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Macro- and micro-nutrient element contents of some fruit growing in Minsk, Belarus

Mineralstoffe und Spurenelemente in Obst aus Minsk, Belarus

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Summary

Mineral contents of several fruits growing in Minsk in Belarus were determined by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES). The highest K (19141 mg/kg) was found in redberry sample, followed by red plum (big) (13352 mg/Kg), strawberry (13287 mg/Kg), blackberry (12896 mg/kg), yellow grape (12215 mg/kg), yellow plum H1 (12438 mg/kg), yellow plum H2 (12124 mg/kg), black grape (big) (11472 mg/kg), black grape (small) (11692 mg/kg), red plum (small) (10743 mg/Kg) and grape (red) (10572 mg/kg). P contents of fruits changed between 394 mg/kg wild apple) and 3422 mg/kg (redberry). Cr, Mo, Ni and Pb were found in very low concentrations. Generally, while Cu contents of fruits change between 1.6 mg/Kg (red hybrit apple) and 8 mg/kg (red berry), Fe contents ranged from 12.5 mg/kg (yellow pear) to 51.4 mg/kg (black berry). It appears that fruits could serve as good source of some nutrients.

Keywords: Fruits, heavy metal, macro- and micro-nutrient elements, ICP-AES

Zusammenfassung

Der Mineralstoffgehalt verschiedener Obstsorten wurde durch induktiv gekoppelte Plasma-Atomemissionsspektrometrie (ICP-AES) bestimmt. Der höchste Kaliumgehalt (19.141 mg/kg) wurde in Holunderbeeren festgestellt, gefolgt von roten Pflaumen (groß) (13.352 mg/kg), Erdbeeren (13.287 mg/kg), Brombeeren (12.896 mg/kg), gelben Trauben (12.215 mg/kg), gelbe Pflaumen der Sorte H1 (12.438 mg/kg), gelbe Pflaumen der Sorte H2 (12.124 mg/kg), schwarze Trauben (groß) (11.472 mg/kg), schwarze Trauben (klein) (11.692 mg/kg), rote Pflaumen (klein) (10743 mg/kg) und rote Trauben (10572 mg/kg). Der P-Gehalt (Phosphorgehalt) betrug bei den Früchten zwischen 394 mg/kg (Wildapfel) und 3422 mg/kg (Rotebeeren). Cr (Chrom), Mo (Molybdän), Ni (Nickel) und Pb (Blei) wurden nur in sehr niedrigen Konzentrationen festgestellt. Obst und Beerenfrüchte können somit eine gute Quelle für bestimmte Mineralstoffe und Spurenelemente sein.

Schlüsselwörter: Obst, Mineralstoffe, Spurenelemente, Schwermetalle, ICP-AES

Introduction

Fruits and vegetables are valuable sources of minerals (Smolin and Grosvenar, 2000; Milton, 2003). The consumption of fresh fruits or juice, food pastes, jellies, jams assure the vitamins for a beter life (Campeanu et al. 2009). Chemical composition of several fruits are very complex. Different fruits will exhibit different capacities due to the presence of dietary antioxidants (Saura-Calixto and Goni, 2006; Nour et al. 2010). The increase in the consumption of refined foods and the lack of vitamins and minerals in the diet can cause health problems (Ivey and Elmen, 1986). The effect of heavy metal contamination of fruit and vegetables cannot be underestimated as these foodstuffs are important components of human diet. The intake of heavy metal-contaminated fruit and vegetables may pose a risk to human health; hence the heavy metal contamination of food is one of the most important aspects of food quality assurance (Radwan and Salama, 2006; Khan et al. 2008). In general, heavy metals are not biodegradable, and they have long biological half-lives. Also they have the potential for accumulation in different body organs, leading to unwanted side effects (Jarup, 2003; Sathawara et al. 2004). Also, the heavy metal contamination of fruit and vegetables may occur due to their irrigation with contaminated water (Al Jassir et al. 2005).

The aim of present study was to determine macro and micro element contents of some fruits collected from Fruit Research Garden of Institute in Minsk in Belarus.

Material and Methods

Plant Material

Fruits were collected from Fruit Research Garden of Institute in Minsk in Belarus. 21 different fruits were used in this experiment. They were transferred to laboratory in cool bags. Fruits were washed with clear distilled water without being peeled off. They were kept in refrigerator by using. 10 fruit samples were used for each analyses.

