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DETERMINING THE CONTENT OF Cd, Cu, Pb AND Zn IN THE LEAVES OF DANDELION (*TARAXACUM OFFICINALE* WEBB.) AND IN THE SOIL BY ICP-OES

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Dandelion (Taraxacum officinale Webb.) is a plant capable of accumulating a certain quantity of metals. The aim of this study was to determine the content of Cd, Cu, Pb and Zn in dandelion leaves and soil that have been sampled from different locations. One group of samples has been influenced by pollution sources of these metals and the other one has not been exposed to the pollutants. The amount of metals in the tested samples has been determined by inductively coupled plasma optical emission spectrometry (ICP-OES).The content of detected metals was higher in leaves and soil samples that were exposed to the negative effect of environmental pollutants, compared to those samples that were not under the influence of contamination sources. The increased content of detected metals in the samples of dandelion leaves that were under the influence of the pollutant may be the result of a synergistic effect, soil, on which this plant species thrives, and the air, that is contaminated by the effects of motor traffic and other forms of pollutants. The results of this study have shown that dandelion can provide a data of environmental pollution by the content of detected metals in its tissue. As dandelion is used in human nutrition, and since heavy metals (Pb, Cd) with cumulative and toxic effects have been detected in it, it is necessary, in order to protect human health, to check the presence and content of these metals in the dandelion plant that is used in human nutrition.

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Key words: *dandelion, metals, soil, pollutants, ICP-OES*

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Introduction

The development and advance of technology, in all spheres of life, are processes that have been rapidly evolving since the industrial revolution in the 18th century. Today we are witnesses of a huge and constant development of technological and industrial processes that leads to a significant improvement in the life of an individual in all social aspects. Unfortunately, such an unstoppable advance, with all the benefits, also brings different negative effects, that can also cause very serious and unsolvable problems for all of the living beings on the planet. Global and local pollution of the environment that harms all the living organisms is definitely one of the biggest problems, and a direct result of constant industrial development of the human species.

Environmental pollutants are of organic and non-organic origin. They can have a bigger or smaller negative effect on the living world. In the big group of non-organic pollutants cadmium and lead must be pointed out. They are especially dangerous, as they are toxic, even in small quantities (1). An increased amount of metals in the environment, taking into consideration the fact that they are eco-toxicological danger, creates a need to find and develop economical chemical methods whose aim would be to detect the presence of metal in tested samples and discover the dangers that living organisms are exposed to because of these pollutants. One of the ways to detect these pollutants is to identify the organisms that, thanks to their ability to accumulate different metals, can give adequate information about the assessment of environmental contamination with these metals. These organisms that give quantitative data that is connected to the environment, for example, how much pollutants are present at the tested location. Every kind of organism that is distributed over a wider geographical area, that is toxitolerant to a large number of metals and that can accumulate them, can be used for metal content determination. These accumulated metal contents reflect the contamination quantity when compared to monitored variables (2).

A large number of different plants shows the capability to accumulate various metals from the environment, and this characteristic qualifies them as adequate indicators of environmental pollution with some toxic metals. Herbaceous plants are capable of accumulating a significant quantity of different metals, and one of those is also dandelion (*Taraxacum officinale* Webb.). Dandelion is a plant species that produces new leaves every year. It is widespread in nature and farmland and one of its characteristics is that it is capable of accumulating traces of elements (2, 3). By reviewing the literature, it is possible to see that dandelion has been used in a number of studies as preferable plant species for determining the level of environmental pollution, based on the metal content in its tissue (4-9). Numerous studies have shown that there is a connection between the quantity of metals present in the tested part of the environment (soil, air, water...) and the detected amount of these elements in dandelion tissue (4, 5, 10). Detected quantities of metals in dandelion samples that have been collected at different distances from the metals pollution source (landfills, roads, industrial plants...) have shown that the amount of metals in the tissue of this plant depends on the distance from the pollution source. Those dandelion samples that have been taken near the pollutant had increased levels of metals compared to the samples taken from areas that haven't been exposed to them (2, 4, 8, 11).

