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BREAKFAST CEREAL AS A SOURCE OF SODIUM, POTASSIUM, CALCIUM AND MAGNESIUM FOR SCHOOL-AGE CHILDREN

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Abstract

Breakfast cereal is a regular component of daily diets in Poland and in other countries. Since these products are very popular components of diets, they should be a source of key nutrients, including minerals. The objective of the study was: 1) to determine how popular cereals were among young and pre-teen school children; 2) to verify whether cereals could be a source of sodium (Na), potassium (K), calcium (Ca) and magnesium (Mg). 232 ready-to-eat products were tested. The content of Na, K, Ca and Mg was determined using flame atomic absorption spectrometry in a Varian SpectrAA 280 FS. Daily intake of Na, K, Ca and Mg by children (aged 7 - 12 years) from 1 serving of breakfast cereals (1 serving size = 30 g cereal + 125 ml milk) was compared with AI (for Na and K) or RDA (for Ca and Mg). The highest content of Na was recorded in cornflakes (approx. 500 mg 100 g^{-1}), K in bran (more than 250 mg 100 g^{-1}), Ca in bran and wholegrain cereals (approx. 57 mg 100 g^{-1}), Mg in bran (nearly 180 mg 100 g^{-1}). It was found that although cereals were not a rich source of Na, K, Ca and Mg for the studied group of consumers, when prepared with milk their nutritional value was significantly enhanced. One serving of breakfast cereals with milk per day would cover 5 - 17% of AI for Na, 5 - 7% of AI for K , 12 - 17% of RDA for Ca and 10 - 57% of RDA for Mg. Cornflakes, which turned out to be the richest source of Na, were the least valuable in terms of the content of the macroelements, in which they resembled rice flakes. All breakfast cereals, while not being particularly rich in Na, K, Ca and Mg, when prepared with milk have a considerably better value for school-age children and ensure a higher consumption of milk.

Keywords: ready to eat cereal, macroelements, AI, RDA, children.

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INTRODUCTION

Breakfast cereal is a regular component of daily diets both in Poland (Borkowska, Bugajska 2013) and in other countries (Harris et al. 2011, Schwartz et al. 2008, Orzáez Villanueva et al. 2000). A continuous increase in the consumption of this group of food products can be observed, mainly among children and school youth, but also among adults (Rampersaud et al. 2005). In 2012, approx. 2.3 kg of breakfast cereals and groats per capita per year were consumed in Poland (Statistical Yearbook … 2013). Since these products are very a popular component of diets, they should be a source of key nutrients, including minerals. The content of these components in cereals is determined by a recipe (grain type, additions such as fruits, nuts or honey, fortification), a grain processing method, and a serving method (e.g. with milk, juice or yoghurt). Breakfast cereals consumed with milk are very popular in European countries, the United States and in Canada (Rampersaud et al. 2005).

Consumers perceive breakfast cereals as products of high nutritive value just because they are often enriched with vitamins and/or minerals. The high content of minerals, mainly Ca, is the basic advantage of cereals, which is most often mentioned alongside such ingredients as fibre and vitamins (Ratusz, Wirowska 2012).

Studies have revealed that diets of school-age children and adolescents in Poland are deficient in calcium, among other elements (Rusińska et al. 2011, Harton et al. 2012), and low in vitamin D (Rusińska et al. 2011). Similarly to the shortage of vitamins D and K_2, deficiency of calcium is the primary cause of inadequate mineralisation of the skeletal system and low peak bone mass gain (Priemel et al. 2010, Esterle et al. 2010). These consumer groups also display an insufficient intake of magnesium (Harton et al. 2012), which is an element responsible for activating numerous enzymatic systems and energy metabolism (Fawcett et al. 1999), and potassium (Kolmaga et al. 2011), which demonstrates an antagonistic effect towards sodium (McGill et al. 2008). Regarding sodium, its excess rather than a deficiency in a diet is a more frequent problem (Harton et al. 2012), primarily due to the consumption of food with a significant addition of table salt. Excessive intake of salt increases the risk of hypertension (He, Weton 2002).

The objective of the study was: 1) to determine how popular cereals were among school children; 2) to verify whether it could be a source of sodium (Na), potassium (K), calcium (Ca) and magnesium (Mg) for this group of consumers. Available literature contains little information regarding this issue.

