Bio-Minerals Contribution of Seasonal Fruits to the Recommended Dietary Allowances

Ioan Gogoaşă[1*], Liana Maria Alda[1], George Andrei Drăghici[1], Despina-Maria Bordean[1], Adina Negrea, Gheorghiţa Jigoria[1], Ariana Velciov[1], Maria Rada[3], Antonela Cozma[1], Iosif Gergen[1]**

[1]Banat's University of Agricultural Science and Veterinary Medicine "King Mihai I of Romania", Romania
[2]Politehnica University - Timisoara, Romania
[3]Victor Babes University of Medicine and Pharmacy, Timisoara, Romania
[*]ionelgogoasa@yahoo.com
[**]despina.bordean@gmail.com

Abstract

The paper presents data regarding the distribution of some mineral bio elements in three assortments of fall fruits – apples, pears and quinces – cultivated in a hill area of Banat, Romania, and an estimate of their mineral supply.

Experimental results obtained through the ICP-MS technique show that the fruits analysed have important contents of K, Ca, Mg, and Na, and appreciable contents of Fe, Mn, Zn, and Cu.

Calculus shows that a consumption of 400 g of fresh fruits (edible parts) supplies the necessary daily amount of macro elements: 14.66% K – in males and females, 9.50% Mg – in females and 7.24% Mg – in males, 2.76% Ca – in males and in females, and 0.18% Na – in males and females. Microelement supply is slightly higher: 16.45% Fe – in males and 7.31% Fe – in females, 12.22% Mn – in females and 9.57% Mn – in males, 9.33% Cu – in males and 5.45% Cu – in females and 3.96% Zn – in males.

Introduction

Apples, pears and quinces, as fall fruits [11] are a true treasure of antioxidants, vitamins, fibbers and minerals [1, 6, 8, 9]. Their nutritive and therapeutic features are determined by the contents in and nature of minerals some of which are essential bio elements for the good functioning of the human body: Ca, Mg, K, P, Fe, Mn, Zn, Cu, Cr, I, Se, etc [4, 3, 5]. This is why we believe it is important to know the share of minerals in different fruits and to estimate their mineral supply.

We determined the concentrations of Na, K, Ca, Mg, Fe, Mn, Zn, Cu, Co, Cr, Ni, Pb and Cd in apples, pears and quinces cultivated in a pollution-free hill area of Banat, Romania. Experimental results allowed us to calculate the mineral supply by these fruits and to estimate the degree of supply of the necessary Na, K, Ca Mg, Fe, Mn, Zn and Cu in the recommended dietary allowances containing fresh fruits.

Experimental

To carry out the experiment, we used three native assortments of fall fruits – apples, pears and quinces – harvested from a hill area of Banat, Romania, known as a pollution-free area.

The total concentration of macro- and micro-elements such as Na, K, Ca, Mg, and Fe, Mn, Zn, Cu, Co, Ni, Cr, Pb, and Cd, respectively, in fresh fruit samples was assessed using the ICP-MS spectrometry technique after calcinations of the samples at 550^0C and extracting from the mineral residue with HNO_3, solution of 0.5N [2, 3].

To measure absorbance, we used the Bruker – Aurora M 90 spectrometer, choosing the working parameters after the recommendations of the producers.

Results and discussion

Experimental results after determining minerals in the three assortments of fresh fruits analysed are shown in Tables 1 and 2 below.

