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HEAVY METALS DETERMINATION IN SELECTED MEDICINAL PLANTS

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ABSTRACT
It were analysed the heavy metals content for some medicinal plants. The analysed heavy metals were: Fe, Mn, Zn, Cu, Cd, Ni, Pb and Cr. Heavy metals content were determinate by flame atomic absorption spectrometry (F-AAS) with high-resolution continuum source ContrAA 300 spectrometer.
Key words:
heavy metals, medicinal plants, flame atomic absorption spectrometry

1. INTRODUCTION

Medicinal plants or parts of them are used successfully in treatment of different kind of diseases for those therapeutically properties. Together with essential nutrients, medicinal plants can also take up small amounts of contaminant heavy metal compounds and can concentrate them. The content in heavy metals of plants is variable, due to the factors like differences between the plants species, geographical area and condition of drying process. When the plants grow on soil witch contain naturally high concentration in heavy metals accumulate them in their tissue [Boyd&Martens, 1998].

For some heavy metals, toxic levels can be just above the background concentrations naturally found in nature. Therefore, it is important for us to inform ourselves about the heavy metals and to take protective measures against excessive exposure. The aim of this study was to determine the concentrations in Fe, Mn, Zn, Cu, Cd, Ni, Pb and Cr for selected medicinal plants: *Epilobium hirsutum* (*Onagraceae* family), *Taraxacum officinale* (*Asteraceae* family), *Rosmarinus officinalis, Salvia officinalis, Satureja hortensis, Majorana hortensis* and *Ocimum basilicum* (*Lamiaceae* family).

2. MATERIALS AND METHODS

MEDICINAL PLANTS SAMPLES PREPARATION

Seven medicinal plants samples were collected of Romanian markets:

S1 - Willowherb (*Epilobium hirsutum,* Pufulita) – *Onagraceae* family
S2 - Rosemary Herb (*Rosmarinus officinalis,* Rozmarin) – *Lamiaceae* family
S3 - Dandelion Leafy (*Taraxacum officinale,* Papadie*)* - *Asteraceae* family

S4 - Sage Herb (*Salvia officinalis,* Salvie) - *Lamiaceae* family
S5 – Savory Herb (*Satureja hortensis,* Cimbru) - *Lamiaceae* family
S6 – Marjoram (*Majorana hortensis,* Maghiran) - *Lamiaceae* family
S7 - Basil Herb *(Ocimum basilicum,* Busuioc) - *Lamiaceae* family

The heavy metals content from medicinal plants samples were analyzed after dry burning of 10 g in the quartz capsules at 650°C for 4 hours. After complete burning a nitric acid 0.5 N solution was added up to 50 mL. The obtained solutions were used for total metals contents determination by flame atomic absorption spectrometry (F-AAS) with high-resolution continuum source.

REAGENTS

The standard solutions (1000 mg/L) were analytical grade from Riedel de Haen (Germany). The nitric acid 65% solution used was of ultra pure grade (Merck, Germany). All solutions were prepared using deionized water.

HEAVY METALS DETERMINATION

Analyses of heavy content were made with ContrAA-300, Analytik-Jena device, by flame atomic absorption spectrometry (FASS) in air/acetylene flame. The device working parameters (air, acetylene, optics and electronics) were adjusted for maximum absorption for each element. Acetylene was of 99.99 % purity. Under the optimum established parameters, standard calibration curves for metals were constructed by plotting absorbency against concentration [Gergen et all, 2006]. In a definite range for each metal a good linearity was observed. The correlation coefficient for the calibration curves (r^2) ranged between 0.9745 - 0.9891. All analyses were made in triplicate and the mean values were reported. All the values obtained for heavy metals contents in medicinal plants were calculated in mg/kg dry matter (ppm).

