Na, K, Ca, Mg, Fe, Zn, Cu and Se contents in fruits consumed in Brazil

Teores de Na, K, Mg, Ca, Fe, Zn, Cu e Se em frutas consumidas no Brasil

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Agradecimentos:
FAPERJ - Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro. Universidade Estadual do Norte Fluminense (UENF).

ABSTRACT

QUEIROZ, V. A. V.; FERREIRA, K. S.; MONNERAT, P. H.; QUEIROZ, L. R.; DOLINSKI, C. Na, K, Ca, Mg, Fe, Zn, Cu and Se contents in fruits consumed in Brazil. *Nutrire:* rev. Soc. Bras. Alim. Nutr.= J. Brazilian Soc. Food Nutr., São Paulo, SP, v. 31, n. 2, p. 61-73, ago. 2006.

Twenty-nine fruits commonly consumed in Brazil were analyzed for mineral composition. Na and K levels were determined by flame photometric procedure and Ca, Mg, Fe, Zn, Cu and Se levels by atomic absorption spectrometry, with organic matter wet oxidation. The results were compared with data from Mexican, American and Brazilian food chemical composition tables. Each fruit was classified as a source of Ca, Mg, Fe, Zn, Cu and Se or not a source of such elements, according to the DRI (Dietary Reference Intakes) and also as a source of Na and K or not a source of such elements according to the RDA (Recommended Dietary Allowance). In general, the mineral levels were lower than those presented in the Brazilian table and there were small differences between the data obtained in this study and the values reported in the literature.

Keywords: Fruit. Minerals. Spectrophotometry, Atomic. Flame photometric.

RESUMEN

Fue determinado el contenido de diversos minerales en veintinueve (29) muestras de frutas de consumo habitual en Brasil. Na y K fueron determinados a través de fotometría de llama y las concentraciones de Ca, Mg, Fe, Zn, Cu y Se utilizando espectrometría de absorción atómica. Los resultados fueron comparados con los valores de tablas de composición química de alimentos de México, Estados Unidos (EUA) y de Brasil. Las frutas fueron clasificadas como siendo o no fuente de Ca, Mg, Fe Zn, Cu y Se de acuerdo con la DRI (Dietary Referente Intakes) y de Na y K a través de la RDA (Recommended Dietary Allowance). En general los niveles de minerales fueron menores que los presentados en la tabla brasilera y se encontraron pequeñas diferencias entre los datos obtenidos en este estudio y los valores citados en la literatura.

Palabras clave: Frutas. Minerales. Espectrofotometría atomíca. Fotometría de llama.

RESUMO

Foi analisada a composição mineral de vinte e nove frutas comumente consumidas no Brasil. A oxidação da matéria orgânica foi realizada via úmida. Os teores de sódio e potássio foram determinados por fotometria de chama e os teores de Ca, Mg, Fe, Zn, Cu e Se por espectrometria de absorção atômica. Os resultados foram comparados com tabelas de composição química de alimentos do México, dos Estados Unidos (EUA) e do Brasil. As frutas foram classificadas como sendo ou não fontes de Ca, Mg, Fe, Zn, Cu e Se de acordo com a DRI (Dietary Reference Intakes) e de Na e K pela RDA (Recommended Dietary Allowance). Os teores minerais foram, em geral, menores que os apresentados pela tabela brasileira e foram encontradas pequenas diferenças entre os dados obtidos no estudo e os valores citados na literatura.

Palavras-chave: Frutas. Minerais. Espectrofotometria atômica. Fotometria de chama.

INTRODUCTION

Brazil is the third producer of fruit in the world, with an approximate production of 40 millions tons of fruits, leading over countries such as the USA, Italy and Spain, being behind China and India. In spite of the great fruit production in Brazil, the intake "per capita" is at the tenth place, totalizing 57.0kg/year (INSTITUTO BRASILEIRO DE FRUTAS, 2004). On the other hand, there is a tendency for changing this scenario. An increase in fruit and vegetable consumption is recently taking place, and this fact is being associated to the reduced risk of contracting illnesses, such as cardiovascular diseases, cancer and Alzheimer. Fruits are considered sources of vitamins A and C, plus minerals, fibers, and several phytochemicals, such as carotenoids, flavonoids, glucosynolates, indoles, isothyocyanates, d-limonene, among others. These compounds considerably in their chemical structures and functions, and they may have chemo-protective properties that can possess physiological effects on human health (KRIS-ETHERTON et al., 2002; O'PREY et al., 2003; POOL-ZOBEL et al., 1997; REDDY; ODHAV; BHOOLA, 2003; STINTZING; CARLE, 2004; ZIEGLER et al., 1996). Moreover, evidence shows that the low consumption of sodium and the high consumption of potassium, magnesium, calcium and fibers present in fruits and greeneries is an effective step to fight plurimetabolic syndrome, which is characterized by hypertension, hypercholesterolemy, obesity and resistance to insulin (KOTCHEN; MC CARRON, 1998; VASKONEN, 2003).