Aim of the study

Taking into consideration these facts, the aim of this study was to determine the content of individual metals (Cd, Cu, Pb and Zn) in dandelion leaves that have been sampled at 6 locations on the territory of the city of Niš and that have been close to the pollution source with these metals (main city roads, a gas station). In order to compare the level of detected metals in dandelion leaves that have been sampled near the pollution source, the level of these metals has also been determined in dandelion leaves samples from 3 locations (local excursion spots) that haven't been impacted by motor traffic. Furthermore, since the amount of detected elements also depends on the chemical composition of soil where this plant grows, the amount of Cd, Cu, Pb and Zn has been determined in the soil from these locations. The amount of cadmium, copper, lead and zinc in the tested samples of soil and dandelion has been determined by inductively coupled plasma optical emission spectrometry (ICP-OES).

Materials and methods

Reagents and chemicals

• ICP multi-element standard solution (*Ultra scientific* (*USA*)), γ = 20.00 ± 0.10 mg/L;
• 65% nitric acid, p.a. (*Merck*, *Darmstad*);
• 36% hydrochloric acid, p.a. (*Merck, Darmstad*);
• 30% hydrogen peroxide (*Fluka*) and
• High purity water, conductivity 0.05 µScm-1(*MicroMed high purity water system, TKA Wasseraufbereitungssysteme GmbH*).

Vials of PVC material were used to store the test samples. In order to remove traces of possibly present metals, the vials were previously washed with 5% nitric acid, then tap water and finally with deionized water.

Instrumentation

The overall analysis was conducted by an iCAP 6000 inductively coupled plasma optical emission spectrometer (*Thermo Scientific, Cambridge, United Kingdom*) which combines an Echelle optical design and a charge injection device (*CID*) solid state detector. iTEVA operating software for iCAP 6000 series was used to control all functions of the instrument. The optimal operating parameters of instrument are given in Table 1.

Table 1. The optimal operating parameters for ICP-OES measurement

Parameter	
Flush Pump Rate	100 rpm
Analysis Pump Rate	50 rpm
RF power	1150 W
Nebulizer gas	0.7 L/min
Coolant Gas Flow	12 L/min
Plasma View	Axial mode

Analytical balance (*Mettler Toledo*) was used to measure the mass.

Samples mineralization was carried out in a VIMS electric (*Serbia*) furnace equipped with a microprocessor programmatic temperature control IVIGOS3123 (± 1 ^{O}C).

A pH meter (*Hanna Instruments, USA*) was used to determine the soil pH value.

Samples

The content of Cd, Cu, Pb and Zn was determined in leaves of dandelion (*Taraxacum officinale* Webb.), which were sampled from different localities in the area and surrounding of the city of Niš. Nine sites (marked 1-9) considered for this study are shown in Table 2. The leaves of dandelion plants of the same developmental stage, were cut with a plastic knife and than were placed in plastic bags. Samples of dandelion, grown near the streets, with high traffic intensity (samples 1 to 6) were taken at two different distances from the street, 1 m (a samples) and 5 m (b samples). In Table 2, the localities of dandelion samples that were not under the impacted to traffic, were marked from 7 to 9. The coordinates of all points from which the samples were collected were determined by GPS.

The soil samples were collected from the same locations as dandelion leaves samples. Soil samples were collected just at the bottom of each sampled plant by plastic spatula. Only the first 5 cm of soil was collected in the root area. Each soil sample was placed in a separate plastic bag and stored at a room temperature.

