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DETERMINING THE CONTENT OF SOME MINERALS IN FRUIT AND VEGETABLE BABY JUICES

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Abstract

Food is the main source of mineral elements but some are also provided with drinking water and supplements. Juices, for example, are an important source of mineral elements. In infants' diet minerals are provided mainly by fruit and vegetable purée juices. Infants and young children should be given juices labelled as "special purpose food". Pasteurised juices are recommended for infants, as they are free of bacteria and toxins, a condition that cannot be completely fulfilled while making juices at home.

The aim of the present work was to determine the content of some minerals in fruit and vegetable juices for infants and children under three years of age. The research material consisted of juices, all before their use-by date, purchased in grocer shops in Lublin in January 2006. In total 20 juices were examined, 8 of which were labelled as 'special purpose food', 2 were recommended by the National Food and Nutrition Institute and ten juices were labelled as 'food for young children'. Juices make an important source of minerals in the diet of infants and young children. The most valuable ones are the fruit and vegetable purée juices, as they provide significant amounts of dry mass which includes fibre, minerals and vitamins. Differences in the content of particular mineral elements in juices result primarily from their composition. Although juices for infants and young children should not contain any additives, products without certificates must be treated with caution as it cannot be excluded that some may contain prohibited compounds, e.g. calcium ascorbate or calcium chloride.

Keywords: mineral components, fruit and vegetable juices, children, infants.

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ZAWARTOŚĆ WYBRANYCH SKŁADNIKÓW MINERALNYCH W SOKACH WARZYWNO-OWOCOWYCH PRZEZNACZONYCH DLA NIEMOWLĄT I MAŁYCH DZIECI

Abstrakt

Źródłem poszczególnych pierwiastków jest głównie pożywienie, niektórych dostarczają woda pitna i suplementy. Ważnym źródłem składników mineralnych w diecie dziecka są soki. Niemowlęta i małe dzieci powinny otrzymywać soki oznaczone jako „żywność specjalnego przeznaczenia żywieniowego". Dla małych dzieci rekomendowane są soki pasteryzowane, ponieważ są one wolne od bakterii i toksyn, a tych warunków mogą nie spełniać soki wytwarzane w domu.

Celem pracy było określenie zawartości wybranych składników mineralnych w sokach warzywno-owocowych przeznaczonych dla niemowląt i dzieci do lat 3. Materiał do badań stanowiły soki zakupione w sklepach spożywczych na terenie Lublina w styczniu 2006 r., w okresie ich przydatności do spożycia. Osiem zakupionych soków miało adnotację, że jest to „środek specjalnego przeznaczenia żywieniowego", 2 były rekomendowane przez Instytut Żywności i Żywienia, natomiast 10 soków nie miało żadnych adnotacji o przeznaczeniu do żywienia niemowląt i małych dzieci. Soki są ważnym źródłem składników mineralnych w diecie niemowląt i małych dzieci. Najcenniejsze są soki przecierowe owocowo-warzywne, ponieważ dostarczają znacznych ilości suchej masy, w skład której wchodzą m.in. błonnik, składniki mineralne i witaminy. Różnice w zawartości poszczególnych składników mineralnych w sokach wynikają przede wszystkim z ich składu komponentowego. Soki dla niemowląt i małych dzieci nie powinny zawierać żadnych substancji dodatkowych, należy jednak traktować z rezerwą produkty bez atestów, nie można bowiem w nich wykluczyć obecności dodatków niedozwolonych, np. askorbianianu wapnia czy chlorku wapnia.

Słowa kluczowe: składniki mineralne, soki owocowo-warzywne, dzieci, niemowlęta.

INTRODUCTION

In the first year of life, the main type of nutrition for a baby is milk. A baby's body requires many nutrients in order to grow into a healthy child.

Determining the demand for mineral elements in infants is based on the knowledge of the composition of human breast milk, which is regarded as the best food in the first period of an infant's life. The concentration of minerals in woman's milk is low and the total content of ash amounts to $0.2\ g \cdot dl^{-1}$. The content of sodium, potassium and chlorine is threefold lower than in cow's milk (these are elements responsible for the osmotic pressure in the kidneys). Iron present in mother's milk is characterised by very high bioavailability, *ca* 50% (LYNCH, STOLTZFUS 2003). By comparison, bioavailability of iron from milk mixtures reaches about ca. 5%.

