

# Essential and Heavy Metals Content in Wild and Cultivated *Mentha* Species from Bosnia and Herzegovina

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## Abstract

Both essential and heavy metals play important roles in human health and diseases. The aim of the present study was to determine concentrations of essential and heavy metals, such as Na, K, Ca, Mg, Cu, Cr, Mn, Ni, Fe, Pb, Zn, and Cd, in the leaves of *Mentha longifolia* L. and *Mentha × piperita* L. The plant material samples were collected from six different locations in Bosnia and Herzegovina (B&H), at selected distances from heavy metal pollution sources. Wet digestion was applied for the dissolution of samples and essential and heavy metals concentrations were analysed by flame atomic absorption spectrometry and (FAAS). Results of the analysis (expressed as  $\text{mg g}^{-1}$ ) were obtained as follows: Na 2.08–4.12; K 14.85–22.54; Ca 9.06–15.53; Mg 1.93–3.12; Cu 0.01–0.05; Cr 0.70–0.90; Mn 0.02–0.09; Ni 1.10–7.00; Fe 0.06–1.11; Pb 0.10–0.90; Zn 0.01–0.04. The cadmium concentration in all samples was below the detection limit by FAAS. Strong correlation between Ni and Pb, as well as Ni and Fe, confirmed mostly environmental and processing influence/impact. In conclusion, *Mentha longifolia* L. and *Mentha × piperita* L. can be used in daily consumption considering the high content of essential metals Fe, Cu, Mg, and Zn, and their beneficial effects on normal body function. In addition, there is no risk of heavy metals to human health after consuming these samples due to lower concentrations.

## Keywords

Essential metals, heavy metals, *Mentha* species, AAS

## 1 Introduction

Medicinal plants are commonly used in traditional medicine as the raw material for many herbal formulations. They contain various substances which can originate from the soil, water, or air and have benefits for humans. Some of these substances are elements/metals present in a wide range of concentration/content. Essential elements (micro- and macro-elements) are important for normal growth and functioning of living organisms. Also, medicinal plants may contain high levels of heavy metals, which cause toxicity and severe metabolic disturbances. Essential metals as micro- and macro-elements (Cu, Zn, Cr, Fe, Mn, K, Na, Mg, and Ca) are needed at low concentrations for normal functioning of enzyme systems, formation of haemoglobin, synthesis of vitamins, and for growth, development and photosynthesis in plants.<sup>1,2</sup> On the other hand, toxic elements, such as Pb, Cd, and Ni, are not necessary to the human body and may cause severe consequences to human health.<sup>3–7</sup> In B&H, *Mentha* species have been used as tea in traditional medicine since ancient times, as well as in different herb formulations as ingredients for making creams, perfumes, soaps, etc. In this work, the content of micro- and macro-elements as well as of some heavy metals was determined in two *Mentha* species – wild and cultivated – using flame atomic absorption spectrometry. In addition, correlation analysis of the total elements content in wild and cultivated *Mentha* samples was performed,

with respect to their element composition as the impact of environmental and other factors.

## 2 Experimental

### 2.1 Materials and methods

The plant samples of *Mentha longifolia* L. and *Mentha × piperita* L. were collected from June to October 2018, at six different locations in B&H: 3 wild and 3 cultivated at selected distances from heavy metal pollution sources-urban locations (100 km and range of elevation 300–1200 m



Fig. 1 – *Mentha longifolia* L. (a) and *Mentha × piperita* L. (b)  
Slika 1 – *Mentha longifolia* L. (a) i *Mentha × piperita* L. (b)

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for wild samples in Bugojno, Rudo, and Sarajevo; and from 3 to 30 km with average elevation of 900 m for cultivated samples in Ključ, Travnik, and Brčko). Fresh leaves of the wild species were collected randomly in sufficient quantities (1 kg to provide representative samples). Samples were cut into small pieces and air-dried in the shade for two weeks, then powdered, sieved, and stored in paper bags for element analysis. Samples of cultivated species were available as tea-bags, packed in boxes by local and domestic manufacturers.