Determination of mineral

Provided fruit samples were dried at 70 ºC in a drying cabinet with air-circulation until they reached constant weight. Later, about 0.5 g dried and ground samples were digested by using 5ml of 65 % HNO_3 and 2 ml of 35 % H_2O_2 in a closed microwave system (Cem-MARS Xpress). The volumes of the digested samples were completed to 20 ml with ultra-deionized water, and mineral contents were determined by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP AES) (Varian-Vista, Australia). Measurements of mineral concentrations were checked using the certified values of related minerals in the reference samples received from the National Institute of Standards and Technology (NIST; Gaithersburg, MD, USA) (Skujins, 1998).

Working conditions of ICP-AES

Instrument:
ICP-AES (Varian-Vista)
RF Power:
0.7–1.5 kw (1.2–1.3 kw for Axial)
Plasma gas flow rate (Ar):
10.5–15 L/min. (radial) 15“ (Axial)
Auxilary gas flow rate (Ar):
1.5“
Viewing height:
5–12 mm
Copy and reading time:
1–5 s (max. 60 s)
Copy time:
3 s (max. 100 s)

Statistical analyses

All analyses were carried out three times and the results are mean±standard deviation (MSTAT C) of 25 independent fruit samples (Püskülcü and İkiz, 1989).

Results and Discussion

The macro element contents of fruits are reported in Table 1. According to results, K, Mg, P and S contents of samples were found high. In addition, Cr, Mo, Ni, Pb and Zn contents of fruits were found very low. The highest K (19141 mg/kg) was found in redberry sample, followed by red plum (big) (13352 mg/kg), strawberry (13287 mg/kg), blackberry (12896 mg/kg), yellow grape (12215 mg/kg), yellow plum H1 (12438 mg/kg), yellow plum H2 (12124 mg/kg), black grape (big) (11472 mg/kg), black grape (small) (11692 mg/kg), red plum (small) (10743 mg/kg) and

TABLE 1: *Macro element contents of fruits (mg/kg, dry matter).*

Samples	Ca	K	Mg	P	S
Apple H1	0 ± 0*	7113 ± 457	346 ± 26	646 ± 37	431 ± 45
President	38 ± 2	8783 ± 290	438 ± 20	1376 ± 162	535 ± 37
Apple H2	16 ± 2	9517 ± 637	420 ± 4	743 ± 35	407 ± 25
Pear (yellow)	425 ± 7	6066 ± 490	517 ± 25	368 ± 33	318 ± 5
Pear (green)	445 ± 34	8920 ± 575	632 ± 42	1217 ± 141	541 ± 16
Blackberry	1133 ± 76	12896 ± 701	1758 ± 32	2675 ± 127	1338 ± 92
Blackgrape (small)	1901 ± 36	11692 ± 592	927 ± 62	1693 ± 135	739 ± 24
Yellow grape	1649 ± 224	12215 ± 497	1129 ± 163	1545 ± 18	658 ± 5
Pear (red)	736 ± 69	3954 ± 291	965 ± 62	767 ± 47	475 ± 41
Black grape (big)	954 ± 46	11472 ± 673	837 ± 66	1462 ± 14	469 ± 1
Grape (red)	274 ± 21	10572 ± 469	612 ± 14	1345 ± 41	362 ± 6
Redberry	857 ± 32	19141 ± 751	990 ± 73	3422 ± 202	1555 ± 208
Strawberry	809 ± 16	13287 ± 730	1064 ± 100	1854 ± 182	725 ± 20
Black plum(long)	207 ± 26	9932 ± 168	592 ± 35	1078 ± 70	287 ± 13
Yellow plum H1	558 ± 50	12438 ± 423	611 ± 29	1243 ± 66	386 ± 49
Yellow plum H2	570 ± 56	12124 ± 196	512 ± 21	1154 ± 100	377 ± 3
Blackplum (small)	548 ± 19	9815 ± 190	845 ± 42	904 ± 52	267 ± 16
Redplum (small)	552 ± 49	10743 ± 293	658 ± 2	1268 ± 48	391 ± 14
Redplum (big)	170 ± 23	13352 ± 320	694 ± 19	1393 ± 22	334 ± 6
Wild apple	414 ± 7	7279 ± 600	352 ± 15	394 ± 59	338 ± 46
Red apple Hybrid	0 ± 0	3714 ± 40	244 ± 24	421 ± 18	316 ± 12

*mean ± standard deviation

grape (red) (10572 mg/kg). P contents of fruits changed between 394 mg/kg wild apple) and 3422 mg/kg (redberry).

