5
Ambrosia elatior	15.1	369	33.5	86.4
Bromus arvensis	4.9	74.6	44.8	7.6
Cephalaria transsilvanica	9.0	670	35.3	50.8
Convolvulus arvensis	29.6	249	48.5	385
Gleochoma hederacum	9.8	330	59.6	93.5
Lathyrus vernus	8.3	151	28.4	49.4
Lolium perenne	5.5	208	33	42.6
Matricaria maritima ssp. inodora	11.6	217	35.6	48.5
Plantago lanceolata	9.9	159	25	71
Plantago major	7.3	317	61.5	18.2
Potentilla anserina	5.0	134	41.4	39.8
Potentilla reptans	7.6	180	62.3	54.9
Ranunculus repens	26.8	284	81.6	55.4
Rorippa austriaca	6.3	246	31.2	52.8
Trifolium pratense	12.1	130	32.1	29.4
Trifolium repens	9.7	446	62.2	24.3
Vicia angustifolia	8.3	173	30.6	31.1
Vicia grandiflora	8.9	381	37.9	38.7
Vicia sepium	8.6	421	50.7	32.7
Xanthium strumarium	12.0	638	38.7	32.2

It seems the *Ambrosia elatior, Gleochoma hederacum*, and *Plantago lanceolata* varieties accumulate the zinc (more than 70 mg kg^{-1}).

We also investigated the mineral content of *Rorippa austriaca*. This variety was the first to grow from the drying up mud layer. Four places were the origin of samples out of which two came from the floodplain and two from arable fields. The iron, sulfur and the zinc content were higher in the floodplain samples (see Table 3). The zinc content of *Rorippa austriaca* was higher (50 mg/kg) with twenty percent in the floodplain samples.

Table 3. Mineral content of *Rorippa austriaca* samples from different sampling sites (2000)

Elements content, mg kg^{-1}	Sampling sites			
	Csaroda	Beregsurány	Tivadar	Gergely-ugornya
B	25.2	28.5	33.5	27.6
Cd	<0.05	0.1	<0.05	<0.05
Cr	0.4	0.7	0.6	1.6
Cu	5.7	7.7	6.6	10.0
Fe	75.4	128	183	222
Li	0.7	0.9	0.9	0.8
Mg	1295	1837	1537	1138
Mn	20.8	28.5	22.7	23.9
Na	298	331	371	376
Ni	1.5	4.0	2.2	1.6
P	2243	2016	1834	2253
Pb	<0.02	<0.02	<0.02	<0.02
S	6957	7001	8515	8638
Zn	31.8	44.3	44.2+	55.1

This result demonstrates the high sulfur content of the new sediment contains sulfide and sulfate chemical form of zinc.

We analyzed the *Trifolium pratense* samples (Table 4) collected in different time to get information about the changing of mineral content time to time.

Table 4. The changing of mineral content during the vegetation period (*Trifolium pratense*)

Mineral content, mg kg^{-1}	Sampling time		
	May	**June**	**July**
Al	97.6	108.5	34.7
Ba	14.4	19.8	15.1
Ca	10971	18025	9549
Cd	0.03	0.04	0.04
Co	0.07	0.1	<005
Cr	0.5	0.9	0.4
Cu	11.2	10.1	12.1
Fe	142	263	130
K	27446	19668	23888
La	0.4	0.4	0.1
Li	0.3	0.5	0.4
Mg	2828	3074	2398
Mn	30.9	38.4	32.1
Mo	0.6	1.0	0.5
Na	276	275	195
Ni	1.3	1.5	1.2
P	2401	2652	2872
S	1685	2254	1997
Zn	22.7	54.8	29.4

The copper content was very stabile during the sampling period. On the other hand the iron, calcium, manganese, and zinc content were higher in June than in May or July.

Conclusions

Comparing the plant varieties element by element we found that as regards several elements it was *Althea officinalis*, *Salvia nemorosa*, *Bidens tripartitus*, *Lotus corniculatus*, *Symphytum officinale*, *Taraxacum officinale* and *Vicia cracca* that accumulated high amount of studied elements.

In terms of micro-element contents we found these plants are the most valuable ones of the plant community we analyzed.

The heavy metal contamination on the studied varieties cannot be proved.

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