Due to different environmental conditions and methods of cultivation, mineral content may vary among different fruits (HARDISSON et al., 2001; SANCHEZ-CASTILLO et al., 1998; TAHVONEN, 1993). There are also a great variety of fruits in the market with unknown chemical composition.

The fruits' composition tables used in Brazil are based on data from foreigner tables and most of the time, they do not reflect the Brazilian reality of nutritional composition in fruit species and varieties produced and consumed here. Moreover, data on Zn, Cu, and Se concentration is unknown in tables used in Brazil (FRANCO, 2001; INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 1981).

Information about the nutrient and non-nutrient composition of different types of food is of major importance for several purposes, including the evaluation of nutrient ingestion, evaluation of the population requirements on nutritional and non-nutritional components, meal planning, therapeutic diet calculation, to mention but a few.

Studies on the composition of fruits produced and consumed in different areas are necessary (HARDISSON et al., 2001). Thus, this work had the main purpose to quantify the contents of Na, K, Ca, Mg, Fe, Zn, Cu and Se in the main fruits consumed in Brazil, in addition to classify the fruits as source, or not, of those minerals in relation to the DRI (Dietary Reference Intakes) or RDA (Recommended Dietary Allowance), and to compare the results with data from literature, as such as a table of food chemical composition, quite used in Brazil, yet containing data compiled from foreign tables (FRANCO, 2001).

MATERIAL AND METHODS

SAMPLES

Ripe fresh fruit samples, ready for consumption, were acquired in the retail trade market in the city of Campos dos Goytacazes – RJ, Brazil. The fruit samples came from the main Brazilian producing regions, thus representing the reality of what is offered in terms of fruits to the Brazilian population.

Twenty-nine types of fresh fruits most consumed in Brazil were analyzed: banana (Prata, Maçã, Nanica and Terra varieties), papaya (Formosa and Golden varieties), orange (Lima, Pêra and Bahia varieties), apple with and without peel (Gala, Fuji, Argentina and Verde varieties), mango (Espada, Tommy and Hadden varieties), pineapple (Pérola), avocado, watermelon, melon (yellow), red guava (Paluma), persimmon (Rama-forte), tangerine (Ponkan), pear (D'Anju) and grape (Benitaka, Itália, Red Globe, Niagara and Rubi varieties) in the period of March to November, 2003.

Six samples of each fruit variety were collected from March to August, 2003. The fruits were collected from different sites and days with the objective of increasing the sample variability. One unit of a median size fruit (for grapes, it was considered one medium bunch) was considered one sample.

SAMPLE PREPARATION

Immediately after the purchase, the fruits were washed in deionized water in order to remove sand particles, fertilizer and chemical residues, and prepared for tests as shown in table 1.

The fruit samples were, then, triturated and homogenized in a commercial processor and weighed in three different Erlenmeyers. For avocado, banana, persimmon, guava, apple, papaya and mango it was weighed 5g, and for pineapple, orange, watermelon, melon, pear, grape and tangerine, 10g. After weighing, the bottles were immediately transferred to a stove with forced air circulation (TECNAL, model TE-038) for drying, at 60°C. After 48 hours, the bottles were again weighed and the humidity content was calculated by gravimetric method.

The organic matter oxidation of the samples was performed by humid means, according to a modified method from AOAC (CUNNIFF, 1998). Ten milliliters of concentrated nitric acid and 1mL of perchloric acid were added to the samples. The bottles were then heated and placed in an exhauster at 70°C for nearly two hours. After that, 10mL of concentrated nitric acid were added and the temperature was elevated slowly until reached 180°C, keeping this temperature for several hours until there was a volume left of about 1mL. The bottles were then cooled and 5mL of 30% hydrogen peroxide were added. One more time, they were kept at 70°C for four hours, until the volume returned to approximately 1mL. One milliliter of concentrated chloridric acid was added (for selenium analysis) and the bottles were maintained at 70°C for one hour. The organic matter digestion was considered complete when the solution was crystalline, transparent and exhaling white steams. When that occurred, the solutions were completed with deionized water up to 25mL. One blank was made for each digested sample battery and all the readings in the spectrophotometer were corrected with these blanks.