## 2.2 Analytical quality control

All chemicals and reagents were of analytical grade: HNO<sub>3</sub> (65 %; Sigma Aldrich, Steinheim, Germany), H<sub>2</sub>O<sub>2</sub> (30 %; Semikem, Sarajevo, Bosnia and Herzegovina), and HCl (37 %; Sigma Aldrich, Steinheim, Germany). Milli-Q water was used throughout the experimental work. Standard solutions of all analysed elements were provided by Merck (Darmstadt, Germany). Concentration of stock standard solution of all elements was 1000 mg l<sup>-1</sup> while calibration standard solutions of each element were obtained by appropriate dilution of the stock solutions.

All of the volumetric glassware was of A grade, and soaked in nitric acid ( $\varphi = 10\%$ ) for 12 h and rinsed with Milli-Q water before use. The sample and blank analyses were performed in triplicate, and the standard deviation was calculated. The value of the detection limit (LOD) for metals Na, K, Mg, Ca, Cu, Cr, Mn, Ni, Fe, Pb, Zn, and Cd were 0.25; 3.00; 0.20; 1.50; 0.25; 0.006; 0.20; 0.01; 6.00; 1.00; 0.50; and 0.002 mg l<sup>-1</sup>, respectively. The limits of detection were calculated from the values of the content of individual elements in the blank and the standard deviation of repeated measurements of the blank. Spiked samples were used to test the methods at varying concentrations of analyte, and the percent recovery was calculated. The acceptable recovery of known additions ranged between 89–104 %.

## 2.3 Sample preparation and elements analysis by FAAS

Elements in the plant samples were extracted following the acid wet digestion procedure: about 2 g ( $\pm 0.1$  mg) of leaves was weighed in the PTFE digestion vessels, 10 ml of the mixture containing 65 % HNO<sub>3</sub>, and 37 % HCl ( $\varphi = 2 : 1$ ) was added and heated on a hotplate at a moderate temperature (40–50 °C) until the brown gases had evaporated. After cooling at room temperature, 1 l of H<sub>2</sub>O<sub>2</sub> ( $\varphi = 30\%$ ) was added and heating continued at the same temperature range until the solution became clear. The cooled solutions were filtered through a quantitative filter paper (Whatman No. 42) into 50 ml calibrated flasks and diluted to full volume with Milli-Q water. Prepared solutions were stored at 4 °C until analysis.

Concentrations of essential metals (Na, K, Mg, Ca, Cu, Cr, Mn, Fe, and Zn) and heavy metals (Ni, Pb, and Cd) in samples of *Mentha* species (wild and cultivated) were determined by FAAS using the instrumental conditions set by the manufacturer (AA240FS, Varian, Australia).

## 3 Results and discussion

In this work, content of essential and heavy metals was determined in two *Mentha* species, *Mentha longifolia* L. and *Mentha × piperita* L. from B&H, collected at six different locations. Results of the analysis are presented in Table 1 (for wild herb species samples) and Table 2 (for cultivated herb species samples), as the mean of three parallel determinations with indicated standard deviation (SD).

Table 1 shows the elements content in *Mentha longifolia* L. (wild herb species). The content ranged from 0.10 mg g<sup>-1</sup> for Pb to 755.00 mg g<sup>-1</sup> for Fe, while in Table 2, metals content in *Mentha × piperita* L. (cultivated herb species) ranged from 0.40 mg g<sup>-1</sup> for Pb to 1108.40 mg g<sup>-1</sup> for Fe. The concentrations of Cr and Cd were below WHO<sup>15,17</sup> permissible limits in wild herb samples. Also, in the *Mentha* herb, the highest concentration was detected for Fe and the lowest for Pb. Relatively low content of Cu in wild samples compared to the content of Zn is due to the fact that higher Cu concentrations mean lower Zn content, because higher concentrations of Cu in the soil relative to Zn can reduce the availability of Zn to a plant, due to competition for the same sites for absorption into the plant root.<sup>23–25</sup>