Table 2. Site identification and its coordinates

No.	Site	Coordinates
1	Street	N43°19'11.7300'' E21°54'0.0324''
2	Street	N43°18'57.9348'' E21°54'55.2816''
3	Street	N43°19'14.3940'' E21°54'1.0080''
4	Roundabout	N43°18'53.9172'' E21°53'52.6848''
5	Street near the railway	N43°18'56.5272'' E21°52'45.2064''
6	Street near the gass station	N43°19'0.9624'' E21°53'35.7720''
7	Park „Čair"	N43°18'0.4612'' E21°54'21.6720''
8	Park „Bubanj"	N43°18'15.4224'' E21°52'21.2160''
9	Natural Park „Kamenički vis"	N43°24'45.3168'' E21°56'5.1468''

Samples preparation

Mineralization of plant material

The plants leaves were cut with a plastic knife and stored in plastic bags. Then, they were washed with deionized water and left to dry in the air. After air drying, they were dried in a kiln at a temperature of 70 ^{O}C. The samples were then homogenized; a mass of 3.0 g of the sample was analyzed. For the detection of metals, the samples were prepared by a dry digestion method (12). Portion of each sample was then weighed and heated at a temperature of 600 ^{O}C for a period of 12 h in porcelain crucible. For complete mineralization of the samples, 1 ml of 65% HNO_3 was added; the samples were heated to dryness and then returned into the furnace. The obtained ash was digested in 3 ml of 65% HNO_3 and filtered through a Whatman No 541 tape in a 50 ml flask.

Pseudo-total cation content determination in soil samples

Soil samples were collected with a plastic ladle, in the immediate vicinity of the dandelion plant from a depth of 0-10 cm. All of the soil samples were spread on plastic trays in fume cupboards and allowed to dry at ambient temperature for 8 days. The pseudo-total amounts of Cd, Cu, Pb and Zn were determined by the digestion of the samples using HNO_3–HCl (aqua regia) by means of the conventional wet acid digestion method (13).

Soil pH value determination

The dry soil sample was homogenized in the spindle and diluted through the sieve 0.5 mm, then weighed 20 g and transferred to a 50 ml flask, then poured with 20 ml of deionized water. The sample than was covered with watch glass and mixed for 5 minutes, then left to stand for one hour. Subsequently, the suspension was filtered. Measurement of the pH value was carried out pH-metric (Hanna Instruments, USA), calibration of pH-meter was carried out with buffers of known concentrations (pH = 4 and pH = 7) (14).

Results

For the determination of the metal content in the samples of dandelion, the calibration method was used. The basic calibration parameters for each test element were determined using deionized water for the concentration of zero and standard solutions of the corresponding concentrations obtained by diluting the base reference multi-elemental standard. Parameters of the analytical calibration curves such as wavelength λ, limits of detection and quantification (LOD and LOQ), correlation coefficient R^2, intercept (b), slope (m), average RSD for repeatability of calibration solutions measurements are shown in Table 3.

Table 3. Parameters of the analytical calibration curves: wavelength λ (nm), limits of detection and quantification (LOD and LOQ, ppm), correlation coefficient (r), intercept (b), slope (m), average RSD (%) for repeatability of calibration solutions measurements

Element	λ (nm)	LOD (ppm)	LOQ (ppm)	r	b	m	RSD (%)
Cd	228.802	0.0828	0.2759	0.999946	0.76	1906	4.07
Cu	324.754	0.1181	0.3936	0.999889	46.67	6072	8.22
Pb	220.353	0.2191	0.7304	0.999619	0.09	153	0.87
Zn	202.548	0.0779	0.2598	0.999952	5.33	9825	1.98

The applied ICP-OES technique allows the element to be viewed at different wavelengths. All analytes were determined on four wavelengths. In this way, it is possible for each element to select the wavelength at which the spectral and matrix interferences are minimized (15). The optimal wavelength for each of the detected elements is determined by comparing the inclination of the corresponding calibration curves.