Table 1 - Scientific names and fruit preparation

Fruit	Scientific name	Preparation
Avocado	*Persea americana* Mill	Without peel, without seeds
Pineapple	*Ananas comosus* L.	Without peel, without peduncle
Banana	*Musa paradisíaca* L.	Without peel
Persimmon	*Diospyrus kaki* L.	With peel, without seeds
Guava	*Psidium guajava* L.	With peel, with seeds
Orange	*Citrus sinensis osbeck*	Without peel, seeds and pulp
Apple	*Malus spp.*	With and without peel and without seeds
Papaya	*Carica papaya* L.	Without peel, without seeds
Mango	*Mangifera indica* L.	Without peel, without seed
Watermelon	*Citrullus lanatus*	Without peel, without seeds (only the red pulp)
Melon	*Cucumis melo* L.	Without peel, without seeds
Pear	*Pyrus communis* L.	With peel, without seeds
Tangerine	*Citrus reticulata*	Without peel, without seeds
Grape (Rubi, Itália, Red Globe and Benitaka)	*Vitis vinífera*	With peel, without seeds
Niagara Grape	*Vitis labrusca*	Without peel, without seeds

MINERAL RECOVERY RATE: EFFICACY TEST

With the objective of evaluating the efficacy method for mineral content determination, recovery tests using previously studied minerals were performed according to procedures described in the literature (MATEJOVIC; DURACKOVA, 1994; NOVOZAMSKY; VAN DER LEE; HOUBA, 1995).

Three units of "Pêra" orange and "Nanica" banana were taken for organic matter oxidation by humid means, with increasing additions of known concentrations of each studied mineral (Na, K, Ca, Mg, Fe, Zn, Cu and Se) starting from level zero.

Mineral content analysis

Na, Fe, Zn, Cu and Se determination were performed directly in the solution after digestion. For Ca, Mg and K, a second dilution was made at 1:20 ratio in strontium chloride solution ($SrCl_2$) 4g.dm^{-3}.

The contents of Na and K were analyzed using a flame photometer (ANALYSER, model 910M) and the minerals Ca, Fe, Mg, Zn, Cu and Se were analyzed using an atomic absorption spectrophotometer (SHIMADZU, model AA-6200) according to procedures described by AOAC (CUNNIFF, 1998).

A hydrate generator, model GBC HG 3000, was coupled to the atomic absorption spectrophotometer for Se determination. To check the hydrate formation, it was used a $NaBH_4$ solution (3g of $NaBH_4$ and NaOH 3g diluted in 500mL of deionized water) and HCl (3M), both filtered and prepared at the moment of analysis.

The instrumental conditions of analysis are synthesized in table 2.

Table 2 - Analysis conditions in the atomic absorption spectrophotometer

Element	Wavelength (nm)	Lamp current (mA)	Slit	Gas flow (L/min) Acetylene	Air
Ca	422.7	10	0.7	2.0	8
Cu	324.8	6	0.7	1.8	8
Fe	248.3	12	0.2	2.2	8
Mg	285.2	8	0.7	1.8	8
Zn	213.9	8	0.7	2.0	8
Se	196.0	10	1.0	2.0	6

For each mineral determination, calibration curves were prepared from stock standard solutions with concentration of 1g.dm^{-3}. The zero point of the calibration curve was prepared with the same reagents and procedures used in the samples' digestion. All the reagents used were P.A. (pro-analysis). Also, all the glassware used were left soaked in HCl (2N) solution overnight and washed in deionized water prior to use.

RESULTS

In this study, the mineral content of different fruits consumed in Brazil was analyzed. Values found for K contents were the highest, varying in average from 92 to 335mg/100g of comestible part, and the Se contents were the lowest, varying from 0.51 to 1.49μg/100g. Sodium values ranged from 0.0 to 17.0mg/100g; Ca from 1.3 to 25.7mg/100g; Mg from 1.9 to 29.4 mg/100g; Fe from 0.11 to 0.53mg/100g; Zn from 0.03 to 0.34mg/100g and Cu from 0.05 to 0.23mg/100g of comestible part (Table 3).