3. ANALYSES, DISCUSSIONS AND INTERPRETATION

The results obtained for Fe, Mn, Cu, Zn, Cd, Ni, Pb and Cr in analyzed medicinal plants are presented in Table 1:

Table 1. The Fe, Mn, Cu, Zn, Cd, Ni, Pb and Cr contents for analyzed medicinal plants

Medicinal plants	Cu ppm	Zn ppm	Cd ppm	Ni ppm	Mn ppm	Fe ppm	Pb ppm	Cr ppm
1. Willowherb (*Epilobium Hirsutum*)	5.8	27.3	0.007	0.72	83.6	69.7	1.65	0.36
2. Rosemary Herb (*Rosmarinus officinalis*)	4.3	21.2	0.0	0.0	8.3	68.6	0.25	0.0
3. Dandelion Leafy (*Taraxacum officinale*)	12.7	31.2	0.622	2.88	59.4	272.0	8.45	0.0
4. Sage Herb (*Salvia officinalis*)	9.8	35.0	0.0	0.57	24.3	140.8	0.35	3.15
5. Savory Herb (*Satureja hortensis*)	9.6	66.4	0.0	4.07	83.7	245.0	0.95	0.19
6. Marjoram (*Origanum majorana*)	8.2	20.0	0.0	0.99	28.2	480.0	0.94	1.22
7. Basil Herb *(Ocimum basilicum)*	14.0	28.0	0.0	0.73	55.9	224.0	0.38	0.0
National limit, ppm	**50**	**50**	**0.5**	**-**	**-**	**-**	**5.0**	**-**

Fe (Iron) is an essential element for humans. Approximately 60% of it is bound in hemoglobin and 10% in Fe-dependent tissue enzymes. The remaining 20% and 10% are stored as ferritin and respectively hemosiderin. Fe can not produce toxic effects in usual amounts. Nevertheless, the sum of published data suggests that Fe repletion beyond requirement may be hazardous [Schümann, 2001]. Marjoram has the greatest content in Fe (480.0 ppm), followed by Dandelion Leafy (272.0 ppm), Savory (245.0 ppm) and Basil herb (224.0 ppm). Rosemary has the smallest content in Fe (68.6 ppm) (Figure 1).

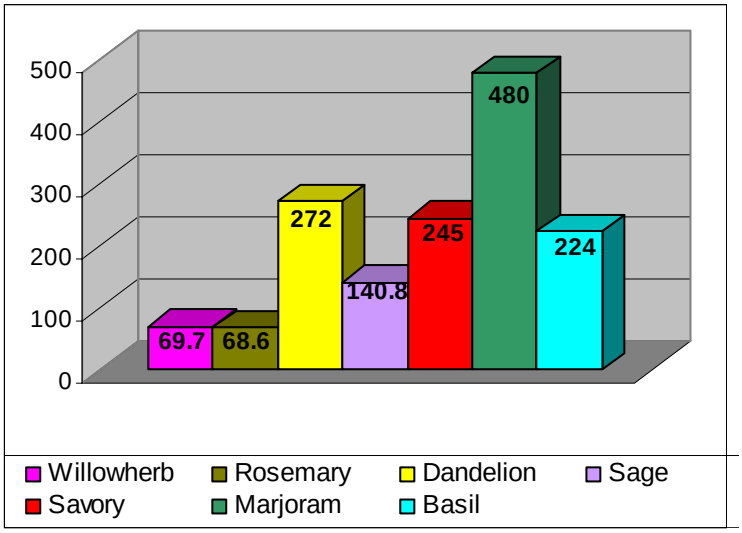

Figure 1. The Fe content (ppm) for analyzed medicinal plants

Mn (Manganese) is both a constituent and an activator of several enzymes and proteins in plant, animal and humans, and has around 20 identified functions. Crowley et al. (2000) reviewed Mn-containing and Mn-dependent enzymes and proteins, including their structures, functions and distributions. The recommended ESADDI values for adults range from 2 to 5 mg Mn/day [Schäfer, 2004]. The smallest content in Mn was determinated for Rosemary (8.3 ppm) and the highest for Willowherb (83.6 ppm) and Savory (83.7 ppm) (Figure 2).