Table 4. The metal content (mg/kg) in dandelion leaves samples collected from selected locations

	The metal content ± SD			
Site	Cd	Cu	Pb	Zn
1*a*	0.25 ± 0.01	20.02 ± 1.23	0.48 ± 0.02	62.71 ± 1.56
1*b*	0.27 ± 0.02	24.11 ± 1.09	0.33 ± 0.03	58.16 ± 1.27
2*a*	0.22 ± 0.02	17.83 ± 1.12	0.39 ± 0.05	48.36 ± 1.38
2*b*	0.18 ± 0.01	19.22 ± 1.37	0.41 ± 0.03	52.88 ± 1.52
3*a*	0.22 ± 0.01	18.23 ± 1.03	0.52 ± 0.11	51.18 ± 1.09
3*b*	0.21 ± 0.01	21.12 ± 1.29	0.49 ± 0.08	49.35 ± 1.17
4*a*	0.29 ± 0.01	16.25 ± 1.11	0.54 ± 0.09	57.26 ± 1.27
4*b*	0.32 ± 0.02	14.32 ± 1.03	0.47 ± 0.10	56.27 ± 1.09
5*a*	0.36 ± 0.02	24.07 ± 1.01	1.84 ± 0.02	56.28 ± 1.86
5*b*	0.32 ± 0.01	19.72 ± 1.26	1.51 ± 0.09	48.39 ± 1.62
6*a*	0.49 ± 0.02	22.12 ± 0.98	2.03 ± 0.04	59.01 ± 2.41
6*b*	0.44 ± 0.03	24.52 ± 1.27	1.88 ± 0.12	56.58 ± 1.88
7	0.15 ± 0.02	9.72 ± 0.68	0.26 ± 0.04	44.68 ± 1.87
8	0.13 ± 0.01	11.14 ± 0.92	0.15 ± 0.03	34.08 ± 1.07
9	0.09 ± 0.02	9.25 ± 0.74	0.18 ± 0.03	36.12 ± 1.41

Table 5. The metal content (mg/kg) in soil samples collected from selected locations

	The metal content ± SD				pH
Site	Cd	Cu	Pb	Zn	
1*a*	0.41 ± 0.12	32.22 ± 2.08	22.34 ± 1.12	98.12 ± 2.80	7.61
1*b*	0.42 ± 0.13	33.16 ± 1.86	21.56 ± 1.23	96.20 ± 3.38	7.52
2*a*	0.50 ± 0.11	28.70 ± 1.12	32.65 ± 1.17	101.37 ± 3.22	7.38
2*b*	0.50 ± 0.12	29.10 ± 1.18	31.30 ± 1.45	100.04 ± 4.15	7.35
3*a*	0.38 ± 0.10	25.19 ± 2.12	27.75 ± 1.16	108.63 ± 3.60	7.56
3*b*	0.38 ± 0.15	24.66 ± 1.75	28.02 ± 1.04	107.22 ± 2.44	7.48
4*a*	0.46 ± 0.08	22.46 ± 1.11	25.85 ± 1.24	98.67 ± 5.17	7.60
4*b*	0.48 ± 0.13	24.20 ± 1.06	25.10 ± 1.05	99.04 ± 4.35	7.63
5*a*	0.60 ± 0.12	34.69 ± 1.09	28.55 ± 1.30	126.52 ± 3.20	7.52
5*b*	0.61 ± 0.15	35.26 ± 1.35	29.06 ± 1.12	125.20 ± 2.18	7.48
6*a*	0.67 ± 0.21	30.97 ± 1.71	38.28 ± 1.52	120.88 ± 5.17	7.28
6*b*	0.66 ± 0.17	29.56 ± 2.05	37.76 ± 1.13	121.02± 4.35	7.30
7	0.33 ± 0.11	8.58 ± 1.36	8.49 ± 0.09	92.13 ± 4.12	7.59
8	0.28 ± 0.09	12.71 ± 2.02	7.10 ± 0.14	75.76 ± 3.92	7.48
9	0.17 ± 0.02	9.05 ± 1.16	3.27 ± 0.16	53.52 ± 4.37	6.69

The obtained values of the content of the detected metals in the dandelion samples, sampled from different localities, as well as the corresponding standard deviations, are shown in Table 4.The contents of the detected metals are shown as the mean value (milligram per kilogram of the test sample, mg/kg) obtained for three successive measurements.

