Available on-line at www.japt.tpa.usab-tm.ro

Journal of Agroalimentary Processes and Technologies 2009, *15*(1), 163-167

Journal of Agroalimentary Processes and Technologies

Determination of the microelements content of some medicinal herbs

D. S. Ştef*, I. Gergen, Monica Hărmănescu, Lavinia Ştef, Mărioara Drugă, Ramona Biron, M. G. Hegheduş

Banat's University of Agricultural Sciences and Veterinary Medicine, Faculty of Food Processing Technology, Timişoara, C. Aradului 119, Romania

Abstract

Microelements , in inorganic form or bind in different combinations (Sel Plex and Fritta), action on humans and animals health, bioproductive performances and meat quality. It were analysed the microelements content for eleven medicinal plants (herbs). The analysed microelements were: Zinc, Manganese, Iron, Copper, Lead and Nickel. Mineral contents were determinate by flame atomic absorption spectrometry (F-AAS) with high resolution continuum source ContrAA 300 spectrometer. The contents in microelements for analysed samples were in range: 15.55 ppm (Phoeniculus) - 1.75 ppm (*Rhamnus frangula*), for Cooper; 41.30 ppm (*Artemisia absinthium*) - 6.44 ppm (*Rhamnus frangula*), for Zinc; 83.44 ppm. (*Rhamnus frangula*) - 25.32 ppm (*Chelidonium majus*), for Manganese; 175.92 ppm (*Taraxacum officinale*) - 21.43 ppm (*Rhamnus frangula*), for Iron; 1.479 ppm (*Epilobium montanum*) - 0.033 ppm (*Plantago major*), for Nickel. For *Echinaceae* herba was not detected Nickel content. The analyzed medicinal plants can be differentiating in three main groups, each of them characterised by appropriate metal composition.

Keywords: microelements, medicinal plants, Zinc, Manganese, Iron, Cooper

1. Introduction

Zinc is a constituent of about 300 enzymes and proteins that participate in all major metabolic processes. As an essential trace element Zinc can impair vital function either by deficiency or excess. Over exposure to Zinc by food, water and air commonly poses no risk to the general population. Dietary reference values for Zinc suggested by various sources (WHO-1996) range from 9.4 to 11.0 mg/day for male adults and from 6.5 to 8.0 mg/day for female adults.

Manganese is one of the essential microelements for plants, animals and humans. It is both a constituent and an activator of several enzymes and proteins in plant, animal and humans, and has around 20 identified functions.

Iron deficiency anemia is a global nutritional problem, affecting nearly 1.78 billion people of which 358 million are from the developing world (WHO, 1998). Iron deficiency has a massive economic cost, adding to the burden on the health system, affecting cognitive performance of children and reducing adult productivity. Inadequate dietary intake and poor bioavailability of iron from food are considered as prime etiological factors of anemia. Despite implementation of large-scale nutritional intervention/prophylaxis programmes, iron deficiency anemia still continues to be a public health problem in most developing countries (Allen and Sabel, 2001).

Iron (Fe) is recognized as one of the most important trace elements for animal growth (Brock, 1994). To prevent and treat iron deficiency, exogenous inorganic iron supplementation was popular in the feed

* Corresponding author: *e-mail address*: ducu_stef@yahoo.com

industry. Iron sources from feed ingredients and supplements vary widely in their bioavailability to the animal. (Rincker et al., 2005a). In recent decades, it was reported that metal chelated with amino acid or protein has good bioavailability in animal (Kegley et al., 2002; Creech et al., 2004). Studies showed chelated or proteinated sources of Fe has 125-185% relative availability compared with ferrous sulphate (Henry and Miller, 1995).

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 Cooper in tea is 50.0 mg/Kg (Ordinance 975/1998).

The goal of this paper was to analyse the microelements content for eleven medicinal plants (herbs). The analysed microelements were: zinc, manganese, iron, copper, lead and nickel

2. Materials and Method

Medicinal plants or parts of them are used successfully in treatment of different kind of diseases for those therapeutically properties. Rhamnus frangula, Echinaceae herba, Phoeniculus, Malva silvestris, Crataegus monogyna, Taraxacum officinale, Plantago major, Artemisia absinthium, Epilobium montanum, Chelidonium majus, Melissae Folium are some of the native medicinal plants witch can be found commonly in Romania.