Table 3 - Fruit mineral contents in 100g of comestible portion (humid weight) ***(continue)***

Fruits		Humidity (%)	Na (mg)	K (mg)	Ca (mg)	Mg (mg)	Fe (mg)	Zn (mg)	Cu (mg)	Se (µg)
Avocado	**(1)**	**78.3 ± 3.3**	**1.0 ± 0.7**	**230 ± 90**	**9.3 ± 2.3**	**20.1± 3.9**	**0.53 ± 0.22**	**0.34 ± 0.04**	**0.15 ± 0.10**	**0.51± 0.1**
	(2)	73.7-81.5	0.4 -2.1	163-395	7.5-12.5	15.4-25.3	0.26-0.94	0.29-0.40	0.07-0.31	0.41-0.62
Pineapple (Pérola)	**(1)**	**86.2 ± 0.9**	**0.3 ± 0.3**	**111 ± 14**	**22.7 ±9.3**	**14.1± 0.9**	**0.24 ± 0.06**	**0.14 ± 0.02**	**0.10 ± 0.04**	**
	(2)	85-87.4	0.0-0.8	99-134	9.6-31.5	12.5-15.4	0.17-0.34	0.11-0.16	0.06-0.17	**
Banana (Maçã)	**(1)**	**71.1 ± 0.5**	**0.7 ± 0.3**	**285 ± 30**	**5.3 ± 2.5**	**29.3 ± 7.2**	**0.25 ± 0.08**	**0.18 ± 0.02**	**0.14 ± 0.04**	**1.23 ± 0.7**
	(2)	70.6-72.1	0.3 -1.1	238-323	2.1-8.5	18.2-37.1	0.17-0.36	0.15-0.21	0.11-0.19	0.51-2.07
Banana (Prata)	**(1)**	**71.5 ± 0.9**	**0.2 ± 0.2**	**304 ± 7**	**6.3 ± 0.7**	**29.4 ± 1.7**	**0.37 ± 0.08**	**0.18 ± 0.02**	**0.14 ± 0.01**	**
	(2)	70.1-72.6	0.0-0.4	299-316	5.4-7.2	26.7-31.0	0.30-0.48	0.15-0.20	0.12-0.16	**
Banana (Nanica)	**(1)**	**76.0 ± 1.9**	**0.1 ± 0.1**	**305 ± 28**	**5.4 ± 2.0**	**29.3 ± 1.3**	**0.39 ± 0.06**	**0.22 ± 0.03**	**0.21 ± 0.03**	**1.24***
	(2)	72.7-77.7	0.0-0.3	275-356	2.8-7.3	28.1-31.3	0.30-0.48	0.16-0.26	0.17-0.26	**
Banana (Terra)	**(1)**	**64.2 ± 4.3**	**0.0**	**331 ± 3**	**1.3 ± 0.8**	**25.2 ± 5.9**	**0.32 ± 0.06**	**0.17± 0.04**	**0.12 ± 0.04**	**
	(2)	58.0-67.8	0.0	329-335	0.3-2.7	19.4-32.7	0.26-0.41	0.14-0.25	0.09-0.19	**
Persimmon	**(1)**	**80.0 ± 1.5**	**0.2 ± 0.1**	**176 ± 10**	**9.8 ± 1.6**	**7.6 ± 0.8**	**0.20 ± 0.01**	**0.07± 0.02**	**0.05 ± 0.02**	**
(Rama Forte)	(2)	78.2-81.8	0.0-0.3	164-187	7.6-12.0	6.9-9.3	0.19-0.21	0.04-0.08	0.03-0.07	**
Red guava (Paluma)	**(1)**	**84.7 ± 1.4**	**1.3 ± 1.8**	**230 ± 42**	**6.7 ± 2.6**	**9.2 ± 1.8**	**0.35 ± 0.12**	**0.21± 0.04**	**0.13 ± 0.03**	**1.15 ± 0.45**
	(2)	82.4-86.1	0.4-5.0	176-280	3.9-10.8	7.3-11.4	0.18-0.48	0.16-0.24	0.09-0.17	0.27-3.33
Orange (Lima)	**(1)**	**89.5 ± 0.8**	**0.2 ± 0.1**	**148 ± 15**	**25.7 ± 6.1**	**11.1 ± 0.59**	**0.11 ± 0.02**	**0.09 ± 0.01**	**0.11 ± 0.05**	**
	(2)	88.4- 90.5	0.1-0.4	135-167	13.8-30.5	10.3-11.7	0.09-0.15	0.08-0.10	0.06-0.20	**
Orange (Bahia)	**(1)**	**89.7 ± 1.3**	**0.3 ± 0.0**	**143 ±18**	**24.9 ± 8.5**	**9.5 ± 1.5**	**0.14 ± 0.02**	**0.09 ± 0.01**	**0.06 ± 0.01**	**
	(2)	87.6-91.2	0.2-0.3	125-171	17.8-38.3	7.6-11.2	0.10-0.17	0.07-0.10	0.05-0.07	**

(1) Average of 6 samples (in triplicate) ± standard deviation.
(2) Range of variation among samples.
* The presence of Se was detected in only one sample.
**Concentrations lower than 0.5 ìg/100g: below the spectrophotometric detection limit.