MATERIAL AND METHODS

Survey research

The survey was carried out in May 2014 among the parents of children aged 7-9 (155 individuals) and 10-12 (155 indiv.) attending primary schools in Lublin (150 children) and in Warsaw (160 children). The examined population of children is described in Table 1. The questionnaire consisted of 17

Table 1

Characteristics of the analysed population of children

Specification	Age of children			
	7 - 9 years		10 - 12 years	
	n	(%)	*n*	(%)
Numer of children	155		155	
Gender				
Girls	91	58.5	79	51.2
Boys	64	41.5	76	48.8
Not eating breakfast cereals	4	2.40	4	2.40
Eating breakfast cereals **	147	95.1	136	87.8
Rice	0	0 *	19	12.2 *
Corn	76	48.8 *	45	29.3 *
Wholegrain	30	19.5 *	45	29.3 *
Cereals bran	0	0.00 *	23	14.6 *
With sugar, chocolate or honey	144	92.7 *	121	78.0 *
Muesli and crunchy	91	58.5 *	72	46.3 *
Other	0	0 *	0	0
Eating breakfast cereals with: **				
Milk	132	85.4	117	75.6
Yoghurt	64	41.5	49	31.7
Juice	0	0	0	0
Other	68	43.9	23	14.6
Additional sugar				
Yes	23	14.6	11	7.3
No	129	82.9	132	85.4
Eating breakfast cereals for: **				
Breakfast	144	92.7	132	85.4
Dinner	34	22.0	42	26.8
Snack	76	48.8	64	41.5
Frequency of eating breakfast cereals				
Every day	98	63.4	87	56.1
1 time daily	57	57.7 ***	79	91.3 ***
2 - 3 times daily	41	42.3 ***	4	4.30 ***
4 times daily or more	0	0 ***	4	4.30 ***
Several times a week	0	0	0	0
1 time a week	30	19.5	23	14.6
Occasionally	11	7.30	19	12.2

* total number of children eating breakfast cereals was assumed as 100%; ** multiple answers to this question allowed ; *** total number of children eating breakfast cereals every day was assumed as 100%

questions, of which 12 were multiple choice questions. The questionnaire asked about children's age, their sex, place of habitation, school grade, consumption of cereals (eagerness, frequency, flavourings, and time of day). In addition, there were questions concerning flavours preferred by children and asking whether parents satisfy such preferences; an explanation of the parents' attitude was also requested with reference to this question. The parents also explained why they gave cereals to their children and whether they believed it was a balanced meal.

Study material

The study material was breakfast cereal purchased in food stores in Lublin from January until May 2012. All breakfast products were ready to eat (RTE). In total, 232 products were studied. They were split into 4 groups according to the following criteria: grain species (rice, corn, wheat, oats, multigrain), flavour (with sugar, chocolate or honey and with dairy added during production), high fibre content (wholegrain, bran), muesli and crunchy cereals (Table 2). Also, 35 samples of cow's milk were analysed on the assump-

Table 2

Na, K, Ca and Mg content in the breakfast cereals and cow's milk (mg 100 g^{-1})

Breakfast cereals	*n*	Macroelements			
		Na	K	Ca	Mg
Rice	15	40.41 ^{c} ± 58.6 (8.3 - 157.2)	78.59^{b} ± 75.2 (13.9 - 200.6)	3.203^{a} ± 0.70 (2.67 - 4.44)	31.44^{a} ± 13.1 (21.9 - 56.8)
Corn	42	504.4 ^{g} ± 171.2 (385.4 - 941.0)	48.14^{a} ± 6.47 (31.4 - 89.9)	7.401^{b} ± 3.08 (3.01 - 10.7)	37.63^{b} ± 11.5 (28.0 - 59.9)
Wheat	21	40.24 ^{c} ± 54.2 (7.4 - 157.2)	210.9^{g} ± 68.3 (114.9 - 320.7)	27.53^{d} ± 27.6 (8.64 - 86.1)	126.1^{h} ± 86.8 (53.0 - 261.1)
Oat	13	14.44 ^{a} ± 8.68 (8.23 - 35.6)	166.2^{e} ± 84.0 (98.4 - 345.3)	48.04^{g} ± 23.7 (11.6 - 79.2)	98.70^{g} ± 18.1 (73.2 - 136.3)
Mixes cereals	20	94.80 ^{de} ± 42.1 (39.6 - 167.2)	147.84^{d} ± 30.8 (112.9 - 200.1)	13.29^{c} ± 11.3 (5.98 - 33.9)	96.32^{g} ± 36.5 (55.6 - 133.4)
Wholegrain	18	26.37 ^{b} ± 5.41 (19.3 - 31.5)	119.5^{c} ± 16.5 (98.3 - 141.7)	56.65^{h} ± 41.9 (10.5 - 121.6)	102.5^{g} ± 44.9 (53.0 - 145.4)
Cereals bran	23	10.78 ^{a} ± 1.67 (8.4 - 13.1)	253.4^{h} ± 66.8 (154.8 - 320.9)	57.13^{h} ± 38.3 (11.6 - 88.6)	178.9^{i} ± 57.9 (112.7 – 261.0)
Sweet cereals *	23	227.1 ^{f} ± 117.9 (17.4 - 404.3)	89.37^{b} ± 42.4 (59.9 - 200.6)	35.86^{e} ± 43.5 (10.98 - 156.0)	54.63^{d} ± 7.52 (39.6 - 68.8)
With dairy **	21	96.27 ^{de} ± 55.4 (27.5 - 191.2)	203.6^{f} ± 88.1 (110.1 - 355.2)	47.82^{g} ± 40.7 (11.6 - 113.6)	43.73^{c} ± 20.0 (12.9 - 73.2)
Muesli and crunchy	36	84.92 ^{d} ± 55.4 (35.6 - 195.4)	182.9^{f} ± 77.2 (50.3 - 302.5)	39.22^{f} ± 23.9 (10.3 - 67.9)	84.33^{f} ± 32.9 (56.4 - 133.4)
Cow milk	35	47.05 ± 5.03 (33.7 - 51.5)	139.6 ± 45.6 (123.1 - 151.6)	117.9 ± 27.9 (108.5 - 131.6)	12.8 ± 5.33 (9.23 - 13.87)