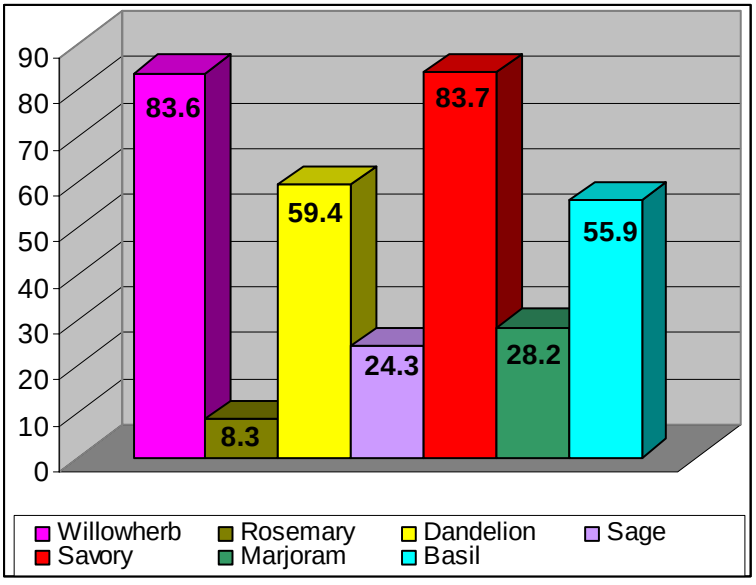

Figure 2. The Mn content (ppm) for analyzed medicinal plants

Zn (Zinc) is a constituent of about 300 enzymes and proteins that participate in all major metabolic processes. The national accepted limit for Zn in tea is 50.0 mg/Kg [Ordinance 975/1998]. The smallest quantity in Zn was determinated for Marjoram (20.0 ppm) and the highest for Savory (66.4 ppm). The value of Zn obtained for Savory is closely higher than national accepted limit for this heavy metal in tea (Figure 3).

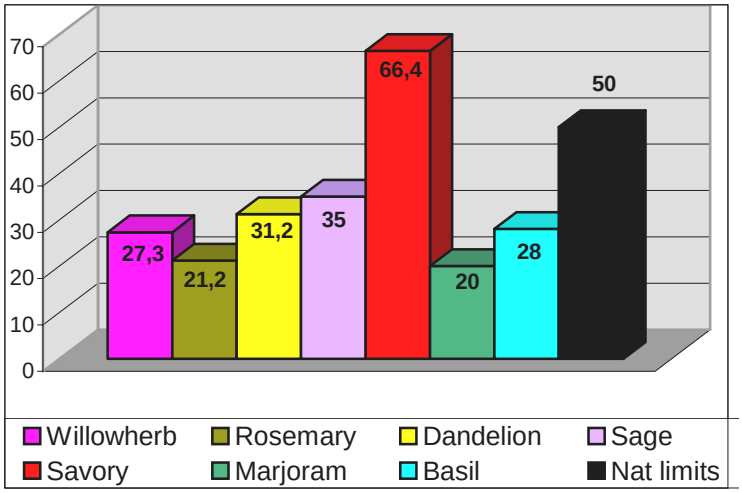

Figure 3. The Zn content (ppm) for analyzed medicinal plants

Cu (Cooper) deficiency in humans is a rare exception, and would not occur if Cu content were more than 2 mg in the daily diet. The national accepted limit for Cu in tea is 50.0 mg/Kg [Ordinance 975/1998]. Basil and Dandelion have the highest contents in Cu (14.0 ppm, respectively 12.7 ppm). Rosemary has the smallest Cu content (4.3 ppm) (Figure 4).