Table 3 - Fruit mineral contents in 100g of comestible portion (humid weight) ***(continuation)***

Fruits		Humidity (%)	Na (mg)	K (mg)	Ca (mg)	Mg (mg)	Fe (mg)	Zn (mg)	Cu (mg)	Se (μg)
Orange (Pêra)	**(1)**	**88.8 ± 1.2**	**0.1 ± 0.2**	**138 ± 6**	**20.2 ± 9.6**	**9.5 ± 1.9**	**0.11 ± 0.03**	**0.08 ± 0.02**	**0.10 ± 0.01**	**
	(2)	87.3-90.2	0.1-0.6	129-144	6.3-33.7	6.9-11.5	0.07-0.12	0.06-0.11	0.08-0.11	**
Papaya (Formosa)	**(1)**	**86.9 ± 0.5**	**2.4 ± 0.5**	**170 ± 9**	**10.4 ± 3.0**	**10.9 ± 3.6**	**0.16 ± 0.02**	**0.09 ± 0.02**	**0.05 ± 0.01**	**0.99 ± 0.70**
	(2)	86.6-87.9	1.8-2.8	157-183	6.2-14.3	6.7-15.2	0.14-0.20	0.07-0.12	0.05-0.06	0.29-1.68
Papaya (Golden)	**(1)**	**86.6 ± 0.7**	**3.2 ± 0.7**	**188 ± 10**	**14.0 ± 3.2**	**10.5 ± 1.4**	**0.22 ± 0.04**	**0.08 ± 0.01**	**0.07 ± 0.01**	**1.49 ± 0.72**
	(2)	85.7-87.8	2.2-3.9	171-196	10.0-19.3	8.4-12.8	0.17-0.26	0.07-0.09	0.07-0.08	0.40-2.21
Apple (Argentina with peel)	**(1)**	**84.2 ± 1.8**	**0.3 ± 0.1**	**104 ± 21**	**5.0 ± 1.5**	**3.5 ± 1.0**	**0.15 ± 0.05**	**0.04 ± 0.02**	**0.07 ± 0.02**	**0.72 ± 0.19**
	(2)	81.8-86.8	0.1-0.4	88-144	2.7-6.5	2.3-5.1	0.12-0.24	0.02-0.07	0.05-0.11	0.59-0.85
Apple (Argentina without peel)	**(1)**	**85.1 ± 1.9**	**0.2 ± 0.2**	**108 ± 23**	**2.9 ± 0.9**	**2.2 ± 0.7**	**0.24 ± 0.12**	**0.03 ± 0.01**	**0.08 ± 0.01**	**
	(2)	82.7-87.2	0.0-0.6	85-142	2.1-4.4	1.6-3.5	0.10-0.24	0.05-0.01	0.06-0.10	**
Apple (Gala with peel)	**(1)**	**85.8 ± 0.5**	**0.6 ± 0.5**	**104 ± 12**	**4.6 ± 1.3**	**3.6 ± 1.1**	**0.20 ± 0.01**	**0.08 ± 0.03**	**0.07 ± 0.01**	**0.69***
	(2)	85.3-86.6	0-1.1	94-127	2.9-6.5	1.9-4.4	0.19-0.21	0.04-0.11	0.05-0.09	**
Apple (Gala without peel)	**(1)**	**86.7 ± 0.5**	**0.5 ± 0.5**	**102 ± 18**	**2.6 ± 0.6**	**2.1 ± 0.6**	**0.17 ± 0.02**	**0.06 ± 0.01**	**0.09 ± 0.02**	**0.72 ± 0.27**
	(2)	86.2-87.3	0.0-1.2	88-134	2.0-3.5	1.2-2.8	0.14-0.21	0.05-0.08	0.05-0.11	0.42-0.93
Apple (Green with peel)	**(1)**	**85.1 ± 1.7**	**0.8 ± 0.7**	**113 ± 10**	**4.1 ± 1.1**	**3.7 ± 0.6**	**0.20 ± 0.06**	**0.04 ± 0.01**	**0.09 ± 0.05**	**
	(2)	82.9-86.7	0-1.9	100-122	5.8-2.6	4.5-2.7	0.25-0.10	0.05-0.02	0.15-0.03	**
Apple (Green without peel)	**(1)**	**85.8 ± 1.8**	**0.6 ± 0.6**	**102 ± 6**	**2.8 ± 0.6**	**2.4 ± 0.6**	**0.14± 0.02**	**0.03 ± 0.01**	**0.09 ± 0.03**	**
	(2)	83.5-87.4	0.0-1.8	92-109	2.0-3.7	1.3-3.1	0.12-0.19	0.01-0.05	0.05-0.14	**
Mango (Espada)	**(1)**	**81.2 ± 2.9**	**0.3 ± 0.3**	**172 ± 17**	**6.3 ± 2.6**	**13.3 ± 1.6**	**0.16 ± 0.04**	**0.10 ± 0.02**	**0.14 ± 0.04**	**0.98 ± 0.13**
	(2)	77.5-85.4	0.0-0.5	161-197	3.0-9.6	11.5-15.1	0.12-0.22	0.07-0.12	0.07-0.2	0.85-1.1
Mango (Haden)	**(1)**	**87.6 ± 1.0**	**0.0 ± 0.0**	**162 ± 28**	**7.8 ± 2.6**	**7.6 ± 1.6**	**0.30 ± 0.03**	**0.13 ± 0.07**	**0.19 ± 0.06**	**0.58 ± 0.24**
	(2)	86.9-88.3	0.0-0.1	143-182	6.0-9.7	6.4-8.7	0.28-0.32	0.08-0.18	0.16-0.23	0.41-0.75

