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Fresh Fruits: A Supplementary Source of Mineral Microelements

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Abstract

This paper contains data concerning the concentration of some microelements in native fresh fruits from private producers in the Banat's hill area. The authors have determined, through flame atomic absorbance spectrometry, the contents in Fe, Mn, Zn and Cu of cherries, sour cherries, plumes, and grapes. Experimental results show that the fruits analysed contain important amounts of Fe (4.20-8.34 mg/kg), Mn (0.81-1.89 mg/kg), Zn (0.97-1.33 mg/kg) and Cu (0.48-1.40 mg/kg). The average mineral supply of the fruits analysed has the following values: Fe – 40.64% (males) and 18.06% (females), Mn – 31.4% (females) and 24.84% (females), Zn – 7.08% (females) and 5.15% (males), Cu – 53.06% (males and females). Experimental results show that cherries, sour cherries, plums and grapes can serve as supplementary sources of Fe, Mn, Zn, and Cu.

Keywords: fresh fruits, microelements, AAS, supplementary sources of microelements

1. Introduction

Due to their rich content of nutrients of major importance for the good functioning of the human body, fruits, together with vegetables, are among the healthiest foods in nature. Their composition count, besides water, variable amounts of compounds important for the human body such as easily digestible sugars, proteins, fats, organic acids, mineral salts, pectin substances and tannins, vitamins, enzymes, fibbers, etc. [3, 15, 19, 20].

The beneficial effects of consuming fresh fruits on a daily basis – shown by numerous scientific studies – refer to reduction of heart disease risk, heart arrest and brain attack, protection against certain types of cancer, preventing obesity and diabetes, slowing down the ageing process, balancing blood pressure, reducing the risk of kidney failure and of bone condition, etc. [3, 6, 7, 14].

With their low supply of fats and their rich supply of elements essential for the good functioning of the human body, fruits and vegetables are foods that should be on the top of the functional foods list since they could be hardly replaced by other produce on a long-term basis.

The nutrient and therapy features of fresh fruits are also due to the content of minerals among which are also essential minerals such as K, Ca, Mg, Fe, Cu, Zn, Mn, etc. [10]. Literature shows that fruits contain important amounts of macro elements and appreciable amounts of essential microelements [2, 5, 11, 16].

With the increase of information due to the diversification and modernisation of analytic methods regarding the distribution of certain mineral

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elements in different fresh or processed fruits, some researchers considered normal to check if such foods could be used as an alternative source of mineral elements. Literature data point out that some fresh fruits could be a supplementary source for the daily-recommended intake of minerals [1, 3, 7, 4].

Considering all this, the authors of this paper considered it would be worth to assess the mineral supply of some native fruits viewed as representative for the Banat's hill area. The authors measured the concentration of some essential microelements such as Fe, Mn, Cu, Zn, Co, and Ni, and eventually assessed the mineral supply of these fruits to the recommended daily intake. Results show that the fruits analysed could be an alternative to the supplementing of mineral diet. Their contribution to the daily-recommended diet is presented below.

2.1 Materials. In order to carry out the experiment, the authors used spring-summer fruits such as cherries and sour cherries and summer-autumn fruits such as plums and grapes from private producers in the Banat's hill area. In the analysis of microelements, the authors used about 100 g (±0.001 g) edible part of the mean sample of fresh fruit.

2.2. Reagents. The sample solutions for Fe, Mn, Zn, and Cu were obtained by diluting with distilled water a solution of 1.000 gL^{-1} stock solutions (Merck, Germany).

For moist disaggregation, they used a solution of HNO_3 0.5 N from HNO_3 65% and distilled water.

2.3. Apparatuses. Measurements were carried out using a Varian Atomic Absorption Spectrometer Instruments of the Varian type of the Spectr AA-110 type. The work parameters were those recommended by the producers of the apparatus. Calcination was done in a calcination oven of the Nabertherm type, model 6/11.