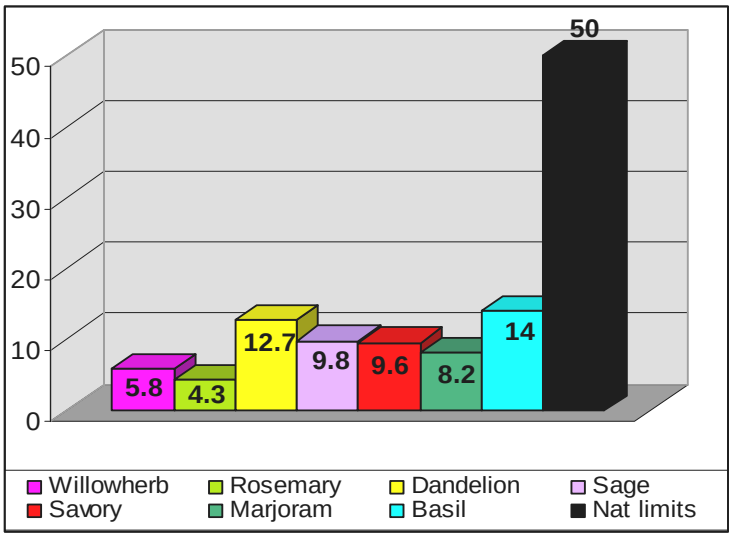

Figure 4. The Cu content (ppm) for analyzed medicinal plants

Cd (Cadmium) inhibit or activate a great number of enzymes, like those rich in accessible sulfhydryl groups [Vollenweider et all, 2006]. The toxic effect of Cd in humans manifests mainly in the kidney and liver. The national legal limit for Cd in tea is 0.5 mg/Kg. In analyzed samples the Cd contents were detected only for Dandelion (0.622 ppm) and Willowherb (0.007 ppm). The Cd content in Dandelion is closely higher than national legal limit for this metal in tea (Figure 5).

Pb (Lead) is not an essential element for life and it is very toxic for the nervous system and the kidneys. The national accepted limit for Pb in tea is 5.0 mg/Kg [Ordinance 975/1998]. The content in Pb for Dandelion (8.45 ppm) is higher than the national limit (5.0 ppm). All the others values obtained for analyzed samples have the Pb contents in range 0.25 – 1.65 ppm (Figure 5).

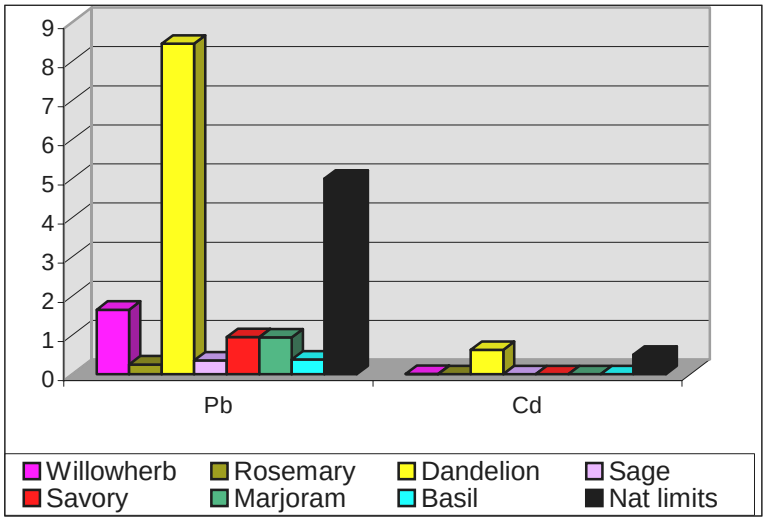

Figure 5. The Cd and Pb contents (ppm) for analyzed medicinal plants

Ni (Nickel) is an essential element for animal nutrition. Excessive soluble Ni compounds are hepatotoxic and nephrotoxic but as aerosols or dusts, insoluble Ni compounds or elemental Ni are very toxic (carcinogenic), justifying a lot of country imposed restricted limits, 0.05-1 mg/m^3 [Sunderman, 2004]. Savory has the greatest content in Ni (4.07 ppm) (Figure 6).

Cr (Chromium) is involved in insulin function. The actual TWA (Time Weighted Average) values for Cr and chromium compounds are: for metal or Cr(III) compounds 0.5 mg/m^3 (irritation, dermatitis), for water soluble Cr(VI) compounds 0.05 mg/m^3 (liver, kidney, respiratory) and for insoluble Cr(VI) compounds 0.01 mg/m^3 (cancer, irritation), [Stoecker, 2004]. In analyzed medicinal plants Cr contents were detected for Sage (3.15ppm), Marjoram (1.22 ppm), Willowherb (0.36 ppm) and Savory (0.19 ppm) (Figure 6).