Table 3 - Fruit mineral contents in 100g of comestible portion (humid weight) ***(conclusion)***

Fruits		Humidity (%)	Na (mg)	K (mg)	Ca (mg)	Mg (mg)	Fe (mg)	Zn (mg)	Cu (mg)	Se (µg)
Mango (Tommy)	**(1)**	**86.6 ± 3.5**	**0.2 ± 0.3**	**130 ± 33**	**6.6 ± 2.9**	**8.6 ± 3.3**	**0.16 ± 0.03**	**0.12 ± 0.03**	**0.16 ± 0.05**	**
	(2)	82.3-90.4	0.0-0.6	106-177	2.9-9.5	6.2-15.0	0.13-0.22	0.10-0.17	0.12-0.22	**
Melon (Yellow)	**(1)**	**92.0 ± 1.2**	**17 ± 9.7**	**189 ± 42**	**4.9 ± 1.4**	**6.1 ± 0.6**	**0.30 ± 0.09**	**0.13 ± 0.03**	**0.05 ± 0.02**	**
	(2)	90.2-93.7	2.9-25.8	139-242	3.1-6.5	5.1-7.0	0.16-0.40	0.09-0.17	0.03-0.09	**
Watermelon	**(1)**	**91.0 ± 0.7**	**0.5 ± 0.2**	**109 ± 13**	**10.0 ± 2.3**	**10.3 ± 1.4**	**0.23 ± 0.06**	**0.12 ± 0.01**	**0.08 ± 0.03**	**
	(2)	90.0-92.2	0.3-0.7	93-126	7.3-13.4	8.1-12.0	0.15-0.30	0.09-0.14	0.06-0.13	**
Pear (D'Anju)	**(1)**	**84.3 ± 1.2**	**3.2 ± 2.8**	**143 ± 15**	**10.7 ± 2.8**	**8.2 ± 1.5**	**0.20 ± 0.06**	**0.10 ± 0.03**	**0.20 ± 0.07**	**
	(2)	83.0-85.9	0.3-7.4	124-159	5.5-13.6	6.3-10.2	0.08-0.22	0.09-0.17	0.13-0.29	**
Tangerine (Ponkan)	**(1)**	**86.2 ± 2.4**	**0.3 ± 0.1**	**147 ± 26**	**15.1 ± 3.8**	**9.6 ± 1.6**	**0.15 ± 0.09**	**0.07 ± 0.02**	**0.09 ± 0.03**	**
	(2)	82.9-90.0	0.1-0.5	107-177	10.4-18.9	7.5-11.4	0.05-0.30	0.06-0.10	0.05-0.13	**
Grape (Benitaka)	**(1)**	**85.2 ± 0.6**	**0.4 ± 0.1**	**240 ± 40**	**4.4 ± 1.9**	**4.7 ± 1.2**	**0.29 ± 0.06**	**0.05 ± 0.00**	**0.16 ± 0.07**	**0.77± 0.02**
	(2)	84.5-85.5	0.2-0.5	193-266	2.3-5.8	3.3-5.4	0.22-0.33	0.04-0.05	0.09-0.23	0.76-0.79
Grape (Itália)	**(1)**	**85.2 ± 0.5**	**0.5 ± 0.1**	**226 ± 11**	**4.7 ± 1.2**	**5.1 ± 0.6**	**0.27 ± 0.06**	**0.05 ± 0.01**	**0.16 ± 0.08**	**
	(2)	84.1-85.6	0.4-0.7	216-235	3.6-5.9	4.2-5.8	0.22-0.36	0.03-0.06	0.06-0.24	**
Grape (Niagara)	**(1)**	**83.9 ± 1.8**	**0.3 ± 0.1**	**196 ± 47**	**5.8 ± 0.7**	**3.9 ± 0.7**	**0.26 ± 0.05**	**0.06 ± 0.02**	**0.17 ± 0.04**	**
	(2)	81.7-86.1	0.2-0.5	133-256	5.2-6.9	3.1-4.7	0.18-0.31	0.04-0.10	0.13-0.24	**
Grape (Red Globe)	**(1)**	**79.4 ± 1.1**	**3.0 ± 3.7**	**154 ± 21**	**4.8 ± 2.1**	**4.9 ± 1.6**	**0.32 ± 0.10**	**0.05 ± 0.01**	**0.10 ± 0.03**	**
	(2)	77.9-80.4	0.8-8.6	127-178	2.2-7.3	3.1-6.5	0.21-0.43	0.03-0.06	0.07-0.11	**
Grape (Rubi)	**(1)**	**83.3 ± 1.9**	**0.4 ± 0.4**	**166 ± 20**	**5.1 ± 1.9**	**4.8 ± 1.7**	**0.23 ± 0.08**	**0.06 ± 0.02**	**0.23 ± 0.10**	**
	(2)	80.8-85.9	0.0-1.2	145-191	3.7-8.6	3.2-7.7	0.12-0.31	0.03-0.08	0.10-0.38	**