In cultivated herb samples (Table 2), no Cd was detected in all three samples, while the highest concentration was detected for Fe and the lowest concentrations for Pb.<sup>24</sup> The detected high concentrations of Fe and Zn in the samples of cultivated species of *Mentha* confirmed the results of previous published papers that the deficiency of Zn leads to a deficiency of Fe in plants.<sup>24,25</sup>

Twelve elements (Na, K, Ca, Mg, Cr, Cu, Mn, Fe, Ni, Cd, Pb, and Zn) were compared in all *Mentha* samples by correlation analysis using Microsoft Excel. The element correlations (Pearson,  $r$ ) in the studied wild and cultivated *Mentha* samples from various sampling sites are reported in Tables 3 and 4. Pearson correlation coefficient,  $r$ , has a value between 0 and 1, and full correlation is represented as 1, while the absence of correlation is represented as  $r < 0$ .

Due to the fact that the content for Cr and Cd was not analysed in the test species *Mentha longifolia* L., because the values were below the limit of detection with FAAS, no Pearson's correlation was performed. Similarly, in *Mentha piperita* L. samples, no correlation was performed for Cd, because the concentration for this heavy metal was below the detection limit of the used method for analysis.<sup>8</sup> Full, strong, and moderate or weak correlations, and absence of correlation with  $r$  values of  $0.9 \leq r < 1$ ,  $0.5 \leq r < 0.8$ ,  $0.2 \leq r < 0.5$ , and  $r \leq 0$ , respectively, were found between major macro-elements and trace micro-elements in both *Mentha* species. These correlations are of the result of the relationship that macro- and micro-elements have in living systems, both in humans and plants, and they are the result of biological, chemical, and metabolic reactions and various signalling pathways. Also, a good correlation between two elements points to the same source of these elements in plant as well in soil (e.g., for Cu and Fe, Cu, and Zn, as well as Cu and Ni).

Table 1 – Content of essential and heavy metals (mean ± SD) mg g<sup>-1</sup> in wild Mentha species (*Mentha longifolia* L.) (n = 3)  
 Tablica 1 – Esencijalni i teški metali (srednja vrijednost ± SD) mg g<sup>-1</sup> u samonikloj vrsti metvice (*Mentha longifolia* L.) (n = 3)

Elements Elementi	Sample I Uzorak I	Sample II Uzorak II	Sample III Uzorak III	Literature values/ mg g <sup>-1</sup> Vrijednosti u literaturi/ mg g <sup>-1</sup>
Na/mgg <sup>-1</sup>	2.08 ± 0.36	2.08 ± 0.03	2.20 ± 0.09	4.90 <sup>12</sup> 1.17 <sup>14</sup> 0.48 <sup>5</sup>
K/mgg <sup>-1</sup>	15.00 ± 0.21	14.85 ± 0.40	15.08 ± 0.80	23.40 <sup>5</sup> 7.23 <sup>14</sup> 0.60 <sup>12</sup>
Mg/mgg <sup>-1</sup>	2.07 ± 0.02	1.93 ± 0.03	2.07 ± 0.06	7.80 <sup>12</sup> 4.83 <sup>5</sup> 3.83 <sup>14</sup>
Ca/mgg <sup>-1</sup>	15.32 ± 0.24	9.57 ± 0.94	10.03 ± 0.10	12.40 <sup>5</sup> 10.32 <sup>14</sup> 3.80 <sup>12</sup>
Cu/mgg <sup>-1</sup>	7.00 ± 0.01	7.30 ± 0.01	10.00 ± 0.01	10–32 <sup>23</sup> 3.82–12.32 <sup>7</sup> 10.60 <sup>24</sup> 1.68 <sup>18</sup>
Cr/mgg <sup>-1</sup>	≤LOD*	≤LOD*	≤LOD*	28–43 <sup>6</sup> 2.40 <sup>23</sup> 1.34 <sup>5</sup> 0.005 <sup>18</sup>
Mn/mgg <sup>-1</sup>	40.30 ± 0.01	21.30 ± 0.01	37.80 ± 0.01	11–276 <sup>6</sup> 114 <sup>24</sup> 53.5 <sup>5</sup> 32.70 <sup>23</sup>
Ni/mgg <sup>-1</sup>	7.00 ± 0.01	3.70 ± 0.01	6.60 ± 0.01	7.20 <sup>12</sup> 3.20 <sup>2</sup> 2.38 <sup>17</sup> 1.02 <sup>24</sup>
Fe/mgg <sup>-1</sup>	645 ± 0.01	755 ± 0.01	659 ± 0.01	150.57–821.02 <sup>8</sup> 532, 281 <sup>11</sup> 275.6–354.6 <sup>10</sup> 293 <sup>20</sup> 263 <sup>24</sup> 108 <sup>5</sup>
Pb/mgg <sup>-1</sup>	0.10 ± 0.01	0.60 ± 0.01	0.90 ± 0.01	1.44–9.24 <sup>7</sup> 0.74 <sup>23</sup> 0.71 <sup>24</sup> 0.82 <sup>17</sup>
Zn/mgg <sup>-1</sup>	13.90 ± 0.01	14.50 ± 0.01	29.90 ± 0.01	32–126 <sup>6</sup> 12.65–52.97 <sup>7</sup> 34.00 <sup>24</sup> 21.00 <sup>5</sup>
Cd/mgg <sup>-1</sup>	≤LOD*	≤LOD*	≤LOD*	0.58 <sup>17</sup> 0.15 <sup>24</sup> 0.11 <sup>23</sup> 0.063 <sup>8</sup>