The soil is one of the major pathways for metal absorption by plants, for this reason, in this study, the soil underlaying the tested dandelion leaves samples was analyzed.

Availability of metals from soil for a plant, that is, its root, depends on the ability of metals to absorb, desorb and complex with one of the components in the soil matrix. These processes are conditioned by soil characteristics such as pH, composition and soil structure. Heavy metal mobility is higher in soil with a lower pH value.

The metal concentration in the soil samples and pH values are presented in Table 5. The contents of the detected metals are shown as the mean value (milligram per kilogram of the test sample, mg/kg) obtained for three successive measurements.

Discussion

Cadmium is an element that is not a part of any compound that has a metabolic significance, and also belongs to the most dangerous environmental pollutants. Plants adopt cadmium mainly through the root, because this heavy metal has great mobility through the soil on which the plant grows (3). It is considered that the normal Cd concentration in plant tissue is between 0.2 and 0.8 mg/kg, while the contents of this metal of 5 to 30 mg/kg are considered to be toxic (3, 16).

Small amounts of *copper* are essential for plant growth, and this element also makes the structure of many enzymes. The phytotoxic level of this metal is 30 mg/kg (18). The normal content of Cu in plants is about 4-15 mg/kg, while the contents of this element over 25 mg/kg are toxic to the plant (16).

Lead is an element that can be delivered to the plants either by soil or by air. The normal contents of this metal in plants range from 0.1 to 10 mg/kg. The toxic contents of Pb are from 30 to 300 mg/kg (16).

Zinc is an essential component for a large number of (> 300) enzymes involved in the synthesis and decomposition of carbohydrates, lipids, proteins and nucleic acids, as well as in the metabolism of other micronutrients. Zn is an element that is not considered to be highly toxic and toxin levels of this metal (300-400 mg/kg), depending on both the plant species and its level of maturity. High zinc content in plants can cause leaf losses, while on the other hand Zn deficiency leads to their deformation. It is believed that the environment is contaminated with zinc when the content of this element, detected in plants, is about 100 mg/kg (16).

The content of cadmium and lead, as the two most toxic metals in the group of determined elements, which are detected in this study, ranged from 0.09 to 0.15 mg/kg (Cd) and 0.15 to 0.26 mg/kg (Pb) for samples collected in the no traffic impacted areas, i.e., from 0.18 to 0.49 mg/kg (Cd) and from 0.33 to 2.03 mg/kg in samples that were impacted by motor traffic (Table 4). Regarding to the content of detected metals (Cd and Pb), in dandelion samples from different locations, it can clearly be seen, that exposure to one of the sources of pollution (traffic, petrol pump, trapping) contributes to the increase of these pollutants in the dandelion plant tissue in relation to samples that were not exposed to the effects of the pollutant of the environment.

The results of this study are in line with the conclusions presented by other authors, that the content of cadmium and lead in the dandelion leaves is lower in samples taken from sites that were protected from traffic (Parks and Natural Parks), in relative to the contents detected in the samples that were impacted by the source of these heavy metals (4, 5, 10, 11).

According to Kloke et al. (17) and Kabata and Pendias (4), the normal contentration of Cd in plants are 0.2-0.8 mg/kg and 0.1-10 mg/kg for Pb. Results for Cd and Pb in this study corresponded to those values. That indicates that detected contents in this paper are below to the toxic limit for those pollutants in analyzed dandelion species.