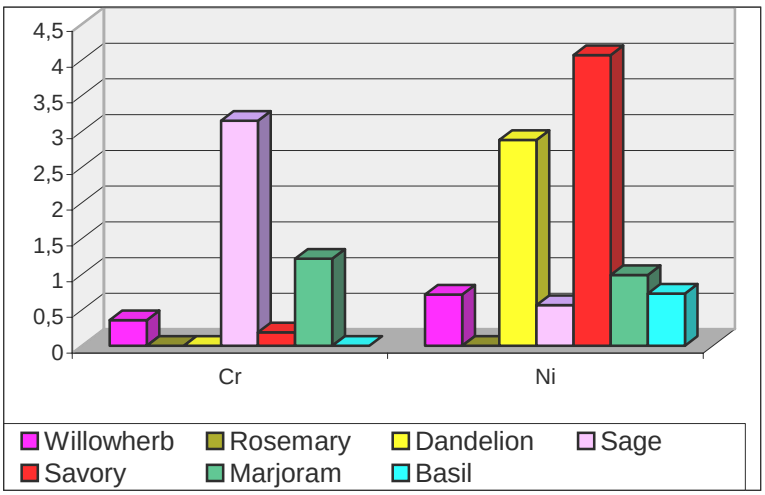

Figure 6. The Cr and Ni contents (ppm) for analyzed medicinal plants

4. CONCLUSIONS

The identified values for Cu in all medicinal plants samples are under national legal limits. Zn content in Savory and Cd and Pb content in Dandelion is up to the national admissible limit. For all the others analyzed medicinal plants heavy metals concentrations are under legal national limits.

REFERENCES

[1.] BOYD ROBERT S., MARTENS SCOTT N., The significance of metal hyperaccumulation for biotic interactions, *Chemoecology*, 8, 1998, p. 1-7.

[2.] CROWLEY J.D., TRAYNOR D.A. and WEATHERBURN D.C., Enzymes and proteins containing manganese: an overview, In: Sigel A., Sigel H., eds. *Metal Ions in Biological Systems*, Vol. 37, Manganese and Its Role in Biological Processes, Marcel Dekker Inc, New York-Basel, 2000, p. 209-278.

[3.] GERGEN I., GOGOAŞĂ I., DRĂGAN S., MOIGRĂDEAN D., HĂRMĂNESCU M., Heavy metal status in fruits and vegetables from a non-poluted area of Romania (Banat County), *Metal Elements in Environment, Medicine and Biology,* Gârban Z., Drăgan P. (Eds. Symp. Series), Tome VII, Publishing House Eurobit, Timişoara, 2006, p. 149-165.

[4.] SCHÄFER U., Manganese*, In: Elements and their Compounds in the Environment*, 2nd Ed., Edited by Merian E., Anke M., Ihnat M., Stoepler M., Wiley-VCH, Weinheim, 2004, p. 901-930.

[5.] SCHÜMANN K., Safety aspects of iron in food, *Ann Nutr. Metab.,* 2001, 45, p. 91-101.

[6.] STOECKER B., Chromium. *In: Elements and their Compounds in the Environment,* 2nd Ed., Edited by Merian E., Anke M., Ihnat M., Stoepler M., Wiley-VCH, Weinheim, 2004, p. 709-729.

[7.] SUNDERMAN F.W.Jr., Nickel, *In: Elements and their Compounds in the Environment*, 2nd Ed., Edited by Merian E., Anke M., Ihnat M., Stoepler M., Wiley-VCH, Weinheim, 2004, p. 841-865.

[8.] VOLLENWEIDER Pierre, Claudia CASIO, Madeleine S. GUNTHARDT-GOERG, Catherine KELLER, Localization and effects of cadmium in leaves of a cadmium-tolerant willow (Salix viminalis L.). Part II Microlocalization and cellular effects of cadmium*, Environmental and Experimental Botany*, 2006, 58, p. 25-40.

[9.] *** Expert from Romanian Ministry of Public Health *Ordinance no 975/1998*. Maximum limits accepted for heavy metal in foods.