Food is the main source of particular chemical elements, but some are provided with drinking water and supplements. An infant immediately after birth lacks properly functioning regulatory mechanisms, while the absorption of minerals, including toxic elements, is more intensive than in older children and adults. Mineral elements are usually absorbed more effectively in the periods of intensive growth and pregnancy (DROBNIK, LATOUR 2006).

Juices are an important source of mineral elements. In infants' diet these elements are provided mainly by fruit and vegetable purée juices. Infants and young children should be given juices labelled as 'special purpose foods'. Making juices for infants at home is not recommended as it is impossible to pasteurize juice under such conditions and this means that some bacteria or toxins may contaminate juice. Pasteurization of fruit juices helps to eliminate bacteria occurring at levels which may cause food poisoning (GILLIAND et al. 2003). Juices that are 100% fruit juice will contain vitamin C, foliate, vitamin B6, iron, potassium and magnesium nutrients, which are essential in a baby's diet.

The aim of this study was to determine crude ash and mineral components (Ca, Mg, Na, K, Fe, Zn, Cu, Mn) in the fruit and vegetable juices for infants and children under three years of age.

MATERIAL AND METHODS

The experimental material included samples of fruit and vegetable juice for babies, all before their use-by date, purchased in Lublin shops in January 2006 (Table 1). In total 20 juices were examined, 8 recommended as 'special purpose food' (A-1, A-2, A-3, A-4, B-1, B-2, B-3, B-4), 2 recommended by the National Food and Nutrition Institute (F-1, F-2) and ten labelled as 'food for young children'. All the products were available in small bottles (175-330 ml) with brightly coloured labels. Most consumers are convinced that these juices are for infants and young children, although not all of them are classified as 'special purpose food'.

The content of dry mass and raw ash in the samples was determined with the AOAC methods (1990). The content of minerals (Ca, Mg, Na, K, Mn, Cu, Fe and Zn) was assayed by means of the AAS flame technique, using a Unicam 939 apparatus (AA Spectrometer Unicam). The determinations were carried out as follows: 10ml of 6N HCl was added to mineralised samples; next the solution was filtered into measuring flasks and filled up to 50 ml with distilled water.

All the analyses were made in three replications.

Table 1

Trade mark and ingrediends in analysed baby juices

Trade mark	Ingredients	Annotation
A-1	apple, carrot	*
A-2	apple, carrot, peach	*
A-3	apple, orange, carrot	*
A-4	apple, apricot, pumpkin	*
B-1	apple, banana, carrot	*
B-2	apple, pear, dog rose	*
B-3	apple, apricot, carrot	*
B-4	carrot, apple, pumpkin, grape	*
C	carrot, apple, strawberry	***
D-1	carrot, apple, banana	***
D-2	carrot, apple, raspberry	***
E	apple, carrot, lemon	***
F-1	carrot, pear, apple	**
F-2	multivitamin	**
G-1	carrot, apple, strawberry	***
G-2	carrot, apple, banana	***
H	carrot, apple, orange	***
I	apple, carrot, strawberry	***
J	carrot, banana	***
K	multivitamin	**

* foods for special purposes
** recommended by the Polish National Food and Nutrition Institute
*** no annotation

RESULTS AND DISCUSSION

Table 2 presents the content of dry mass, crude ash and minerals in the juices.

The content of dry mass was 7.35% to 14.40%. The highest content of dry matter was found in F-2, A-4 and F-1 juices. The lowest amount of dry mass was observed in the juice labelled as J. This value was significantly

Table 2

Dry matter (%), crude ash (%) and some minerals levels in the fruit-vegetable baby juices (n=3)