However, the given fact is that dandelion can also be used mainly as a salad in human nutrition, the contents of Cd and Pb detected in this study are compared to the maximum allowed content of these metals in the fresh dandelion leaves (0.2 mg/kg for Cd and 0.3 mg/kg for Pb) prescribed by the World Health Organization (WHO) (1). In all samples of dandelion taken from the sites impacted to the pollutants, the contents of cadmium and lead were above the maximum allowed (Table 4), while the contents of these metals in the dandelion leaves taken from locations that were not exposed to the sources of contamination were below the prescribed limits for this plant species. Detected contents of Cd and Pb in this study, in samples from uncontaminated sites, are low, but due to the cumulative effect these metals have, as well as due to their ability to deposit in the vital organs of humans, it is necessary to monitor the content of these metals in the dandelion plant, which are used in human nutrition. As this plant species has the ability to accumulate Cd and Pb from the environment, particular attention should be paid to the location from which dandelion is taken, and if used for the human nutrition, the plant has to be taken from sites that are not impacted by motor traffic and other environment pollutants.

The content of copper and zinc in the tested dandelion samples ranged from 9.25 to 11.14 mg/kg (Cu) and from 34.08 to 44.68 mg/kg (Zn) from uncontaminated sites relative to the content of these elements from the sites that were exposed to the source of pollutants, which ranged from 14.32 to 24.52 mg/kg (Cu) or from 48.36 to 62.71 mg/kg (Zn). As in the instance of Cd and Pb, the content of Cu and Zn was higher in dandelion samples that were sampled near the source of pollution compared to samples that were not exposed to the effects of these sources.

These results confirmed that elevated contents of some metals can be found in the dandelion leaves, if this plant species is exposed to the source of the pollutant. The concentration of Cu and Zn in the samples tested was lower than that which would be toxic to this plant species (16).

By comparing Cd, Cu, Pb, and Zn content in analyzed dandelion samples taken at two different distances (1 m and 5 m) from the sites that were exposed to sources of pollution, samples 1-6 (Table 4), it can be seen that there is no regular trend of concentration of detected metals in this study, with the distance from the source of pollution. This is not in agreement with the authors who perceived such a trend in their studies (2, 5, 6, 8, 18) but it is in agreement with the Gicomina et al. study where there was also no correlation between metal content and distance from source of pollution (1).This may be due to the fact that such studies regarded point sources of pollution and/or that the total distance from the street considered in our research (max of 5m) was too short.

The soil is one of the major pathway for metal accumulation in plants, because of that, in this study was analyzed the soil underlaying the dandelion samples.

The content of metals detected in the soil is given in Table 5, while Table 6 gives the maximum limit values, remediation values and maximum permissible values of Cd, Pb, Cu and Zn content in the soil, which are prescribed by the respective Regulations and Regulation of the Republic of Serbia (19, 20).

Table 6. Maximum limit, remediation and maximum permissible values of Cd, Cu, Pb and Zn in the soil expressed as mg/kg

Metals	Maximum limit values	Remediation values	Maximum permissible values
Cd	0.8	12	up to 3
Cu	36	190	up to 100
Pb	85	530	up to 100
Zn	140	720	up to 300

Regarding the detected content of Cd, Cu, Pb and Zn in the soil samples, it can be seen that the concentrations of these metals are higher in soil sampled from the sites that are exposed to the pollutants, compared to those soil samples from locations that are not near polluted sources (Table 5). Also, the content of detected metals in all tested soil samples is below the maximum limit values prescribed by the legislation of the Republic of Serbia (Table 6).

The soil's metal availability for the plant, i.e., its root, depends on the ability of the metal to adsorb, desorb, and compile with one of the components in the soil matrix. These processes are conditioned by soil characteristics such as pH, composition and soil structure.

The results of the pH measurement of the soil samples are part of Table 5. It can be seen that the samples are mildly basic to neutral. The lowest pH value of all samples shows the soil from location 9 and this value was 6.69. The soil pH value is very important for the mobility of the metal ions in it, and therefore for the resorption of plants. Namely, if the value of the pH of the soil is lower, the soil is more acidic, and the mobility of the metal ion is higher.