2.3. Procedure. Determining microelements proper needed two steps: mineralising fruit samples (dried previously at 105^0C) by calcination, followed by the solubilisation of the ashes in nitric acid 0.5 N and the measurement of analysed element absorbance in the air-acetylene flame [3].

Sample calcination was done at 500^0C, in two sessions of 4 h each. After cooling, the ashes were retaken with 25 mL of HNO_3 0.5 N solution, and then evaporated until almost dry; the last operation was repeated two times. After the complete solubilisation the samples solution was filtered and made up to 50 ml with bidistilled water and was submitted for analysis.

Results

Experimental results of determining Fe, Mn, Zn, and Cu in analysed fruits are shown in *Table 1*.

Table 1. Concentration of Fe, Mn, Zn, and Cu in some fresh fruits

Fruits	Values	Mineral content, mg/kg fresh fruits			
		Fe	Mn	Zn	Cu
Cherries	minimum	5.00	0.5	0.70	0.80
	maximum	8.00	2.00	2.5	3.70
	average	**5.62**	**0.90**	**1.12**	**1.40**
Sour cherries	minimum	5.95	0.29	1.00	0.52
	maximum	11.8	1.85	2.5	2.15
	average	**8.34**	**0.97**	**1.33**	**1.40**
Plums	minimum	3.1	0.52	0.75	0.11
	maximum	6.8	2.10	2.25	1.00
	average	**4.20**	**0.81**	**1.11**	**0.48**
Grapes	minimum	4.90	0.55	0.50	0.20
	maximum	11.1	4.10	2.10	1.05
	average	**7.85**	**1.89**	**0.97**	**0.54**
Mean value		***6.50***	***1.14***	***1.13***	***0.96***

Table 2. Dietary Reference Intakes (DRIs): Recommended Dietary Allowances and Adequate Intakes, Elements [17]

Element, mg	Recommended values	
	males	females
Iron	8	18
Manganese	2.3	1.8
Zinc	11	8
Copper	0.9	0.9

Table 3. Concentration of Fe, Mn, Zn, and Cu in 500 g fresh fruit

Fruits	Mineral content (mg/500 g fresh fruits)			
	Fe	Mn	Zn	Cu
Cherries	2.81	0.45	0.56	0.70
Sour cherries	4.17	0.49	0.67	0.70
Plums	2.10	0.41	0.56	0.24
Grapes	3.93	0.95	0.49	0.27
Mean value	***3.25***	***0.57***	***0.57***	***0.48***

Table 4. Mineral supply (%) in the daily-recommended diet of 500 g of fresh fruit for people aged 30-70

Fruit	Gender	Mineral supply			
		Fe	Mn	Zn	Cu
Cherries	*Males*	35.13	19.57	5.09	77.78
	Females	15.61	25.00	7.00	77.78
Sour cherries	*Males*	52.13	21.09	6.05	77.78
	Females	23.17	26.94	11.08	77.78
Plums	*Males*	26.25	17.61	5.05	26.67
	Females	11.67	22.50	6.94	26.67
Grapes	*Males*	49.13	41.09	4.41	30.00
	Females	21.83	52.50	6.06	30.00
Mean value	***Males***	***40.64***	***24.84***	***5.15***	***53.06***
	Females	***18.06***	***31.74***	***7.08***	***53.06***

As shown in Table 1, the concentration of microelements in cherries, sour cherries, plums, and grapes has different values depending on the nature of the fruit and of the element being analysed. If we take into account the mean values of the concentrations of the microelements in the studied fruits, we note that, except for Fe, these values are relatively close. Therefore, Fe is the element the best represented in all the fruits analysed; the rest of the elements – Mn, Zn and Cu – have relatively close mean concentrations.

Iron is an essential microelement: it has a respiratory function and makes up haemoglobin and certain enzymes. It plays a role in cell energetic, in the processes of oxi-reduction and in the synthesis of nucleic acids; it supports the human body's defence system against the aggressiveness of infectious factors. Assimilating iron is linked to the presence of copper, cobalt, and manganese, as well as to that of vitamins C and C2 [2, 9].