Trade mark	Dry matter (%)	Crude ash (%)	Macroelements ($mg \cdot g^{-1}$)				Microelements ($\mu g \cdot g^{-1}$)			
			Ca	Mg	Na	K	Fe	Zn	Cu	Mn
A-1	11.50	0.29	0.06	0.06	0.11	0.97	2.60	2.20	0.45	1.07
A-2	11.00	0.34	0.06	0.06	0.10	0.69	3.25	1.97	0.87	1.37
A-3	11.20	0.39	0.05	0.06	0.06	0.75	2.40	1.40	0.45	0.91
A-4	12.50	0.37	0.06	0.15	0.03	1.17	3.52	1.10	0.51	0.37
B-1	11.80	0.41	0.05	0.09	0.07	1.16	4.57	3.00	0.82	1.24
B-2	10.90	0.28	0.05	0.11	0.02	0.74	3.35	1.53	0.89	2.59
B-3	14.40	0.45	0.06	0.08	0.08	1.38	3.72	1.21	0.72	0.89
B-4	10.40	0.40	0.07	0.07	0.13	1.10	4.50	3.28	0.84	1.40
C	11.44	0.14	0.03	0.04	0.15	0.45	2.98	2.23	0.60	1.25
D-1	10.25	0.31	0.08	0.05	0.17	0.54	2.47	3.85	0.48	0.81
D-2	10.46	0.37	0.04	0.04	0.16	0.59	4.20	1.58	0.42	0.47
E	11.85	0.23	0.06	0.05	0.05	0.48	2.37	1.69	0.50	0.68
F-1	12.49	0.25	0.04	0.04	0.06	0.63	1.19	2.00	0.23	1.24
F-2	12.5	0.20	0.04	0.05	0.03	0.55	0.36	1.66	0.09	0.72
G-1	11.73	0.14	0.06	0.04	0.05	0.48	0.82	1.49	0.14	1.60
G-2	11.91	0.16	0.06	0.05	0.07	0.41	1.06	1.95	0.32	0.60
H	10.31	0.24	0.04	0.04	0.15	0.40	2.54	1.55	0.33	1.22
I	12.20	0.23	0.04	0.04	0.16	0.48	3.61	1.97	0.92	1.46
J	7.35	0.19	0.09	0.05	0.12	0.44	2.93	2.10	0.34	1.30
K	11.18	0.19	0.03	0.05	0.01	0.52	4.06	1.45	0.29	0.34

different from the remaining results. The juice contained carrots and bananas, which are characterised by a low content of water (KUNACHOWICZ et al. 1998). This, together with the low content of dry matter we determined proves that the juice was highly diluted, which is very bad because dry mass includes fibre, minerals and vitamins. In infants' diet these elements are provided mainly by fruit and vegetable purée juices. Juice J contained very little ash and few minerals in comparison with the other juices. It should be noticed that no information concerning any certificates could be found on the label of this juice.

The level of calcium in juices ranged from 0.025 $mg \cdot g^{-1}$ to 0.084 $mg \cdot g^{-1}$. The highest content of calcium was in juice J; its lowest amount occurred in juice C. The labels did not offer any information concerning the percentage of these two ingredients. The content of mineral elements in plants depends to a high degree on the soil's abundance, including the intensity of fertilisation (KRUCZEK 2005). Increased presence of calcium in juices may occur as a result of using acidity regulators during the production process, e.g. calcium ascorbate or calcium chloride. These substances are used to prevent enzymatic browning or to enrich the products in vitamin C, to prevent changes in the smell of juices and as antioxidants and acidity regulators (GUZ et al. 2007, MAO et al. 2007, ZHU et al. 2007). Although juices for infants and young children are not supposed to contain any such substances, products without any certificates should be treated with caution. Since the label on juice J does not give a detailed description of its composition, the presence of prohibited additives cannot be excluded. Some concern can arise because this juice is extremely popular among consumers, which was observed by the authors, and its chemical composition may suggest some harmful effect on very young organisms. Most probably its popularity results from its price. The lowest amount of calcium in juice C was probably caused by its composition. Carrots and apples contain relatively little calcium and, apart from these ingredients, only wild strawberry aroma was used for the production.

