VEGETABLES, FRUITS, HONEY AND POLLEN, A NATURAL SOURCE OF ZINC

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ABSTRACT
This work aimed to evaluate zinc content in six common vegetables (parsley, carrot, dill, onion, cucumber and beans), three common fruits (apples, raspberry and dog rose), bees honey and pollen. Determination of zinc content in soil, raw vegetables and fruits, as well as in bees honey and pollen from local apiaries were carried out by FAAS. All experiments and analyses were performed in triplicate. Overall, the highest zinc concentration was found in the leaves (carrot 48.07 mg kg^{-1}, parsley 46.62 mg kg^{-1}, dog rose leaves 36.13 mg kg^{-1}) and beans crops (41.26 mg kg^{-1}). According to our study the highest content occurs in the plants of the *Apiaceae* Family and in *Rosa canina* leaves.

Keywords: zinc, vegetables, crops, bee's honey and pollen, principal component analysis

INTRODUCTION

Zinc, like all metals, is a natural component of the Earth's crust and an inherent part of our environment (INTERNATIONAL ZINC ASSOCIATION, 2002). This microelement enters into the composition of more than three hundred enzymes and proteins, which are involved in all major metabolic processes (HARMANESCU ET AL., 2007). Therefore, zinc is an essential mineral of "exceptional biologic and public health importance" (HAMBIDGE AND KREBS, 2007). Deficiency of zinc affects about two billion people in the developing world and is associated with many diseases (PRASAD, 2003). The World Health Organization Report 2002 have regarded zinc deficiency as one of the leading causes of illness and disease in low-income countries, and have ranked it 5th among the leading 10 risk factors (INTERNATIONAL ZINC ASSOCIATION, 2002).

Petroselinum crispum L., the parsley, is a commonly grown culinary and medicinal herb that is often used in domestic medicine (i.e., nursing, medicine, and other healing practices associated with the home environment) as a natural vitamin and mineral supplement (CHEVALLIER, 1996).

Daucus carota sativus L., the carrot, is a root vegetable. The most commonly eaten part is the taproot. Although the greens are also edible parts, they are rarely eaten by humans and sometimes used as aromatic spice (CHEVALLIER, 1996).

Anethum graveolens L., the dill, is a very high source of minerals: Calcium: 1784 mg, Potassium: 3308 mg, Zinc: 3.3 mg (DUKE AND AYENSU, 1985). The commonly parts eaten by humans are the leaves and the seeds.

Allium cepa L., the onion, is the most widely cultivated species of the genus *Allium* (BREWSTER, 1994). This vegetable accumulates very low content of zinc in the roots (DUKE AND AYENSU, 1985).
Cucumis sativus L., the cucumber, is a common ingredient of salads, being valued mainly for its crisp texture and juiciness (HEDRICK, 1919). This vegetable is very watery, with little flavour (DREWNOWSKI AND GOMEZ-CARNEROS, 2000), and contains a low amount of zinc - 0.20 mg (USDA NUTRIENT DATABASE, 2012).
Phaseolus vulgaris L., the common bean, is an herbaceous annual plant with high content of potassium and zinc (USDA NUTRIENT DATABASE, 2012).
Malus domestica Mill., the apple, is one of the most widely cultivated tree fruits. Apples are one of the healthiest fruits due to their high vitamin content (USDA NUTRIENT DATABASE, 2012).
Rubus idaeus L., the raspberry, contains significant amounts of polyphenol antioxidants (e.g., anthocyanin pigments) which can provide protection against several human diseases. The total zinc content of the raspberries is 0.52 mg/100 g fresh weight (GEORGE MATELJAN FOUNDATION, 2012).
Rosa canina, also known as the Dog rose, is a variable climbing wild rose species native to Europe, northwest Africa and western Asia (LIM ET AL., 2005).

MATERIAL AND METHODS

The study was performed on plants of the families *Apiaceea*, *Cucurbitaceae*, *Alliaceae*, *Fabaceae* and *Rosaceae* (*Table 1*) as well as on bee's honey and pollen samples. All samples were collected from west part of Romania (Banat County).