In the fruits analysed, Fe was found in concentrations ranging between 4.20 mg/kg (plums) and 8.34 mg/kg (sour cherries); the mean concentration of Fe in the four fruit assortments is 6.50 mg/kg. The richest fruits in Fe are sour cherries and grapes, while the poorest ones are plums.

Manganese, a microelement that enhance the activity of many enzymes and vitamins of the Complex B, has beneficial effects on the nervous system reducing irritability and increasing the ability of memorising.

It also frees the body from pollutants, participates in the synthesis of collagen and in the metabolism of sugars, steroids, and certain hormones, thus increasing male procreation potential [2, 13].

Manganese was determined in amounts smaller than those of Fe, but relatively close to those of Zn and Cu. Concentrations of Mn ranged between 0.81 mg/kg (plums) and 1.89 mg/kg (grapes); there were higher contents of Mn in grapes, the rest of the fruits having smaller but close concentrations.

Zinc, an active microelement of a large number of enzymes, where it plays a structural, regulator, or catalytic role, is essential in growth and development; it also plays an important role in the metabolism of proteins, lipids, sugars, and nucleic acids, making up DNA structure. It is crucial for the maintenance of the structure and the integrity of cell membrane, as well as for the integrity of the immune system, playing an anti-infectious, anti-tumour role. On the other hand, Zn activates the synthesis of insulin and detoxifying processes to remove pollutant chemical compounds; it acts as an antioxidant and it enhances the synthesis of the sexual male hormone [2, 12].

Concentrations of Zn, determined in the four fruit assortments analysed have values close to their mean, i.e. 1.13 mg/kg. Compared with concentrations of Fe, Zn concentration is almost five times smaller, but about equal to the concentration of Mn and Cu.

Copper is a microelement that makes up numerous enzymes being indispensable in cell respiration and in bone formation. It is also particularly important because it is involved in a series of processes: it helps fix iron, it helps haemoglobin and red cell formation, it prevents excessive blood clogging, it takes part in the metabolism of vitamin C, it is anti-infectious and anti-inflammatory, it facilitates the normal functioning of the heart, it intervenes in the growth process, it prevents cancer, etc. [2, 11].

The concentration of copper in the analysed fruit assortments is uneven. The lowest concentrations have very close values: plums (0.24 mg/kg) and grapes (0.27 mg/kg); an almost double concentration compared to that of Zn was found in cherries and sour cherries (1.40 mg/kg).

All this shows that a hierarchy of the distribution of microelements among the studied fruits would be rather difficult. However, we can say that grapes and plums are the best represented as far as the content of Fe is concerned; grapes have the best content of Mn; cherries and sour cherries have the highest amounts of Cu; as for Zn, the concentration values of this element in the fruits we analysed are close.

The mean values of the concentrations of Fe, Mn, Zn, and Cu in the fruits we have analysed (presented in Table 1) show that they have important contents of such essential microelements. Taking into account the high contents of Fe, Mn, Zn, and Cu compared to other foods, we ask ourselves if fresh fruits could be a supplementary source of minerals in humans' daily diet.

To assess the mineral supply of cherries, i.e. to determine the measure in which they supply the necessary minerals of a daily diet with Fe, Mn, Cu, and Zn, we need to take into account the individual values of the necessary minerals in the daily recommended diet for both males and females aged 30-70 (Table 2) and the amount of fruits to eat during 2-3 meals a day.

Data shown in Table 2 based on the recommendations of nutrient specialists (Table 3) allowed us to determine the mineral supply (mineral intake: MI) in a daily diet corresponding to each of the fruits we analysed:

$$MI\,[\%] = \frac{c}{a} \cdot 100$$

where MI – mineral supply, c – amount of elements (mg) eaten/day, a – amount of element (mg) recommended/day.

The mineral supply of the fruits analysed, i.e. the degree of coverage of the daily-recommended mineral diet with Fe, Mn, Zn, and Cu for 500 g of fresh fruit is shown in Table 4.