\*LOD – limit of detection

Table 2 – Content of essential and heavy metals ( $\text{mg g}^{-1} \pm \text{SD}$ ) in cultivated Mentha species (*Mentha × piperita* L.) ( $n = 3$ )  
 Tablica 2 – Esencijalni i teški metali (srednja vrijednost  $\pm$  SD)  $\text{mg g}^{-1}$  u kultiviranoj vrsti metvice (*Mentha × piperita* L.) ( $n = 3$ )

Elements Elementi	Sample I Uzorak I	Sample II Uzorak II	Sample III Uzorak III	Literature values/ $\text{mg g}^{-1}$ Vrijednosti u literaturi/ $\text{mg g}^{-1}$
Na/ $\text{mg g}^{-1}$	$4.11 \pm 2.01$	$3.82 \pm 0.03$	$3.70 \pm 0.25$	4.90 <sup>12</sup> 1.17 <sup>14</sup> 0.48 <sup>5</sup>
K/ $\text{mg g}^{-1}$	$16.99 \pm 0.68$	$22.54 \pm 0.02$	$20.97 \pm 2.12$	23.40 <sup>5</sup> 7.23 <sup>14</sup> 0.60 <sup>12</sup>
Mg/ $\text{mg g}^{-1}$	$3.12 \pm 0.27$	$2.96 \pm 0.01$	$2.17 \pm 0.08$	7.80 <sup>12</sup> 4.83 <sup>5</sup> 3.83 <sup>14</sup>
Ca/ $\text{mg g}^{-1}$	$15.53 \pm 0.35$	$15.33 \pm 0.34$	$9.08 \pm 0.27$	12.40 <sup>5</sup> 10.32 <sup>14</sup> 3.80 <sup>12</sup>
Cu/ $\text{mg g}^{-1}$	$4.46 \pm 0.06$	$12.00 \pm 0.01$	$12.50 \pm 0.01$	10–32 <sup>23</sup> 3.82–12.32 <sup>7</sup> 10.60 <sup>24</sup> 1.68 <sup>18</sup>
Cr/ $\text{mg g}^{-1}$	$0.70 \pm 0.01$	$0.90 \pm 0.01$	$0.80 \pm 0.01$	28–43 <sup>6</sup> 2.40 <sup>23</sup> 1.34 <sup>5</sup> 0.005 <sup>18</sup>
Mn/ $\text{mg g}^{-1}$	$94.00 \pm 0.01$	$85.20 \pm 0.01$	$69.20 \pm 0.01$	11–276 <sup>6</sup> 114 <sup>24</sup> 53.5 <sup>5</sup> 32.70 <sup>23</sup>
Ni/ $\text{mg g}^{-1}$	$4.60 \pm 0.01$	$1.10 \pm 0.01$	$3.70 \pm 0.01$	7.20 <sup>12</sup> 3.20 <sup>23</sup> 2.38 <sup>17</sup> 1.02 <sup>24</sup>
Fe/ $\text{mg g}^{-1}$	$1108 \pm 0.16$	$619 \pm 0.03$	$644 \pm 0.05$	150.57–821.02 <sup>8</sup> 532, 281 <sup>11</sup> 275.6–354.6 <sup>10</sup> 293 <sup>20</sup> 263 <sup>24</sup> 108 <sup>5</sup>
Pb/ $\text{mg g}^{-1}$	$0.60 \pm 0.01$	$0.40 \pm 0.01$	$0.90 \pm 0.01$	1.44–9.24 <sup>7</sup> 0.74 <sup>23</sup> 0.71 <sup>24</sup> 0.82 <sup>17</sup>
Zn/ $\text{mg g}^{-1}$	$31.70 \pm 0.01$	$38.60 \pm 0.02$	$39.30 \pm 0.01$	32–126 <sup>6</sup> 12.65–52.97 <sup>7</sup> 34.00 <sup>24</sup> 21.00 <sup>5</sup>
Cd/ $\text{mg g}^{-1}$	$\leq \text{LOD}^*$	$\leq \text{LOD}^*$	$\leq \text{LOD}^*$	0.58 <sup>17</sup> 0.15 <sup>24</sup> 0.11 <sup>23</sup> 0.063 <sup>8</sup>