Medicinal plants samples preparation

Eleven medicinal plants samples were collected of Romanian markets. The eleven analysed plants are: Sample 1 - Crusin, Rhamnus frangula; Sample 2 - Echinacee, Echinaceae herba; Sample 3 - Fenicul, Phoeniculus; Sample 4 - Nalba, Malva silvestris; Sample 5 - Paducel, Crataegus monogyna; Sample 6 - Papadia, Taraxacum officinale; Sample 7 - Patlagină, Plantago major; Sample 8 - Pelin, Artemisia absinthium; Sample 9 - Pufulita, Epilobium montanum; Sample 10 - Rostopasca, Chelidonium majus; Sample 11 - Roinita, Melissae Folium. The metals content from medicinal plants samples were analysed after dry burning of 10g in the quartz capsules at 6500C for 4 hours. After complete burning a nitric acid 0,5 N solution was added up to 50 ml. The solution obtained 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 deionised water.

Metals content determination

Analysis of metals content was 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, 1996). In a definite range for each metal a good linearity was observed. The correlation coefficient for the calibration curves (r2) ranged between 0.9745-0.9891. All analyses were made in triplicate and mean values were reported. All the values obtained for metals contents in analysed samples were calculated in mg/kg dry matter (ppm).

Results and discussions

The metals contents of plants are variable, due to the factors like differences between the plants species, geographical area, conditions of drying process. Metals contents in soil are a great importance for their effect of animals and humans, through the biologic chain: soil – plant – feed and food. The accessibility of metals for plants depends on soil reaction, mineral colloids, soil humidity, microbiological activity and organic matter content. Organic matter, especially humus compounds, can form organic-metallic compounds with high mobility in soil solutions and with high availability for plants (Kabata and Pendias, 2001).

The Cooper, Zinc, Manganese, Iron, Lead and Nickel concentrations in analyzed samples are presented in table 1.

Table 1: The concentrations in Cooper, Zinc, Manganese, Iron, Lead and Nickel in analyzed samples

Specification	**Cooper**	**Zinc**	**Manganese**	**Iron**	**Lead**	**Nickel**
0	1	2	3	4	5	6
Rhamnus frangula	1.75	5.44	83.44	21.43	0.0	0.519
Echinaceae herba	5.67	12.31	35.75	68.41	0.0	0.00
Phoeniculus	15.55	23.98	26.31	63.66	0.0	0.140
Malva silvestris	5.44	28.19	39.18	66.03	0.0	0.781
Crataegus monogyna	10.09	25.97	24.44	97.89	0.154	0.942
Taraxacum officinale	7.32	22.05	44.25	175.92	0.0	0.472
Plantago major	7.19	27.37	31.09	100.72	0.0	0.033
Artemisia absinthium	11.14	41.30	53.85	171.52	0.0	0.312
Epilobium montanum	9.44	26.96	25.95	50.34	3.457	1.479
Chelidonium majus	8.72	32.64	25.32	109.12	0.0	0.755
Melissae Folium	10.95	26.73	40.96	108.22	0.0	0.693

Cooper is one of several trace heavy metals that are essential to life, despite being as inherently toxic as nonessential trace heavy metals (Cadmium, Lead). 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 Cooper in tea is 50.0 mg/Kg (Ordinance 975/1998). For analysed samples Phoeniculus has the highest content in Cooper (15.55 ppm), followed by Artemisia absinthium (11.14 ppm). Rhamnus frangula has the smallest Cooper concentration (1.75 ppm).

The national accepted limit for **Zinc** in tea is 50.0 mg/kg (Ordinance 975/1998). The analysed samples contend Zinc in range 41.30-5.44 ppm. The smaller quantity was determinate for Rhamnus frangula (6.44 ppm) and the higher for Artemisia absinthium (41.30 ppm).

Manganese is one essential microelements for plants, animals and humans. It is both a constituent and an activator of several enzymes and protein 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. In humans, the range between deficiency and toxicity of Mn is narrow. The recommended ESADDI values for adults range from 2 to 5 mg Mn/day (Schafer, 2004). The contents in Mn for analysed samples were in range 25.32 – 83.44 ppm. The low content was determinated for Chelidonium majus (25.32 ppm) and the highest for Rhamnus frangula (83.44 ppm).

