Potential of coltsfoot for biomonitoring metal polluted soils

L. Levei [1,2], E. Kovacs[1,3], M.A. Hoaghia[1], A. Moldovan[1], O. Cadar[1], E.A. Levei[1] and A. Ozunu[2,4]

[1]INCDO-INOE 2000, Research Institute for Analytical Instrumentation, 67 Donath, 400293, Cluj-Napoca, Romania
[2]Babes-Bolyai University, Environmental Science and Engineering Faculty, 30 Fantanele, 400294, Cluj-Napoca, Romania
[3]University of Agricultural Science and Veterinary Medicine, Faculty of Horticulture, 3-5 Calea Manastur, 400372, Cluj-Napoca, Romania
[4]University of the Free State, DIMTEC, Nelson Mandela Street, 9300, Bloemfontein, South Africa

INTRODUCTION

Pollution of soils with metals is a global environmental problem, due to their potential toxicity, persistence and non-biodegradability. Coltsfoot (*Tussilago farfara L*) was used as a bioindicator of soil pollution with metals, considering its high ability to adapt to scarce environments such as soils with low nutrient and high metal content.

The objective of the study was to assess the suitability of coltsfoot to be used for biomonitoring of soil pollution with Cd, Cr, Cu, Ni, Pb and Zn in industrial and urban areas from Romania.

SITE DESCRIPTION AND SAMPLING

Coltsfoot (*Tussilago farfara L*) leaves and the adjacent soil were sampled from urban (Cluj-Napoca) and industrial (tailings impoundments near Baia Mare) areas. The soil samples were air dried, grinded and sieved to pass 250 µm mesh sieves. The leaves were washed in ultrapure water, oven dried at 105±5°C and powdered.

MATERIALS AND METHODS

Soil samples (1g) were digested with 28 ml *aqua regia* (7 ml of 65% HNO_3 and 21 ml of 37% HCl) on a sand bath for at least 2 h and diluted to 100 ml with ultrapure water.

Plant samples (0.5 g) were digested with 2 ml 30% H_2O_2 and 5 ml 65% HNO_3 in a closed PTFE vessels using a microwave digestion system.

The metal contents (Cd, Cr, Cu, Ni, Pb and Zn) in soils were determined by inductively coupled plasma optical emission spectrometry using an 5300 Optima DV (Perkin Elmer, US) spectrometer, while in coltsfoot leaves by inductively coupled plasma mass spectrometry using an Elan DRC II (Perkin Elmer, US) spectrometer.

RESULTS AND DISCUSSIONS

The obtained data showed that the metal content differed significantly between the studied industrial and urban area. The range of metal contents (mg/kg) in the industrial area varied between 506-3200 for Cu, 570-3064 for Pb, 698-1900 for Zn, 7.9-38 for Cd, 16-56 for Cr and 10.5-38 for Ni. In soils from the urban area, the values for Cu, Pb and Zn were much lower, whereas the values for Cd, Cr and Ni were comparable with those in soils from industrial area.

Table 1. Metal content (mg/kg) in soil samples (I-industrial, U-urban)