\*LOD – limit of detection

Table 3 – Element correlations (Pearson, *r*) in wild species of *Mentha longifolia* L.Tablica 3 – Korelacija elemenata (Pearson, *r*) u divljim vrstama *Mentha longifolia* L.

Elements Elementi	Na	K	Ca	Mg	Cu	Mn	Ni	Fe	Pb	Zn
Na	1	0.75	-0.43	0.53	0.99	0.40	0.86	-0.40	0.78	0.99
K		1	0.27	0.96	0.68	0.90	0.31	-0.91	0.18	0.73
Ca			1	0.54	-0.52	0.66	-0.83	-0.65	-0.90	-0.47
Mg				1	0.44	0.99	0.02	-0.99	-0.12	0.50
Cu					1	0.31	0.90	-0.31	0.84	0.99
Mn						1	-0.13	-0.99	-0.26	0.36
Ni							1	0.13	0.99	0.88
Fe								1	0.26	-0.36
Pb									1	0.81
Zn										1

Table 4 – Element correlations (Pearson) in cultivated species of *Mentha piperita* L.Tablica 4 – Korelacija elemenata (Pearson) u kultiviranim vrstama *Mentha piperita* L.

Elements Elementi	Na	K	Ca	Mg	Cu	Cr	Mn	Ni	Fe	Pb	Zn
Na	1	-0.85	0.74	0.82	0.96	-0.69	0.92	0.47	0.95	-0.39	-0.98
K		1	-0.27	-0.39	-0.96	0.97	-0.57	-0.87	-0.97	-0.16	0.93
Ca			1	0.99	0.51	-0.03	0.95	-0.24	0.48	-0.91	-0.59
Mg				1	0.62	-0.16	0.98	-0.12	0.59	-0.84	-0.69
Cu					1	-0.87	0.76	0.71	0.99	-0.10	-0.99
Cr						1	-0.35	-0.96	-0.89	-0.40	0.82
Mn							1	0.08	0.74	-0.72	-0.82
Ni								1	0.73	0.63	-0.64
Fe									1	-0.07	-0.99
Pb										1	0.20
Zn											1