Table 1. Analyzed plants samples

Crt. No.	Family	Plant Latin Name	Plant Common Name	Studied parts
1.	***Apiaceae or Umbelliferae***	*Petroselinum crispum*	Parsley	roots, leaves
2.		*Daucus carota sativus*	Carrot	roots, leaves
3.		*Anethum graveolens*	Dill	leaves
4.	***Alliaceae***	*Allium cepa*	Onion	roots
5.	***Cucurbitaceae***	*Cucumis sativus*	Cucumber	fruits, leaves
6.	***Fabaceae***	*Phaseolus vulgaris*	Beans	fruits
7.	***Rosaceae***	*Malus domestica*	Apples	fruits, skin
8.		*Rubus idaeus*	Raspberry	fruits, leaves
9.		*Rosa canina*	Dog rose	fruits, leaves

Samples collection and preparation

Soil

Soil and plant samples were collected from the same sites. Soil sampling was done to a depth of maximum 20 cm. Honey and pollen samples were tapped 500 m away from the apiary location. The soil samples were dried for two days and then passed through a sieve to remove the potential soil impurities. The surface soil samples were analyzed using the procedure recommended by LINDSAY AND NORVEL (BORDEAN D-M, 2006).

Plants and fruits

All samples were washed off with double distilled water to remove dust and air pollutants. Then, the plants and fruits were cut in small slices and were oven dried at

105°C to constant weight. After that, the dried samples were ground and stored at room temperature till analysis.

Honey Bees

The honey bees samples were prepared for Zn content analysis using the method of TANANAKI CHRISOULA (45°C, 55 °C , 65 °C, 75 °C for 1, 6, 24 and 48 hours) optimized by DESPINA BORDEAN (45°C, 65 °C, 75 °C, 100 °C for 1, 6, 12 and 12 hours) (BORDEAN D-M, 2006).

Bee's Pollen

Zinc from bee pollen samples was analyzed after dry burning of 10 g in the quartz capsules at 650°C, for 4 hours.

Analytical determinations

After complete burning, 0.5 N nitric acid solution was added up to 50 mL. The solutions obtained were used for the determination of total zinc content in samples. Flame Atomic Absorption Spectrometry (FAAS) was conducted in Food Analysis Research Test Laboratory at Banat`s University of Agricultural Sciences and Veterinary Medicine from Timisoara, Romania. The standard solutions (1000 mg/L) were analytical grade from Riedel de-Haen Laboratory (Seelze, Germany), whereas only ultra pure nitric acid (65%, ρ = 1.39 g/cm^3, Merck KGaA, Darmstadt, Germany) was used to prepare the digestion solutions. All solutions were prepared using deionized water. Analyses of zinc content were carried out by FASS in air/acetylene flame (model ContrAA-300, Analytik-Jena device). The device working parameters (air, acetylene, optics and electronics) were adjusted for maximum absorption of Zn. Acetylene was of 99.99 % purity. All analyses were performed in triplicate and only the mean values were taken into account.

Statistical analysis

The data were statistically analyzed using two statistical packages: MVSP 3.1 and PAST 2.14 (HAMMER ET AL., 2001).

RESULTS AND DISCUSSIONS

The zinc composition of the studied samples (mg kg^{-1} fresh matter) is presented in *Figure 1*. Each value in the graphic is an average of 3 replicates.

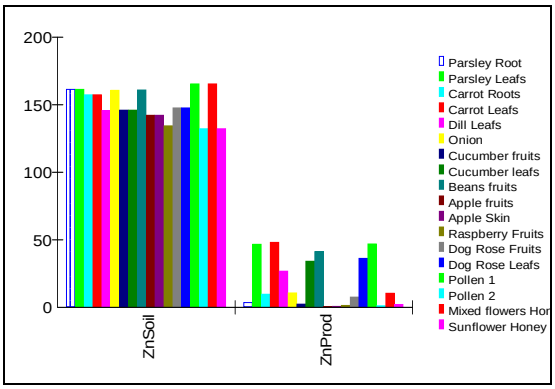

Figure 1. Zn content in ZnSoil and in ZnProd

ZnSoil- contend of Zn in soil samples; ZnProd- contend of Zn in vegetables, fruits, honey and pollen.

It was found that soil samples present similar Zn profiles whereas the products samples reveal variations of Zn concentration (as shown in *Figure 1* and *Figure 2*).