MINERAL RECOVERY RATES

The recovery rates of known nutrients from "Pêra" orange and "Nanica" banana units, ranged from 90.6 to 95.3% for Na; 95.8 to 100.3% for K; 95.5 to 97.5% for Ca; 97 to 99.5% for Mg; 99.2 to 100.2% for Fe; 98.6 to 103.3% for Zn; 98.5 to 103% for Cu and 88.2 to 90.5% for Se.

MINERAL CONTENT ANALYSIS

The average concentrations, in 100g of comestible portion (humid weight) of Na, K, Ca, Mg, Fe, Zn, Cu and Se in different fruits analyzed, their respective standard deviations, and variation scope are in table 3. The average represents the amount of each mineral recovered from six samples analyzed in triplicate.

The mineral contents in Argentina, Gala, Green and Fuji apple varieties showed small differences among themselves. The mineral content in apples with peel tended to be higher, when compared to the apples without peel, but the mineral contents were very low in this fruit in both the cases, and the variation found among them had no nutritional importance.

The mineral contents of three orange varieties were similar. The same happened with Formosa and Golden papayas and with three varieties of mango analyzed.

There was a greater variation in K contents in the samples of Benitaka (240 ± 40mg/100g), Itália (226 ± 11mg/100g) and Niagara (196 ± 47mg/100g) grapes, in relation to Red Globe (154 ± 21mg/100g) and Rubi (166 ± 20mg/100g) grapes.

DISCUSSION

It is known that the mineral contents of foods are influenced by a series of factors, such as climatic conditions (including light, temperature and humidity), chemical composition of the soil, genetic differences, manure addition to the soil, so forth and so on (HARDISSON et al., 2001; TAHVONEN, 1993). These factors may have contributed to the variations found in the present study and the consulted references.

Comparison to Franco's table (2001) and Dietary Reference Intakes (DRI) or Recommended Dietary Allowance (RDA)

The minerals content found in the different fruit species studied were compared to the DRI of each mineral for a 19-50 year-old adult: 1000mg of Ca, 420mg of Mg, 8mg (for men) and 18mg (for women) of Fe, 11mg (for men) and 8mg (for woman) of Zn, 0.9mg of Cu and 55μg of Se (National Academies, 2004). For Na and K it was used the RDA value of 2000mg (NATIONAL RESEARCH COUNCIL, 1989). The fruits were classified according to the FDA (Food and Drug Administration) definition. "Excellent" and "good" nutrient sources are those fruits of which the ingested alimentary portions can supply at least 20% and 10-20% of the DRI, respectively (MILLER-IHLI, 1996).

Low Na concentrations (less than 2% of DRI) were detected in all analyzed fruit samples (Table 3). The fruit that presented the highest average of Na content was melon, with 17.0mg/100g; however, this amount was low, when compared to the DRI value. The Na concentrations were, in general, about five times smaller than those detected in similar fruits from the USA (MILLER-IHLI, 1996) and Mexico (SANCHES-CASTILLO et al., 1998). Franco's (2001) table shows Na contents even more elevated. For instance, in the case of "Maçã" banana, that table reports a mean value of Na more than 80 times higher (55mg/100g) than the one found in this study (0.7mg/100g).