Table 1. Concentration of Na, K, Ca and Mg (mean values) in some fall fruits

Specification	Macroelements, mg/kg fresh fruit			
	Na	K	Ca	Mg
Apples	4.20	1079	51.2	44.5
Pears	12.5	2551	81.9	112
Quinces	3.10	1538	72.8	72.3
Mean values	***7***	***1723***	***69***	***76***

Table 2. Concentration of Fe, Mn, Zn, Cu, Cr, Co, Ni, Pb and Cd (mean values) in fall fruits

Fruit	Micro-elements, mg/kg fresh fruit								
	Fe	Mn	Zn	Cu	Cr	Co	Ni	Pb	Cd
Apples	2.18	0.44	0.22	0.07	0.01	0.01	0.01	< 0.01	SLD
Pears	3.14	0.44	1.39	0.25	0.01	0.02	0.01	< 0.01	SLD
Quinces	4.54	0.78	1.67	0.32	0.02	0.01	0.09	< 0.01	SLD
Mean values	***3.29***	***0.55***	***1.09***	***0.21***	***0.01***	***0.01***	***0.04***	***0.00***	***0.00***

As shown in Tables 1 and 2, the share of minerals in the fruit assortments analysed is uneven. Of the total elements analysed, the best represented are macro-elements, i.e. over 99%. Among them, K is the best represented, followed by Magnesium and Calcium, and by Natrium, respectively.

Potassium was determined within concentration limits of 1079 mg/kg (apples) and 2551 mg/kg (pears), its value reaching 1723 mg/kg.

Magnesium was determined in much smaller concentrations than Potassium, its concentration ranging between 44.5 and 112 mg/kg; pears are the richest fruits in Mg.

Calcium was determined in much smaller concentrations than Potassium (51.2 mg/kg – 81.9 mg/kg), the mean value of its concentration being 69.00 mg/kg, relatively close to the concentration of magnesium.

Natrium was determined in the lowest concentration compared to K, Ca and Mg, the mean value of its concentration being 7 mg/kg. The highest values were in pears (12.5 mg/kg), while the lowest were in quinces (4.2 mg/kg) and apples (3.10 mg/kg).

Microelements were identified in much smaller concentrations compared to macro-elements (Table 2). There was also uneven distribution of microelements: the best represented was Fe, followed by Zn, Mn, and Cu. The rest of microelements, Cr, Co, Ni, Pb and Cd, in working conditions, were identified in extremely small concentrations, at the limit or beneath the limit of detection of the apparatus.

Iron was determined in concentrations between 2.18 mg/kg (apples) and 4.54 mg/kg (quinces); the mean value of the concentration of Fe was 3.29 mg/kg.

Zinc was determined in smaller concentrations than Fe, but in larger concentrations than Mn and Cu, and much larger than Mn and Cu. The concentration of Zn ranged between 0.22 mg/kg (apples) and 1.17 mg/kg (quinces); quinces and pears are richer in Zn.

Manganese was determined within close concentration limits, i.e. between 0.44 mg/kg (apples and pears) and 0.78 mg/kg (quinces); the mean concentration of Mn was 0.55 mg/kg.

Copper was determined in small concentrations ranging between 0.07 mg/kg (apples) and 0.32 mg/kg (quinces), the mean concentration reaching 0.21 mg/kg; quinces are the richest in cooper.
Zinc and Copper, essential bio elements, can harm above certain concentration limits. Comparing the values determined with maximum admitted limits [10], we see that the fruits we analysed do not show any contamination risk by Zn and Cu.
Cobalt, Chromium and Nickel were identified in extremely small concentrations, which explains why we did not consider them in estimating mineral supply.
Lead and Cadmium, high toxicity metals, were practically not determined under experimental conditions; therefore, there is no contamination risk by Pb and Cd.
We can say that the fall fruits we analysed have important amounts of K, Ca, Mg, and Na, appreciable amounts of Fe, Mn, Zn, and Cu and no risk of contamination by toxic elements.
The mean values of the concentrations of Na, K, Ca, Mg, Fe, Zn, Mn, and Cu in the assortments of fall fruits we analysed (Tables 1 and 2) and the recommended mineral intake [12] allowed us to estimate their supply in the recommended dietary allowances [7, 12].
The mineral supply, i.e. the degree of coverage of the recommended dietary allowances of minerals calculate for 400 g of fresh fruit (the equivalent of two medium-size apples eaten at two main meals) is shown in Table 3 below.