The strong correlation between Ni and Pb, as well as Ni and Fe, indicates primarily the influence of environmental factors in the case of *Mentha longifolia* L. and its cultivation (sources of heavy metal contamination in herb could be linked to irrigation water and polluted soil) and processing (due to harvesting and storage) in a sample of *Mentha piperita* L., since in this work, measured concentrations of Ni and Pb as toxic metals are lower than those obtained in other studies.<sup>7,12</sup> As presented in Tables 3 and 4, full, strong, and moderate correlations were found between the measured elements.<sup>6,7,8,24</sup> In general, full and moderate correlations were found between macro-elements and trace elements, which include alkaline earth cations as well as essential metals, *i.e.*, Cr, Cu, Zn, Fe, and Mn.

### 3.1 Main essential elements (macro-elements)

The metals Ca, Mg, K, and Na represent the main essential macro-elements, available in high concentrations in almost all plant materials. In both species of *Mentha*, the highest concentrations were found for K (14.65–22.54 mg g<sup>-1</sup>) and Ca (9.08–15.53 mg g<sup>-1</sup>), followed by Na and Mg (2.08–4.12 and 1.93–3.12 mg g<sup>-1</sup>, respectively). These elements have important functions in plants as well as the human body. K maintains the fluid and electrolyte balance in the human body, and is responsible for transduction of nerve impulses, while Ca is the most abundant element in our body that helps form and maintain healthy bones. Mg has a key role in many enzymes as their central component; it

plays a major role in overall cell functions including proteins, lipids, and carbohydrate metabolism. On the other hand, Na is responsible for depolarisation of cellular membrane, and for the water equilibrium in both, intra- and inter-cellular medium. Comparing the obtained results for macro-elements with the results of other authors, it was found that the concentrations of these elements were similar for samples of *Mentha longifolia* L. sample, while their concentrations varied greatly for samples of *Mentha × piperita* L.<sup>5,12,14</sup>

### 3.2 Essential trace elements (micro-elements)

In the analysed species of *Mentha*, the highest concentrations of trace essential elements were found for Fe (619.30–1108.40 mg g<sup>-1</sup>) and Cu (4.46–12.50 mg g<sup>-1</sup>), followed by Cr, Zn, and Mn (0.70–0.90 mg g<sup>-1</sup>, 13.90–39.30 mg g<sup>-1</sup>, and 21.30–94.00 mg g<sup>-1</sup>, respectively). The high concentration of Fe in herbs is due to fact that Fe originates mainly from soil and rock materials. The concentration of Cr was below detection limits in samples of wild *Mentha* herb. Essential micro-elements play an important role in the growth and development of plants and they also have many key biological and chemical functions in the human organism. Additionally, trace elements are a component of enzymes and hormones as a structural part of proteins and carbohydrate complexes involved in biochemical reactions in the human body. Zn and Fe together with enzymes are necessary for the proper functioning and maintenance of the immune system and a deficiency of one of them means a deficiency of the other metals. In addition, Zn is essential for the activity of numerous enzymes, while Fe is an essential element for living cells, and its deficiency is associated with anaemia. Mn is a micronutrient in plants as well as humans. It is a major contributor to various processes in plants including photosynthesis, respiration, and nitrogen assimilation. Deficiency of Mn in plants due to higher soil pH values and less use of fertilizers is similar to Fe deficiency, and leads to interveinal chlorosis of young leaves. Mn is a trace element and vital for human bodily functions because it contributes to the metabolism of amino acids, cholesterol, glucose, and carbohydrates. It also plays a role in bone formation, blood clotting, and reducing inflammation. Contents of Zn and Fe that were found in both *Mentha* species are a consequence of their bioavailability in plants, which were very similar, taking into account which forms were present from inorganic salts and organic matter contents of these two elements in the plant. Therefore, excess of Zn increased the level of Fe, and conversely, lower Fe concentrations correlate with lower Zn content. This was confirmed in this work, because higher concentrations of Fe and Zn were found in samples of both *Mentha* species, which were higher compared to the concentrations of these two elements measured in other studies. All of the above elements were present in values determined and confirmed by other authors.<sup>5,6,7,8,10,11,23,24</sup>