High contents of K were found in most fruits (except for apples, watermelon and pineapple). The most elevated average contents of this nutrient were detected in all varieties of bananas (286 to 332mg/100g), reaching more than 20% the IDR. Therefore, they could be ranked as "excellent" sources of this nutrient in a portion of 150g. Moreover, in regards to expressive concentrations of K, "Benitaka" grape (240mg/100g) and "Itália" grape (226mg/100g), avocado (230mg/100g) and guava (230mg/100g) were considered "good" sources of this mineral with values ranging from 15 to 18% of IDR. Sanches-Castillo et al. (1998), in Mexico, have detected an average content of K quite higher in banana (637mg/100g) and avocado (308 to 391mg/100g); yet in the case of grapes, these authors found smaller concentrations (185mg/100g) than the ones found in the present study. The K reported in Franco's table (2001) are lower than the ones found in this study for guava, "Itália" grape, watermelon (twice as low) and tangerine (three times lower), also they are twice as much in "Espada" mango.

Due to the high K level in the majority of fruits analyzed, there should be an incentive for their consumption to prevent and treat high blood pressure. It has been shown continuously in clinic and epidemiological studies that the most important task of K is blood pressure regulation in healthy and in hypertense individuals (KOTCHEN; MCCARRON, 1998; VASKONEN, 2003).

Due to the low concentration of Cu in the IDR (0.9mg), almost all fruits have been considered sources of Cu, and avocado, guava and all varieties of bananas ("Prata, Maçã, Nanica and Terra") and mangoes ("Hade, Tommy and Espada") were considered "excellent" source of this mineral in 150g. The fruits with the highest and smallest average copper contents in the USA (MILLER-IHLI, 1996) and Mexico (SANCHES-CASTILLO et al., 1998) were the same found in this study. Moreover, avocado, was the fruit considered to have the highest average copper concentration in the USA and Mexico, showing 0.359mg/100g and 3.2mg/100g contents (10 times higher than in this study), respectively.

The highest contents of Mg were detected in bananas (25.2 to 29.4mg/100g) and avocado (20.1mg/100g). Data here shown matched those of Miller-Ihli (1996); however, Sanches-Castillo et al. (1998) found concentrations about twice as high for this mineral in banana (64mg/100g) and six-fold higher in mango (73mg/100g). Franco's table (2001) does not present the contents of Mg in mango, papaya and guava, however it does show concentrations twice as low of this mineral in oranges and about seven times higher for persimmon. In this study, only bananas could be classified as "good" sources of Mg, and they can contribute with approximately 10% of DRI in the 150g portion.

Low concentrations of calcium, iron, zinc and selenium were detected in all analyzed fruits. Therefore no fruit could be considered as a source of these minerals according to Miller-Ihli (1996). Sanches-Castillo et al. (1998) reported a quite elevated concentration of Fe in melon (1.3mg/100g) and double concentration of Zn in avocado than the present study. Franco's table (2001) presents twice as more elevated content of zinc in pineapple (0.25mg/100g) in comparison to this study, and it does not provide data about this mineral in persimmon, watermelon, guava, orange, papaya, melon and tangerine. Furthermore, his table displays calcium concentrations twice as high for papaya, apple, guava and "Prata" banana; three times higher for tangerine, "Espada" mango and melon and four, six and twenty times higher for bananas "Nanica", "Maçã" and "Terra", respectively, than this present study.

CONCLUSIONS

In general, the mineral contents detected in fruits analyzed in this work were similar to those reported for similar fruits analyzed in the USA and in Mexico, with some exceptions. Franco's table (2001), which is quite used in Brazil, shows mineral contents in fruits ranging from 2 to 80 times higher than those detected in this study. This fact confirms the necessity of elaborating tables with cultivated and consumed fruits in Brazil, and also to constantly update them.

Considering a 150g portion, avocado and all varieties of banana and mango presented Cu contents higher than 20% of IDR, which allows the ranking of these fruits as "excellent" sources of this mineral. The remaining fruits (except "Lima" orange, "Formosa" papaya, melon and persimmon) reached 10 to 20% of IDR, and they were ranked as "good" sources of Cu, whereas bananas (all varieties) were classified as "excellent" K sources and the other fruits as "good" sources of this nutrient (except for pineapple and watermelon). Only bananas reached at least 10% of IDR for Mg. Contents of Na, Ca, Fe, Zn and Se were lower than 10% of IDR, therefore they could not be considered a "good" alimentary sources of these elements.

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Recebido para publicação em 05/10/05.
Aprovado em 23/02/06.