Calcium makes the major element of bones and teeth. It also participates in muscle contractions, conduction of nerve impulses and cell membrane permeability, blood coagulation. Moreover, calcium is a co-factor of numerous enzymes, e.g. those active in glycogenesis. Because of rapidly increasing mass of the body, including bones, a particularly high demand for calcium and phosphorus occurs between the ages of 1-3 and 10-15 years. The recommended calcium/phosphorus ratio in the diet of a child between 1 and 3 years of age should be 1 : 1 (2:1 would be ideal) (SZOTOWA et al. 1996). Calcium bioavailability with food is 25-50% and is depressed by aninutrient substances (oxalic acid, phytic acid) but raised by some amino acids, lactose and vitamin D (WAINE 2001, LYNCH, STOLTZFUS 2003). Protein has positive and negative effects on calcium balance. Dietary protein stimulates the production of insulin-like growth factor-1, a factor that promotes osteoblast-mediated bone formation. On the other hand, protein increases urinary calcium losses (KERSTETTER 2003). In children, pregnant women and during lactation the level of absorption rises (WAINE 2001). Shortage of calcium in children is manifested by rickets and inadequate growth.

The content of magnesium in juices ranged from 0.035 $mg \cdot g^{-1}$ to 0.145 $mg \cdot g^{-1}$. The highest level of magnesium was observed in juice A-4, which could result from its high content of pumpkin (20%) and low volume of water in the product. Pumpkin contains 14 mg of magnesium per 100 g of the raw product (KUNACHOWICZ et al. 1998). The lowest amount of magnesium was in juice C. Its main components were carrots and apples, which are poor in magnesium. The authors' own studies revealed that juice C had the lowest amounts of calcium and magnesium among all the juices. Little magnesium was also noted in juice H (0.036 mg·g^{-1}). The composition of this juice revealed that it was made of large amounts of apple juice and apple Cremogen, and apples contain small amounts of magnesium. The content of Mg in apples is 3 mg per 100 g of the raw product (KUNACHOWICZ et al. 1998). According to MARZEC et al. (2007) fruit juices for infants contained 12.1-76 mg of magnesium per 1 g.

The highest level of sodium was determined in juices D-1 (0.168 mg·g^{-1}), D-2 (0.162 mg·g^{-1}) and I (0.164 mg·g^{-1}), whereas its lowest presence was noted in juice K (0.013 mg·g^{-1}). High content of sodium probably meant a high share of carrots in the juices, yet the labels did not give any information concerning the percentage composition of the product. Carrots contain 82 mg of sodium per 100 g of the raw product (KUNACHOWICZ et al. 1998).

The highest amount of potassium was detected in juice B-3 (1.380 mg·g^{-1}), and its lowest level was observed in juice H (0.398 mg·g^{-1}). Little potassium was also found in juice G-2 (0.408 mg·g^{-1}). High content of potassium in juice B-3 results from a high content of this element in carrots and other fruit used to produce this juice. According to KUNACHOWICZ et al. (1998) the content of potassium is 282 mg 100·g^{-1} in carrots and from 118 mg 100·g^{-1} (pears) to 395 mg 100·g^{-1} (bananas) in other fruit. The lowest content of potassium was noted in juice G-2 made from carrots, apples and bananas.

The highest content of iron was revealed in juice B-1 (4.57 μg·g^{-1}), slightly lower values were determined in juices B-4 (4.50 μg·g^{-1}) and D-2 (4.200 μg·g^{-1}). The lowest amount of iron occurred in juices F-2 (0.36 μg·g^{-1}) and G-1 (0.82 μg·g^{-1}). The content of iron in juices depends on the percentage composition of raw materials. Studies by MARZEC et al. (2007) revealed that fruit juices for infants contained from 0.76 to 2.92 μg of Fe in 1 g. About 10% of iron is absorbed from an average food ration. The presence of calcium reduces the absorption of iron, whereas the presence of copper increases its absorption (HALLBERG et al. 1993, SZOTOWA et al. 1996, BEARD, TOBIN 2000). Iron absorption is also stimulated by ascorbate acid (CARPENTER, MAHONEY 1992, DAVIS et al. 1992). Fruit juice is marketed as a healthy, natural source of vitamin C. However, vitamin C in fresh fruits has greater bioavailability than vitamin C added to fortified juices.