### 3.3 Non-essential elements (heavy metals)

*Mentha* herb, as a medicinal plant, may contain toxic elements, *i.e.*, heavy metals originating from the environment,

during processing, harvesting, or storage. Also, contamination of the herb with various heavy metals may occur during cultivation of the plant, as an impact of soil content, present nutrients, fertilizers, *etc.*, as well as through processing and packaging of herb materials. Non-essential and toxic elements Pb and Ni were present almost in the same levels in both tested samples of *Mentha* species.<sup>7,12,17,23,24</sup> In addition, in all samples, the measured content of Pb was significantly below recommended value of 10 mg kg<sup>-1</sup> (WHO).<sup>19,21</sup>

## 4 Conclusion

The order of concentrations of essential and heavy metals in two *Mentha* species, wild and cultivated, determined by FAAS, was as follows: K > Ca > Na > Mg > Fe > Mn > Cu > Zn > Cr > Ni > Pb. Cadmium concentration was below the limit of detection by FAAS in all tested *Mentha* samples. The content of all metals were found to be in good agreement with those found in reported data of other authors/studies. These results show that both *Mentha* species are a good source of essential metals with low concentrations of heavy metals, and are safe for use both as a beverage and in different herbal formulations.

### DECLARATION OF CONFLICTING INTERESTS

The author declares no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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### List of abbreviations

#### Popis kratica

- AAS – atomic absorption spectrometry  
– atomska apsorpcijska spektrometrija
- FAAS – flame atomic absorption spectrometry  
– plamena atomska apsorpcijska spektrometrija
- LOD – limit of detection  
– granica detekcije
- PTFE – polytetrafluoroethylene  
– politetrafluoroetilen
- SD – standard deviation  
– standardna devijacija

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## SAŽETAK

### Sadržaj esencijalnih i teških metala u divljim i kultiviranim vrstama metvice iz Bosne i Hercegovine

Šaćira Mandal

Esencijalni i teški metali imaju ključnu ulogu na ljudsko zdravlje i bolesti. Cilj ove studije bio je odrediti koncentracije esencijalnih i teških metala kao što su Na, K, Ca, Mg, Cu, Cr, Mn, Ni, Fe, Pb, Zn i Cd u lišću *Mentha longifolia* L. i *Mentha × piperita* L. Uzorci biljnog materijala prikupljeni su sa šest različitih lokacija Bosne i Hercegovine (BiH), na odabranim udaljenostima od izvora onečišćenja teškim metalima. Za otapanje uzoraka primijenjena je mokra digestija, a koncentracije esencijalnih i teških metala analizirane su plamenom atomskom apsorpcijskom spektrometrijom (PAAS). Rezultati analize (izraženi u  $\text{mg g}^{-1}$ ) dobiveni su kako slijedi: Na 2,08 – 4,12; K 14,85 – 22,54; Ca 9,06 – 15,53; Mg 1,93 – 3,12; Cu 0,01 – 0,05; Cr 0,70 – 0,90; Mn 0,02 – 0,09; Ni 1,10 – 7,00; Fe 0,06 – 1,11; Pb 0,10 – 0,90; Zn 0,01 – 0,04. Koncentracija kadmija od  $0,002 \text{ mg l}^{-1}$  bila je ispod granice detekcije PAAS-a. Snažna povezanost između Ni i Pb, kao i Ni i Fe, uglavnom je potvrdila utjecaj okoline i procesa prerade. Zaključno, *Mentha longifolia* L. i *Mentha × piperita* L. mogu se svakodnevno konzumirati s obzirom na visok sadržaj Fe, Cu, Mg i Zn i njihove blagotvorne učinke na normalno funkcioniranje organizma. Dodatno, nakon konzumiranja tih uzoraka ne postoji rizik od teških metala za ljudsko zdravlje zbog niskih koncentracija.

#### Ključne riječi

Esencijalni metali, teški metali, vrste metvice, AAS

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