The micro element contents of fruits are summarized in Table 2. Micro element contents of fruits showed differences depending on fruit species. Cr, Mo, Ni and Pb concentrations of fruits were found very low. Generally, while Cu contents of fruits change between 1.6 mg/kg (red hybrit apple) and 8 mg/kg (red berry), Fe contents ranged from 12.5 mg/kg (yellow pear) to 51.4 mg/kg (black berry). In addition, Mn contents were found between 1.5 mg/kg (Apple H2) and 17.2 mg/kg (Blackberry).

Ferreira et al (2005) reported that Argentienan apple and Avacado contained 0.02 mg/100g and 0.20 mg/100 g Cu, respectively. Leterme et al. (2006) established between 36.0 to 1782 mg K/100 g edible portion; 280.0 to 1242 mg Ca /100 g; 0.7 to 8.4 mg Fe / 100 g in apple. In addition, mineral composition of different pear cultivars ranged between 2.5 and 19.5 mg Na /100 g; 897 and 1688 mg K /100 g; 11.5 and 46.5 mg Ca/100 g; 35.5 and 117.0 mg Mg/100 g of fresh pears (Guil et al. 1998). Also, mineral composition of different pear cultivars ranged between 2.5 to 19.5 mg/100 gNa, 897 to 1688 mg/100 g K, 11.5 to 46.5 mg/100 g Ca and 35.5 mg/100 g to 117 mg/100 g Mg. As a result, different fruit species had different macro and micro nutrients. These differences of the element contents of fruit cultivars may be due to growth conditions, varieties, genetic factors, harvesting time, soil properties, geographical variations (Chen et al., 2007; Özcan et al., 2008).

Discussion

From these results it can be concluded that the mineral contents of fruits are affected by the processing conditions, the varieties, species and analytical conditions. This is an important result as human health is directly affected by ingestion of fruit and vegetables; the biomonitoring of trace elements in fleshy fruits needs to be continued because these are the main sources of food for humans in many parts of the world (Elbagermi et al. 2012). To have higher content of macro elements of fruits is very useful due to human nutrition. It appears that fruits could serve as good source of some nutrients.

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Conflict of interest

No conflict of interest amoung authors.

TABLE 2: *Micro element and heavy metal contents of fruits (mg/ kg, dry matter).*