Zinc was present most abundantly in juice D-1 (3.85 μg·g^{-1}), which resulted from the ingredients: carrots, apples and bananas, which are all rich in zinc. The least zinc was found in juice A-4 (1.10 μg·g^{-1}), despite the fact that pumpkin, an ingredient of this juice, contains the largest amount of zinc, and juice B-3 (1.21 μg·g^{-1}). The content of zinc in the authors' own studies was higher than that reported by MARZEC et al. (2005), where its average content in fruit juices was 0.51 μg·g^{-1}.

Following the Polish norm PN-A-75048:1994, the content of zinc as an element harmful for human health in fruit and vegetable juices for babies must not exceed 15.0 $\mu g \cdot g^{-1}$ of the product. Zinc plays an important role in human growth as it is active in more than 300 enzymes by participating in their structure and catalytic and regulatory reactions. It is closely related to bone metabolism and therefore plays a positive role in the growth and development (FESTA et al. 1985, BRANDAO-NETO et al. 1995). Zinc insufficiency may lead to inhibiting the growth in children and to changes in their appetite, taste, smell and body weight loss (BRANDAO-NETO et al. 1995, BLACK et al. 2004).

The largest content of copper was observed in juice I (0.915 $\mu g \cdot g^{-1}$). This most probably resulted from a large share of copper in raspberries. The lowest content of this element was found in juice F-2 (0.090 $\mu g \cdot g^{-1}$). In the studies performed by MARZEC et al. (2005) the determined value of copper in fruit juices was on average 0.31 $\mu g \cdot g^{-1}$. This value was slightly lower than the results obtained in the authors' own studies. Little information could be found in the available references concerning the toxicity of copper in infants' organisms, which suggests copper homeostasis in young organisms. Similarly, copper insufficiency is rare and the information in the literature usually concerns infants fed with cow's milk for a long time (LONNERDAL 2005). According to the Polish norm PN-A-75048:1994, the content of copper in vegetable and fruit juices for children must not exceed 4.0 $\mu g \cdot g^{-1}$ of the product.

Most manganese was present in juice B-2 (2.59 $\mu g \cdot g^{-1}$) and this value was significantly different from the other results. This was most probably caused by the presence of wild rose fruit as an ingredient of the juice. The lowest amounts of manganese were detected in juices K (0.339 $\mu g \cdot g^{-1}$) and A-4 (0.370 $\mu g \cdot g^{-1}$). The studies by MARZEC et al. (2007) revealed the presence of 0.21-1.80 mg of manganese in 1kg of fruit juice for infants. The symptoms of manganese insufficiency are rare as manganese is in large abundance in food products. If it insufficiency occurs, it may lead to disorders of the growth and development in children (LJUNG, VAHTER 2007).

No specific data could be found in the available bibliography which would refer to the content of mineral elements in juices for children and their maximum values of these minerals. It is known that the content of minerals should not be higher than the recommended daily nutritional norms. Food products for infants and young children should be labelled as far as the content of minerals is concerned. The packaging of the product is supposed to include the information regarding the content of such ingredients if they amount to no less than 5% of daily intake (SZPONAR, MOJSKA 1996). No such information was found on any packaging.

The chemical composition of food products for infants and young children must be continuously monitored. Many authors (MARZEC, ZARĘBA 2003, WINIARSKA-MIECZAN, GIL 2007, WINIARSKA-MIECZAN, KWIECIEŃ 2007) have shown that foods for special purposes (baby juices and baby foodstuff) are not always safe in respect of lead level.

WINIARSKA-MIECZAN and GIL (2007) demonstrated that, unlike juices, convenience foods for infants are not very popular in Poland. The authors' own survey studies have revealed that more than 90% of parents of young children declared a wish to purchase fruit and vegetable juices (WINIARSKA-MIECZAN, KWIECIEŃ 2007). The respondents stated that the most vital characteristic of juices was their nutritional value, and as many as 86% of the respondents were satisfied with the quality of juices.

CONCLUSION

Juices are an important source of mineral elements in the diet of infants and young children. The most valuable juices are those produced from fruit and vegetables in the form of purée, since they offer large amounts of dry mass, which contains fibre, minerals and vitamins. The differences in the content of particular minerals in juices result primarily from their ingredients.

Although juices for infants and young children should not contain any additives, products with no certificates should be treated with caution as the presence of prohibited additives, such as calcium ascorbate or calcium chloride in their composition, cannot be excluded.

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