Iron is an essential element for humans, ranging to approx. 4200 mg/body. Approximately 60% of it is bound in haemoglobin and 10% in Fe-dependent tissue enzymes. The remaining 20% and 10% are stored as ferritin and respectively hemosiderin. The Fe turnover is approximately 30 mg/day (Schumann and Elsenhaus, 2004). Iron can not produce toxic effects in usual amounts. Nevertheless, the sum of published data suggests that Fe repletion beyond requirement may be hazardous (Schumann, 2001). Taraxacum officinale has the greatest content in Iron (175.92 ppm), followed by *Artemisia absinthium* (171.25 ppm). *Rhamnus frangula* has the smallest content in Fe (21.43 ppm).

Nickel is an essential element for animal nutrition. The Nickel requirement of humans has been estimated to be 25-35 µg/day (Anke et. al., 1995). *Epilobium montanum* has the great content in Nickel (1.479 ppm), followed by *Crataegus monogyna* (0.942 ppm). For *Echinaceae* herba was not detected Nickel content.

Lead is not an essential element for life and it is very toxic for the nervous system and for the kidneys. The national accepted limit for Lead in tea is 5.0 mg/Kg (Ordinance 975/1998).

The cases - dendrogram obtained using Cu, Zn, Mn, Fe, Pb and Ni like variables is presented in Figure 1:

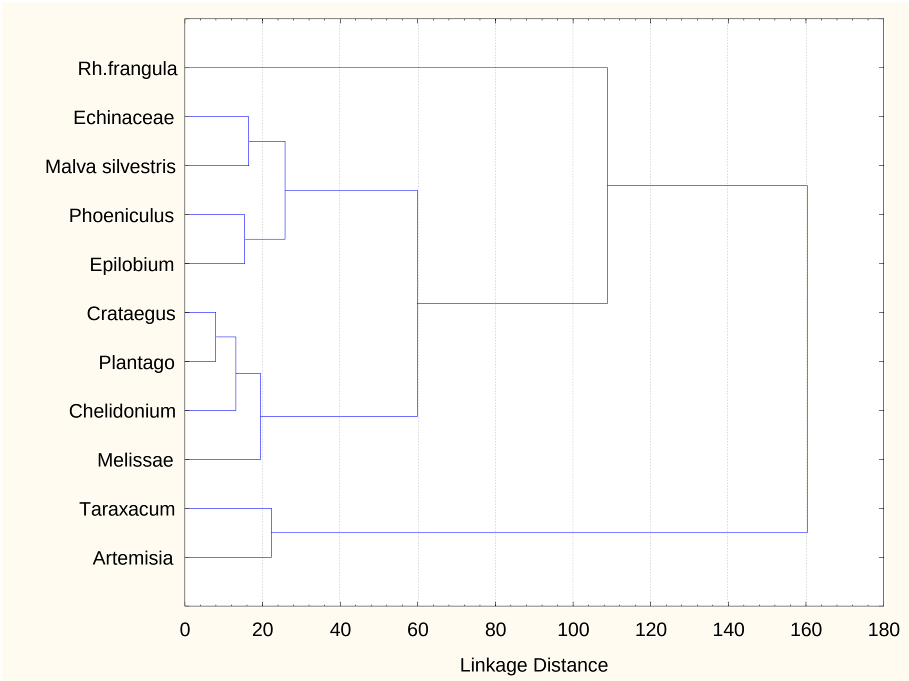

Figure 1. The cases – dendrogram

This dendrogram shows that analyzed medical plants can be differentiate in three main groups, each of them characterised by appropriate metal composition.

First group contains only R*hamnus frangula,* which has the highest content in Mn (83.44 ppm).

The second group is formed by two subgroups. First subgroup contains *Echinaceae* herba, *Malva silvestris*, Phoeniculus and Epilobium montanum, plants characterized by a medium Zn, Mn and Fe contents.

The plants of secondary subgroup are: *Crataegus monogyna, Plantago major, Chelidonium majus and Melissae Folium,* which have also a medium contents in Zn and Mn, but higher content in Fe than the first subgroup.

Taraxacum officinale and *Artemisia absinthium* are the plants included in the third group, characterized by high contents in Cu (7.32 ppm, respectively 11.14 ppm), Zn (22.05 ppm, respectively 41.30 ppm) and Mn (44.25 ppm, respectively 53.85 ppm). Also in these plants were detected the highest content in Fe (175.92 ppm, respectively 171.52 ppm).