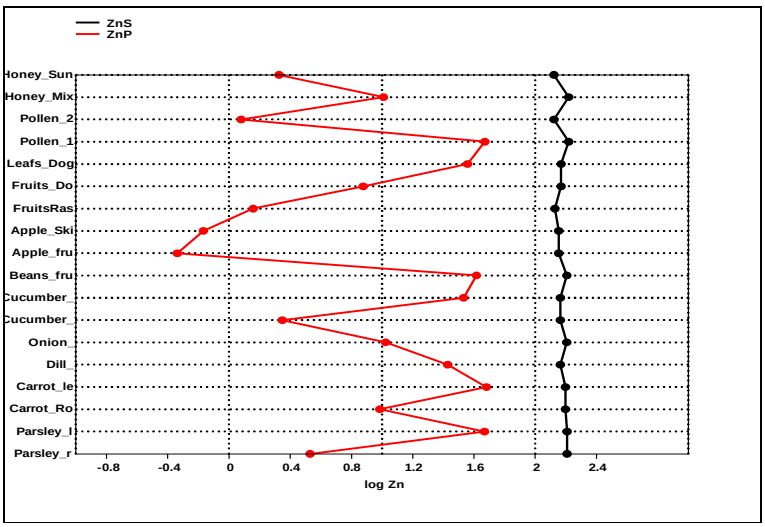

Figure2. Logarithm of Zn content in soil and studied products

ZnS- contend of Zn in soil samples; ZnP- contend of Zn in vegetables, fruits, honey and pollen.

The Principal Components Analysis of the data presents the levels to which the accumulation of Zn in the product samples was influenced by the Zn soil content (*Figure 3*).

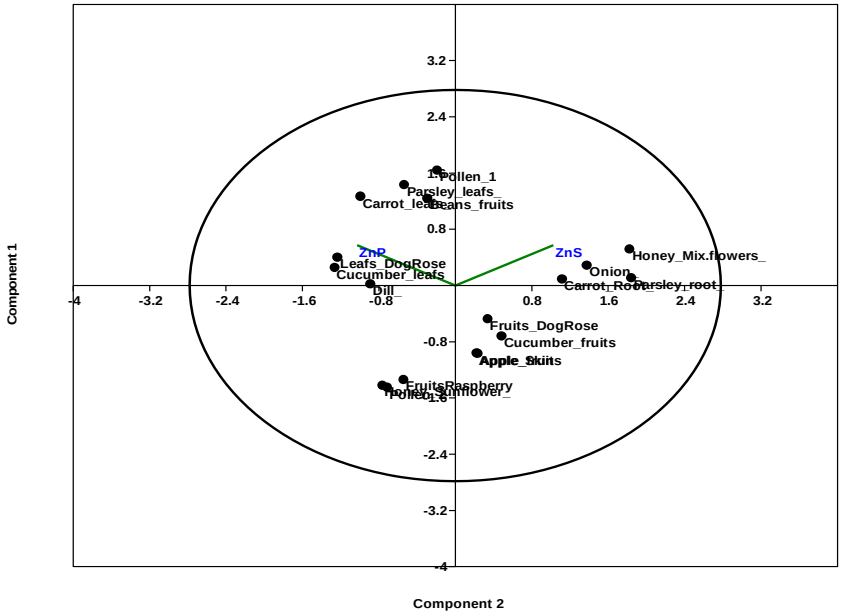

Figure 3. Graphical representation of PCA scores for soil and studied products

As shown in *Figure 3*, the highest accumulation of Zn have occurred in leaves (carrot, parsley, Dog Rose, cucumber and dill) followed by pollen 1, onion and mixed flowers honey.

CONCLUSIONS

The highest content of zinc occurs in the leaves of the *Apiaceae* Family, in *Rosa canina* (*Rosaceae*)and in the fruits of *Phaseolus vulgaris (L.), Fabaceae* Familly. Compared with the reference in soil, the values were lower than the maximum allowable limits (MAL) for Zn, excepting the mixed flowers honey (10.22 mg kg^{-1} honey) where the value have exceeded the national maximal limit (5 mg kg^{-1} honey).The mentioned products (carrot, parsley, Dog Rose, cucumber, dill, pollen and honey) are recommended to be consumed as high sources of zinc.

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