Based on the obtained results (Table 5), it can be seen that soil samples from contaminated sites had higher content of detected metals regarding the soil sampled from locations that were not impacted by the source of contamination. According to this, it can be concluded that proximity to the source of pollution increases the content of detected metals in the soil on which the analyzed plant species grows.

Conclusion

The results of this study have shown that dandelion leaves can provide a good data of environmental pollution, because the content of detected metals (Cd, Cu, Pb and Zn) was higher in samples that were exposed to the negative effect of environmental pollutants compared to those samples that were not under the influence of pollution's sources. The metal concentration in the samples of dandelion leaves is proportional to urbanization, industrial activity, and density of traffic.

The content of detected metals in all dandelion samples was below the level that would be considered toxic to this plant species.

The amount of Cd, Cu, Pb and Zn in soil samples was higher in soil exposed to atmospheric and exhaust gas pollution, compared to samples that were not under this negative impact. The content of detected metals in soil samples was below the maximum limit values prescribed by the legislation of the Republic of Serbia.

The increased content of detected metals in the samples of dandelion that were under the influence of the pollutant, may be the result of a synergistic effect, soil on which this plant species thrives and the air that is contaminated by the effects of motor traffic and other forms of pollutants.

As dandelion is used in human nutrition, and since heavy metals with cumulative and toxic effects have been detected in it, Pb and Cd, it is necessary, in order to protect human health, to check the content of these metals in the dandelion used in human nutrition. Also, due to the ability of this plant species to adsorb Pb and Cd, if it is additionally exposed to them, it is necessary to take into account from which site this plant species is taken for nutrition.

The ICP-OES method proved to be a good method for determining the content of cadmium, copper, lead and zinc in this type of samples.

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ODREĐIVANJE SADRŽAJA KADMIJUMA, BAKRA, OLOVA I CINKA U LISTOVIMA MASLAČKA (*TARAXACUM OFFICINALE* WEBB.) I ZEMLJIŠTU ICP-OES METODOM

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Maslačak (*Taraxacum officinale* Webb.) je biljna vrsta koja može da akumulira određenu količinu metala. Cilj ove studije bio je da se odredi sadržaj Cd, Cu, Pb i Zn u listovima maslačka i zemljištu, koji su uzorkovani sa različitih lokaliteta. Jedna grupa uzoraka bila je izložena uticaju izvora zagađenja ovih metala, dok druga grupa nije bila pod uticajem zagađivača. Količina metala u ispitivanim uzorcima određena je primenom tehnike indukovano kuplovane plazme optički emisione spektrometrije (ICP-OES). Sadržaj detektovanih metala bio je veći u uzorcima lista maslačka i zemljišta koji su bili izloženi negativnom uticaju zagađivača životne sredine, u odnosu na one uzorke koji nisu bili pod uticajem ovih izvora zagađenja. Povećani sadržaj detektovanih metala u uzorcima listova maslačka, koji su bili pod uticajem štetnog dejstva zagađivača, može biti rezultat sinergističkog efekta zemljišta, na kome ova biljna vrsta uspeva i vazduha, koji je zagađen motornim saobraćajem i drugim vidovima zagađenja. Rezultati ove studije pokazali su da maslačak, na osnovu količine detektovanih metala u biljnom tkivu, može pružiti podatke o zagađenju životne sredine. Kako se maslačak koristi u ljudskoj ishrani, a kako su u listu ove biljne vrste detektovani teški metali (Pb i Cd), koji imaju kumulativno i toksično dejstvo, neophodno je, u cilju zaštite ljudskog zdravlja, proveravati prisustvo i sadržaj ovih metala u maslačku koji se koristi u ljudskoj ishrani.

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Ključne reči: *maslačak, metali, zemljište, zagađivači, ICP-OES*