Conclusions

The contents in microelements for analysed samples were in range: 15.55 ppm (*Phoeniculus*) - 1.75 ppm (*Rhamnus frangula*), for *Cooper*; 41.30 ppm (*Artemisia absinthium*) - 6.44 ppm (*Rhamnus frangula*), for *Zinc;* 83.44 ppm. (*Rhamnus frangula*) - 25.32 ppm (*Chelidonium majus*), for *Manganese;* 175.92 ppm (*Taraxacum officinale*) - 21.43 ppm (*Rhamnus frangula*), for *Iron;* 1.479 ppm (*Epilobium montanum*) - 0.033 ppm (*Plantago major*), for *Nickel.* For *Echinaceae* herba was not detected Nickel content.

The analyzed medical plants can be differentiating in three main groups, each of them characterised by appropriate metal composition.

Acknowledgements

We are most grateful to The National University Research Council (code 896) for financial support.

References

1. Allen, L. and Sabel, J. C., 2001. Prevalence of nutritional anaemia. In U. Ramakrishnan (Ed.), *Nutritional anaemia* (pp. 7-23). New York: CRC Press.
2. Anke M., Angelow L., Glei M., Müller M. and Illing H., 1995. The biological importance of nickel in the food chain, *Fresenius J. Anal. Chem.,* **352**, p. 92-96.
3. Brock, J.H., 1994. Iron in infection, immunity, inflammation and neoplasia. In: Brock, J.H., Halliday, J.W., Pippard, M.J., Powell, L.W. (Eds.), Iron Metabolism in Health and Disease. W.B. Saunders, London, pp. 354-389.
4. Creech, B.L., Spears, J.W., Flowers, W.L., Hill, G.M., Lloyd, K.E., Armstrong, T.A., Engle, T.E., 2004. Effect of dietary trace mineral concentration and source (inorganic vs. chelated) on performance, mineral status, and fecal mineral excretion in pigs from weaning through finishing. *J. Anim. Sci*. **82**, 2140-2147.
5. Crowley J.D., Traynor D.A. and Weatherburn D.C., 2000. 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, p. 209-278.
6. Gergen I., Gogoaşă I., Drăgan Simona, Moigrădean Diana, Hărmănescu Monica, 2006. 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, p. 149-165.
7. Henry, P.R., Miller, E.R., 1995. Iron availability. In: Ammerman, C.B., Baker, D.H., Lewis, A.S. (Eds.), Bioavailability of Nutrients for Animals. Academic Press, San Diego, pp. 169-199.
8. Kabata A., Pendias H., 2001. Trace Elements in Soils and Plants, 3rd Edition, CRC Press, Boca Raton, Fl., p. 365.
9. Kegley, E.B., Spears, J.W., Flowers, W.L., Schoenherr, W.D., 2002. Iron methionine as a source of iron for the neonatal pig. *Nutr. Res*. **22**, 1209-1217.
10. Rincker, M.J., Clarke, S.L., Eisenstein, R.S., Link, J.E., Hill, G.M., 2005. Effects of iron supplementation on binding activity of iron regulatory proteins and the subsequent effect on growth performance and indices of hematological and mineral status of young pigs. *J. Anim. Sci*. **83**, 2137-2145.
11. Schäfer U., 2004. Manganese*, In: Elements and their Compounds in the Environment*, 2nd Ed., Edited by Merian E., Anke M., Ihnat M., Stoepler M., Wiley-VCH, Weinheim, p. 901-930.
12. Schumann K. and Elsenhans B., 2004. Iron, *In: Elements and their Compounds in the Environment*, 2nd Ed., Edited by Merian E., Anke M., Ihnat M., Stoepler M., Wiley-VCH, Weinheim, p. 811-823.
13. Schumann, K., 2001. Safety aspects of iron in food, *Ann Nutr. Metab.,* **45**, p. 91-101.
14. *** Excerpt from Romanian Ministry of Public Health *Ordinance no 975/1998*. Maximum limits accepted for heavy metal in foods.
15. *** WHO, Report on meetings of expert committees and study groups. Evaluation of certain food additives and contaminants. *World Heath Organization*, Geneva, Switzerland, 2001, EB109/33.