Samples	B	Cr	Cu	Fe	Mn	Mo	Ni	Pb	Zn
Apple H1	9.5 ± 0.5*	0.025 ± 0.002	4.0 ± 0.1	18.4 ± 1.6	2.2 ± 0.2	0.208 ± 0.032	0.382 ± 0.024	0.198 ± 0.020	0.40 ± 0.03
President	25.9 ± 1.5	0.032 ± 0.003	5.3 ± 0.5	20.5 ± 0.8	1.4 ± 0.1	0.375 ± 0.002	0.245 ± 0.048	0.142 ± 0.014	1.24 ± 0.21
Apple H2	7.2 ± 0.6	0.032 ± 0.002	3.3 ± 0.4	13.2 ± 2.2	1.5 ± 0.0	0.171 ± 0.013	0.250 ± 0.038	0.117 ± 0.013	0.69 ± 0.03
Pear (yellow)	8.3 ± 0.8	0.102 ± 0.010	2.6 ± 0.0	12.5 ± 0.4	3.3 ± 0.2	0.165 ± 0.028	0.487 ± 0.066	0.128 ± 0.018	0.98 ± 0.00
Pear (green)	13.4 ± 0.4	0.068 ± 0.005	9.7 ± 1.1	14.3 ± 0.4	2.5 ± 0.1	0.424 ± 0.017	0.543 ± 0.020	0.210 ± 0.016	4.49 ± 0.16
Blackberry	7.7 ± 1.5	0.048 ± 0.012	6.0 ± 0.3	51.4 ± 0.0	17.2 ± 1.2	0.285 ± 0.040	0.702 ± 0.020	0.018 ± 0.002	5.81 ± 0.22
Blackgrape(small)	23.2 ± 2.2	0.010 ± 0.001	6.9 ± 0.3	21.0 ± 1.5	7.6 ± 1.0	0.295 ± 0.010	0.399 ± 0.085	0.162 ± 0.009	5.23 ± 0.17
Yellow grape	21.0 ± 0.7	0.028 ± 0.004	5.7 ± 0.1	17.5 ± 0.4	5.3 ± 0.4	0.163 ± 0.006	0.801 ± 0.132	0.000 ± 0.000	3.67 ± 0.21
Pear (red)	9.5 ± 0.1	0.057 ± 0.009	5.7 ± 0.1	20.4 ± 1.3	7.6 ± 0.2	0.229 ± 0.038	0.576 ± 0.115	0.222 ± 0.024	3.20 ± 0.22
Black grape (big)	16.7 ± 1.3	0.019 ± 0.008	6.6 ± 0.4	18.3 ± 0.2	7.4 ± 0.3	0.233 ± 0.004	0.233 ± 0.050	0.114 ± 0.014	2.58 ± 0.17
Grape (red)	13.7 ± 1.1	0.113 ± 0.015	4.8 ± 0.2	13.9 ± 1.5	2.1 ± 0.1	0.101 ± 0.004	0.111 ± 0.017	0.229 ± 0.035	1.39 ± 0.09
Redberry	13.6 ± 0.8	0.055 ± 0.015	8.0 ± 0.3	49.1 ± 2.5	6.6 ± 0.5	0.603 ± 0.011	0.478 ± 0.121	0.000 ± 0.000	6.91 ± 0.71
Strawberry	12.5 ± 0.1	0.016 ± 0.006	5.3 ± 0.2	35.3 ± 2.2	9.6 ± 0.4	0.384 ± 0.074	0.387 ± 0.105	0.000 ± 0.000	4.47 ± 0.25
Black plum(long)	15.4 ± 1.6	0.032 ± 0.005	5.4 ± 0.6	16.6 ± 1.0	4.2 ± 0.2	0.120 ± 0.002	0.243 ± 0.053	0.125 ± 0.011	1.84 ± 0.22
Yellow plum H1	12.1 ± 0.0	0.019 ± 0.004	4.8 ± 0.4	16.5 ± 2.8	3.0 ± 0.2	0.405 ± 0.002	0.453 ± 0.100	0.000 ± 0.000	3.64 ± 0.37
Yellow plum H2	9.1 ± 0.4	0.050 ± 0.002	5.3 ± 0.6	15.7 ± 1.2	3.5 ± 0.0	0.235 ± 0.058	0.223 ± 0.028	0.172 ± 0.026	2.71 ± 0.26
Blackplum (small)	15.6 ± 0.3	0.236 ± 0.029	4.2 ± 0.2	15.4 ± 1.8	4.7 ± 0.1	0.243 ± 0.011	0.165 ± 0.027	0.058 ± 0.011	3.56 ± 0.44
Redplum(small)	20.6 ± 0.6	0.028 ± 0.003	6.2 ± 0.4	17.9 ± 0.8	4.8 ± 0.1	0.289 ± 0.028	0.275 ± 0.022	0.000 ± 0.000	3.76 ± 0.64
Redplum(big)	23.9 ± 1.0	0.086 ± 0.005	5.8 ± 0.3	14.8 ± 1.1	5.8 ± 0.2	0.150 ± 0.023	0.310 ± 0.059	0.000 ± 0.000	2.26 ± 0.08
Wild apple	13.4 ± 1.6	0.083 ± 0.001	2.8 ± 0.3	18.9 ± 2.2	2.8 ± 0.5	0.174 ± 0.009	0.315 ± 0.029	0.066 ± 0.011	0.92 ± 0.16
Red apple Hybrid	10.4 ± 0.9	0.073 ± 0.004	1.6 ± 0.1	16.3 ± 2.0	1.8 ± 0.1	0.100 ± 0.017	0.551 ± 0.091	0.000 ± 0.000	0.49 ± 0.05

*mean ± standard deviation

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