Table 3. Mean supply with some bio elements of the recommended dietary allowances for a mean consumption of 400 g of fresh fruit

Group/Life Stage	Bio element supply of the RDA (%)							
	Na	K	Ca	Mg	Fe	Mn	Zn	Cu
Males, aged 30-70	0.18	14.66	2.76	7.24	16.45	9.57	3.96	9.33
Females, aged 30-70	0.18	14.66	2.76	9.50	7.31	12.22	5.45	9.33

The mean supply of bio elements in the recommended dietary allowances by fall fruits has different values depending on the nature of the element and on the category of consumer (male of female).
In the case of macro-elements, the supply of minerals reached 14.66% K – in males and females, 9.50% Mg – in females and 7.24% Mg – in males, 2.76% Ca – in males and females, and 0.18% Na – in males and females.
The supply in microelements is slightly higher: 16.45% Fe – in males and 7.31% Fe – in females, 12.22% Mn – in females and 9.57% Mn – in males, 9.33 % Cu – in males and females, and 5.45% Zn – in females and 3.96% Cu – in males.

Conclusions

The analysed Fall fruits are to be noted for their important contents of K, Ca, Mg, and Na and for their appreciable amounts of Fe, Mn, Zn, and Cu, showing no contamination risk by toxic elements.
The mean values of the mineral supply in the recommended dietary allowances, under experimental conditions, show that these fruits could be taken into account as an alternative supplementary source of certain bio elements such as K, Mg, Fe, Mn, Mn, and Cu.

Acknowledgements

We thank Prof.Dr.Eng. Petru Negrea for ICP-MS spectrometry, Politehnica University - Research Institute for Renewable Energy (ICER) – Timisoara.

References

[1]. I.J. Cindric, I. Krizman, M. Zeimer, Š. Kampic, G. Medunic, G. Stingeder, Food Chem 135 (4), pp. 2675-2680, (2012).
[2]. A. Dehelean and D.A. Magdaș, The Scientific World Journal, Volume 2013, pp. 285-289, (2013).
[3]. I.Gogoașă, L.M. Alda, D. Bordean, M. Rada, A. Velciov, S. Popescu, S. Alda, I. Gergen, Journal of Horticulture, Forestry and Biotechnology, Volume 18(4), pp. 108-112, (2014).
[4]. M. Grembecka, P. Szefer, Grembecka M, Szefer P., Environmental Monitoring and Assessment , Volume 185, Issue 11, pp. 9139-9160, (2013).
[5]. R. C., Heghedűş-Mîndru, G. Heghedűş, P. Negrea, R. Şumălan, A. Negrea¸ D. Ştef, Annals of Agricultural and Environmental Medicine, Vol 21, No 1, 98–105, (2014).
[6]. C. Ji-luan; WU, Ji-hong; J. Ying, HU Xiao-song, Spectroscopy and Spectral Analysis, Volume 9, Number 2, pp. 496-498 (2009).
[7]. O.A. Levander, Hortscience, Vol. 25(12), (1990).
[8]. O. Rop, J. Balík , V. Řezníček, T. Juríková, P. Škardová, P. Salaš, J. Sochor , J. Mlček and D. Kramářová, Czech J. Food Sci. Vol. 29, No. 1: 65–73, (2011).
[9]. D. Todea, O. Cadar, D. Simedru, C. Roman, C. Tanaselia, I. Suatean, A. Naghiu, Not Bot Horti Agrobo, 42(2), pp.523-52, (2014).
[10]. ORDIN nr. 975/1998 al Ministerului Român de Sanatate Publica JECFA, (2005).
[11]. http://incomemagazine.ro/articole/topul-celor-mai-sanatoase-fructe-ale-toamnei.
[12]. www.nap.edu. Dietary Reference Intakes (DRIs): Recommended Dietary Allowances and Adequate Intakes, Elements.