EVALUATION OF TRANSFER AND BIOACCUMULATION FACTORS OF HEAVY METALS IN DIFFERENT PARSLEY SAMPLES

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Abstract

Heavy metals transfer factors help to observe metals impact on agricultural products (vegetables and/or fruits) to evaluate different bioaccumulation scenarios to interpret available experimental results and for designing fingerprints or bioaccumulation maps. The aim of this study was to evaluate the transfer factors (TF) of some heavy metals (HMs) including (Fe, Mn, Zn, Cu, Ni, Pb and Cd) from soil to root and leaves of parsley samples cultivated on polluted and nonpolluted areas and to identify the fingerprint of transferred metals. The heavy metal (HM) content was analyzed using Flame Atomic Absorption Spectrometry (FAAS) technique. The bioaccumulation factor (BF) and TF in parsley samples were used for obtaining the fingerprints (HMs bioaccumulation maps) of parsley samples.

Introduction

The pollution at global level is continuously increasing and that is causing nutritional modifications. The plants have the capacity to sequestrate and/or to remove metals from the soil through roots and/ or shoots. Plants heavy metals concentrations can be correlated with their surrounding environment (soil, aer and water) [4]. Many plants can be used as biological indicators with specificity to heavy metals [6].
Metal toxicity presents noteworthy relationship with the characteristics, which are in control of the metal tolerance, including chemical interaction and ionic speciation [1].
The transfer (translocation) factor (TF), offers information about the capability of a plant to translocate the metal ions from roots through shoots and to leaves of a plant.
The bioaccumulation factor (BAF) from soil to plant expressed by the ratio of metal concentration in plant tissues divided by the heavy metal concentrations in soil and used as an indicator of the parsley accumulation behavior.
The aim of the study was to analyse the capacity of parsley roots and leaves to accumulate heavy metals and to generate the heavy metal fingerprints of parley based on TF and BAF Values

Experimental

The parsley roots and leaves used for the study investigation were sampled in triplicate from ten different private vegetables farms. All the samples were washed with double distillated water, weighed, dried at 105 °C and grinded. The heavy metals concentrations were determined by flame atomic absorption spectrometry as described by Bordean et al, 2014 [3].

The transfer factors (TF) of Mn, Zn, Cu, Ni, Cd, Pb, from roots to leaves [1] were calculated using equation 1:

$$TF = \frac{C_{leafs}}{C_{root}} \quad (1)$$

TF = transfer or translocation factors of metals from roots to leaves
C_{leaf} = metal concentration in fresh weight plant tissue [mgKg $^{-1}$];
C_{root} = metal concentration in fresh plant tissue [mgKg $^{-1}$]

The bioaccumulation factors (BAF) were calculated as the ratio of metal concentration in the parsley plants (roots and shoots) to that of the soil [5], as specified in equation 2:

$$BAF = \frac{C_{plant}}{C_{soil}} \quad (2)$$

BAF = bioaccumulation factors of metals from soil to plant
C_{plant} = metal concentration in fresh weight plant tissue [mgKg $^{-1}$];
C_{soil} = metal concentration in dry soil [mgKg $^{-1}$].

Results and discussion

The heavy metals (manganese, zinc, copper, nickel, cadmium and lead) concentrations were determinate for all collected parsley samples, as well as of the soil samples were the plants were cultivated. All heavy metal analysis of soil, parsley roots and parsley leafs (table 1) were performed in triplicate and the values were used to calculate TF and BAF (table 2).

Table 1 Heavy metals concentrations of soil, parsley root and parsley leaf samples

Vegetables, soil/Me content ± Standard Deviation (SD)	**Mn ± SD**	**Zn ± SD**	**Cu ± SD**	**Ni ± SD**	**Cd ± SD**	**Pb ± SD**
Parsley Root	3.75 ± 0.87	3.92 ± 0.68	1.35 ± 0.47	0.22 ± 0.09	0.01 ± 0.00	0.11 ± 0.03
Parsley Leaf	6.98 ± 0.84	9.41 ± 1.75	1.27 ± 0.35	0.55 ± 0.17	0.04 ± 0.02	0.42 ± 0.11
Soil samples	1537.71±18.18	159.33± 8.57	27.83±6.23	12.22±1.08	0.19±0.05	27.15±4.89

Heavy metals concentrations in parsley root and leaves collected from 10 from investigated areas (mgKg^{-1} fresh weight, * $p < 0.05$); Heavy metals concentrations in soil samples collected from 10 from investigated areas (mgKg^{-1} dry weight, * $p < 0.05$)

Based on Baker and Brooks, 1989 studies, if TF presents values higher than 1, this shows that the plant transfers the metal from root to leaves [2].