As shown above, the values of the mineral supply of cherries, sour cherries, plums and grapes have different values depending on the mineral concentration of each mineral and on the gender and age of the consumer.

Among the fruits analysed, we noted due to their important supply: in Fe – sour cherries and grapes (52.13% and 49.13%, respectively, in males); Mn – in grapes (52.5% in females and 41.09% in males); Cu – in cherries and sour cherries (77.78% in males and females); Zn – in sour cherries (11.08 in females).

Since nutritionists recommend alternate consumption of fresh fruits, we need to assess the mineral supply of the studied fruits taking into account the mean values of Fe, Mn, Zn, and Cu calculated as the arithmetic mean of the concentrations in each fruit. The mean values of the supply of Fe, Mn, Zn, and Cu are graphically illustrated in Figure 1.

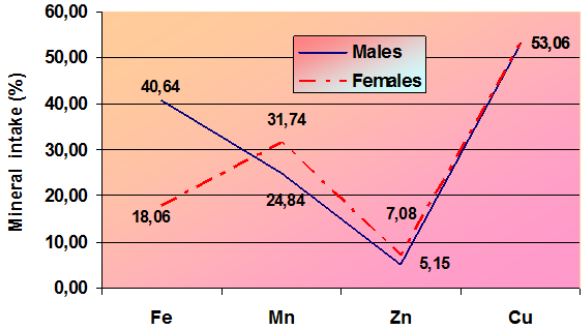

Figure 1. Mean mineral supply in the recommended daily diet for 500 g of fresh fruit in males and females aged 30-70

In this case, the degree of coverage of the mineral diet has the following values: Fe – 40.64% (males) and 18.06% (females), Mn – 31.4% (males) and 24.84% (females), Zn – 7.08% (females) and 5.15% (males), Cu – 53.06% (males and females).

4. Conclusions

Native fresh fruits analysed – cherries, sour cherries, plums and grapes – from the Banat's hill area (Romania) are remarkable for their important contents of microelements: Fe > Mn ≅ Zn ≅ Cu.

Grapes and sour cherries are the best represented as far as the content of Fe is concerned: 8.34 mg/kg and 7.85 mg/kg, respectively; grapes are the best represented in Mn (1.89 mg/kg); sour cherries and cherries are the best represented in Cu (1.10 mg/kg); Zn is rather constant in all analysed fruits (0.97-1.33 mg/kg).

The values of the mineral supply of cherries, sour cherries, plums and grapes are different depending on the mineral concentration of each mineral and on consumer's gender and age. Among the fruits analysed, we noted for their important supplies: in Fe – in sour cherries and grapes (52.13% in females and 49.13% in males); in Mn – in grapes (52.5% in females and 41.09% in males); in Cu – in cherries and sour cherries (77.78% in males and females); in Zn – in sour cherries (11.08% in females).

The mean mineral supply, the degree of coverage of the mineral diet has the following values: Fe – 40.64% (males) and 18.06% (females), Mn – 31.4% (females) and 24.84% (females), Zn – 7.08% (females) and 5.15% (males), Cu – 53.06% (males and females).

Experimental results confirm that the fresh fruits analysed – cherries, sour cherries, plums and grapes – could be supplementary sources of Fe, Mn, Zn, and Cu.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

References

1. Allabaksh Murad Basha, Nookala Yasovardhan, Suggala V. Satyanarayana, Gopireddy V. Subba Reddy, Aerattukkara Vinod Kumar, Trace metals in vegetables and fruits cultivated around the surroundings of Tummalapalle uranium mining site, Andhra Pradesh, India, *Toxicology Reports*, **2014**, *1*, 505–512
2. Anjum M.R., Mamon A.N. and Kazi T.G., Trace Metal Contents of Vegetables and Fruits of Hyderabad Retail Market *F. Ismail, Pakistan Journal of Nutrition*, **2011**, *10*(4), 365-372, 2011
3. Gogoaşă I., Alda Liana Maria, Drăghici A.G., Bordean Despina-Maria, Negrea Adina, Jigoria Gheorghiţa, Velciov Ariana, Rada Maria, Cozma Antonela, Gergen I., Bio-Minerals Contribution of Seasonal Fruits to the Recommended Dietary Allowances, *Proceedings of the 21st International Symposium on Analytical and Environmental Problems* September 28, **2015**, Publisher: University of Szeged, Department of Inorganic and Analytical Chemistry, H-6720 Szeged, Dóm tér 7, Hungary ISBN 978-963-306-411-5, 105-108