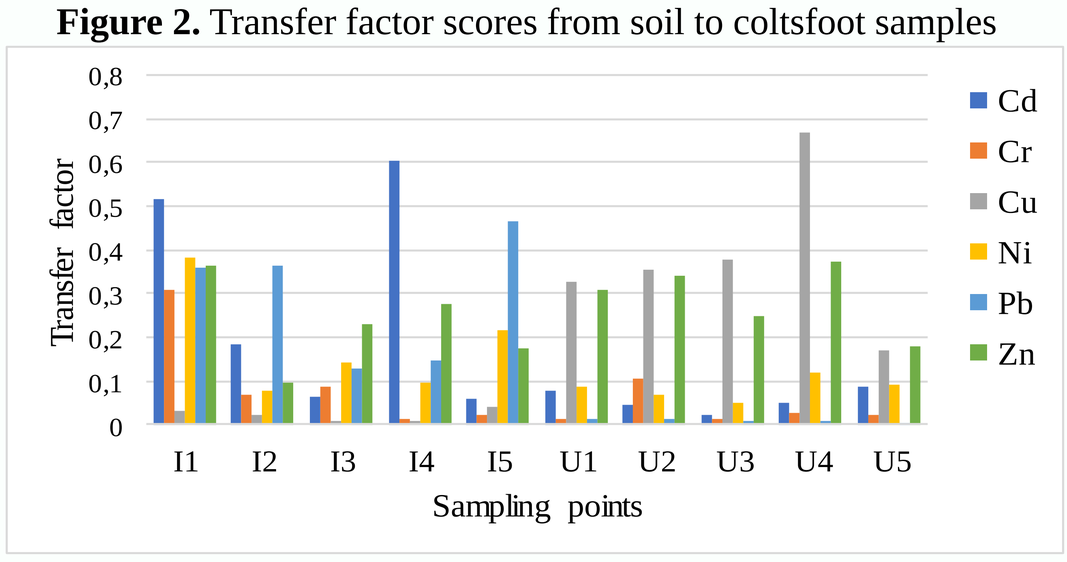
Samples	Cu	Pb	Zn	Cd	Cr	Ni
I1	527	570	797	7.9	16.0	10.5
I2	3200	736	1730	16.8	56.2	38.0
I3	2736	3064	1900	38.0	42.1	27.2
I4	2640	2038	1112	8.0	49.4	28.9
I5	506	802	698	10.7	65.1	12.6
U1	13.7	18.8	51.1	1.27	18.9	22.2
U2	26.9	22.9	94.8	2.4	37.3	55.1
U3	25.1	33.1	95.4	3.3	46.3	55.6
U4	17.4	15,9	69	2.5	22.3	32.4
U5	59	33.0	132	1.5	49.7	37.8
min	*13.7*	*15.9*	*51.1*	*1.3*	*16.0*	*10.5*
max	*3200*	*3064*	*1900*	*38.0*	*65.1*	*55.6*
average	*975*	*733*	*668*	*9.2*	*40.3*	*32.0*

Table 2. Metal content (mg/kg) in coltsfoot leaves (I=industrial, U=urban)

Coltsfoot	Cu	Pb	Zn	Cd	Cr	Ni
I1	17.8	205	290	4.1	4.9	4.0
I2	68.1	270	169	3.1	3.9	3.0
I3	21.1	393	437	2.4	3.7	3.9
I4	23.4	300	309	4.8	0.6	2.8
I5	21.4	375	122	0.7	1.4	2.7
U1	4.5	0.2	15.9	0.1	0.3	2.0
U2	9.6	0.3	32.3	0.1	3.9	3.8
U3	9.5	0.3	23.9	0.1	0.6	2.8
U4	11.6	0.1	25.9	0.1	0.6	3.9
U5	10.1	0.1	24.0	0.1	1.2	3.5

In the industrial area relatively high values for Zn (122-437 mg/kg), Pb (205-393 mg/kg) and Cu (17.8-68.1 mg/kg) and low contents of Cr (0.6-4.9 mg/kg), Cd (0.7-4.8 mg/kg) and Ni (2.7-4 mg/kg) were found in the coltsfoot leaves.

Figure 2. Transfer factor scores from soil to coltsfoot samples



The ability of coltsfoot to uptake the metals was assessed using the transfer factors (TFs), calculated as the ratio between the metal content in coltsfoot leaves and in soil. The TFs were higher for Pb and Cd in the industrial area (TFs<0.3), for Cu in the urban area (TFs<0.4) and comparable for Zn, Cr and Ni, but lower than 1.0 for each metal in both areas, indicating that coltsfoot exclude the metals from the uptake (hyperaccumulation).

Generally, TFs scores indicated an accumulation capacity decreasing in the following order Pb>Cd>Zn>Ni>Cr>Cu in the industrial area (Baia-Mare) and Cu>Zn>Ni>Cd>Cr>Pb in the urban area (Cluj-Napoca).

CONCLUSIONS

The results of the research showed 10-fold higher contents of Cu, Cd and Zn and 100-fold higher contents of Pb in the coltsfoot leaves grown in the industrial area, than in those grown in the urban area, while the content of Cr and Ni were comparable. The findings suggest that coltsfoot could be used to biomonitor metals in moderately polluted soils, but at high metal contents coltsfoot may develop an adaptation mechanism to limit the uptake of toxic metals.

ACKNOWLEDGEMENTS

This work was funded by the Romanian National Core Program, project no. PN 19-18.01.01 (contract no. 18N/08.02.2019).