As we can observe the translocation of heavy metals from roots to leaf in parsley is higher than 1 for Mn, Zn, Ni, Cd and Pb, but its lower than 1 for copper, which means it is not transferring copper, from roots to leaf.

Table 2 Presentation of translocation (transfer factors) and bioaccumulation factors of some heavy metals in parsley samples

Transfer and bioaccumulation factors	**Heavy metals**					
	Mn	**Zn**	**Cu**	**Ni**	**Cd**	**Pb**
TF	1.861	2.401	0.941	2.500	4.000	3.818
BAF	0.003	0.042	0.047	0.032	0.132	0.010

Legend: TF = transfer or translocation factor; BAF = bioaccumulation factor

At the same time, the bioaccumulation factors are lower than 1, which means that parsley can be an excluder of heavy metals (table 2). Based on the observations made by Radulescu et al, 2013, if the BAF is higher than 1, then the plants can be considered to behave like bioaccumulators of heavy metals and if the BAF is lower than 1, then the plant might be appreciated as an excluder of heavy metals [5].
The fingerprint of parsley samples based on TF and BAF for the studied heavy metals is presented in figure 1.

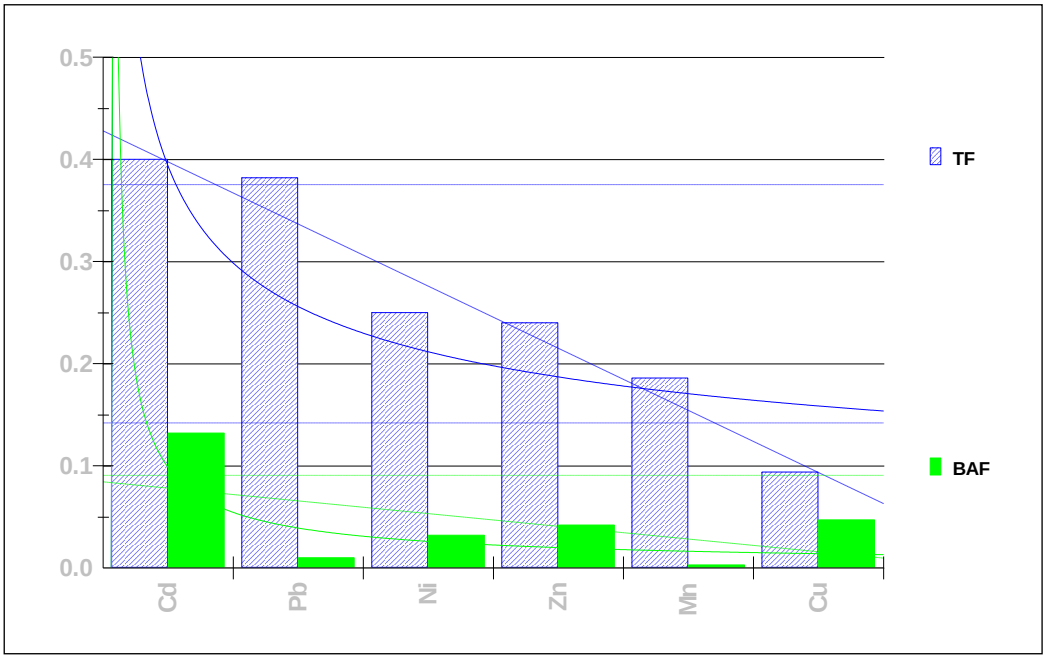

Figure 1. Heavy metals Fingerprint based on parsley TF and BAF, using Pareto Style
Legend: TF = transfer or translocation factor; BAF = bioaccumulation factor

Conclusion

The fingerprint presented can be used to identify the plants that are most suitable for nutrition, but also to reveal the best phytoremediators of soils. The obtained results explain why parsley and cilantro are used for heavy metals detoxification programs and are recommended in different detoxification diets for neurovegetative diseases like Alzheimer and Parkinson.

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