4. Gogoaşă I., Alda Liana Maria, Bordean Despina, Rada Maria, Velciov Ariana, Popescu Sofia, Alda S., Gergen I., Preliminary research regarding the use of some berries (blueberries, blackberries and raspberries) as supplementary sources of bio minerals, *Journal of Horticulture, Forestry and Biotechnology*, **2014**, *18*(4), 108- 112, 2014
5. Grembecka Małgorzata and Szefer Piotr, Comparative assessment of essential and heavy metals in fruits from different geographical origins, *Environ Monit Assess.* **2013**, *185*(11), 9139–9160.
6. Hung, H.C., *et al.*, Fruit and vegetable intake and risk of major chronic disease. *J. Natl Cancer Inst*, **2004**, *96*(21), 1577-84.
7. Levander Orville A., Fruit and Vegetable Contributions to Dietary Mineral Intake in Human Health and Disease, *Hortscience*, **1990**, *25*(12).
8. Liu Simin, Serdula Mary, Janket Sok-Ja, Cook Nancy R., Sesso Howard D., Willett Walter C., Manson Joann, Buring Julie E. , A prospective study of fruit and vegetable intake and the risk of type 2, *Diabetes Care*, **2004**, *27*(12).
9. Ishida K, *Iron*. In: Elements and their compounds in the environment, Meriam, E., Anke, M., Ihnat, M., Stoeppler, M., (Eds.), Wiley-VCH Verlag, Weinheim, 2004.
10. Mehari, T.F., Greene, L., Duncan, A.L. and Fakayode, S.O., Trace and Macro Elements Concentrations in Selected Fresh Fruits, Vegetables, Herbs, and Processed Foods in North Carolina, USA. *Journal of Environmental Protection*, **2015**, *6*, 573-583.
11. Mohammed M I, Musa R A and Salisu A A, Spectrophotometric determination of trace elements in some fruits and vegetables, *Journal of Chemical and Pharmaceutical Research*, **2013**, *5*(5), 159-166
12. Peganova Svetlana, Eder K., *Zinc. In: Elements and their compounds in the environment*, Meriam, E., Anke, M., Ihnat, M., Stoeppler, M., (Eds.), Wiley-VCH Verlag, Weinheim, 2004.
13. Schäfer U., *Manganese*. In: *Elements and their compounds in the environment*, Meriam, E., Anke, M., Ihnat, M., Stoeppler, M., (Eds.), Wiley-VCH Verlag, Weinheim, 2004.
14. Slavin Joanne L., Lloyd Beate, *Health Benefits of Fruits and* Vegetables, *Adv Nutr*., **2012**, *3*, 506-516
15. Soetan K. O., Olaiya C. O. and Oyewole O. E., The importance of mineral elements for humans, domestic animals and plants: A review, *African Journal of Food Science*, **2010**, *4*(5), 200-222.
16. Stefanut M.N., David I., Stanoiev Z., Macarie C., The Monitoring of Heavy Metals in Fruits, *Chem. Bull. "Politehnica" Univ. (Timişoara)*, **2007**, *52*(66), 1-2
17. http://www.nal.usda.gov/fnic/DRI/DRI_Tables/recommended_intakes_individuals.pdf
18. http://www.nhs.uk/Conditions/vitamins-minerals/Pages/Vitamins-minerals.aspx
19. http://www.lenntech.com/fruit-vegetable-mineral-content.htm
20. http://www.nutrition-and-you.com/cherry-fruit.html