* flakes enriched with sugar, chocolate or honey during production; ** flakes enriched with dairy (milk, yoghurt) during production; $^{a, b, c, d, \ldots}$ - significant differences between breakfast cereals

tion that breakfast cereal is most often served with milk, the fact which is supported by both literature (MURPHY 2007) and the results of the authors' own research. Homogenised cow's milk with 2% fat content, packed in foil bags or cartons, was purchased in May 2012 prior to their best before date. All the analysed milk was produced in Polish dairies. The milk was frozen at a temperature of –20°C until analysis.

Chemical analyses

Samples of cereals weighing approx. 30 g were ground in a laboratory grinding mill. Three samples of approx. 3 g of each product were weighed and dried at a temperature of 105°C for 12 h. Milk samples (approx. 20 ml) were thawed at room temperature, three samples of 5 ml of each product were taken and dried at 65°C for 24 h, and subsequently at 105°C for 12 h. Afterwards, all samples were subjected to combined mineralisation in a muffle furnace, using hydrogen peroxide as an oxidant: the samples were dry-mineralised at 450°C for 12 h. The resulting ash was added to 2 ml of hydrogen peroxide, vaporised to dryness and re-burnt for 12 h at 450°C. The procedure was repeated four times. The resulting white-colour ash was dissolved in 10 ml of 1M HNO_3. The content of Na, K, Ca and Mg was determined using flame atomic absorption spectrometry in a Varian SpectrAA 280 FS, using an SPS3 Autosampler (Table 3). A series of solutions of varying concentrations were prepared for all the examined ions by diluting the standards: 0.00, 0.10, 0.20, 0.40, 1.00, and 2.00 ng mL^{-1}.

Table 3

Measurement parameters for the determination of Pb and Cd

Specification	Na	K	Ca	Mg
Wavelength (nm)	589.0	766.5	422.7	202.6
Lamp current (mA)	-	-	10	4
Spectral band pass (nm)	0.2	0.2	0.5	1.0
LOD (mg kg^{-1})	20.0	20.0	28.0	18.0
LOQ (mg kg^{-1})	40.0	40.0	56.0	36.0
Pure gas	C_2H_2/air	C_2H_2/air	C_2H_2/air	C_2H_2/air
Mean recovery rate	99%	94%	99%	105%
The deviation of duplicate measurement	2.4%	4.6%	7.0%	3.7%
Quality control				
Blank samples	yes	yes	yes	yes
CRM *	LGC-7173	LGC-7173	LGC-7173	LGC-7173

* The certified reference material (CRM) contained: Na 0.17 g 100 g^{-1}, K 0.74 g 100 g^{-1}, Ca 1.44 g 100 g^{-1}, Mg 0.16 g 100 g^{-1}

Calculations

The levels of Na, K, Ca and Mg in breakfast cereals were expressed in mg per 100 g of the product, while in milk they were given in mg per 100 ml. Also, the content of the mineral components was calculated per 1 serving (30 g of cereal + 125 ml of 2% fat milk), the serving size being predefined by the producer of the cereal. In addition, the extent to which one serving of the product covered the requirement of the macroelements among children aged 7-9 and 10-12 years was calculated as a norm according to current recommendations in Poland, i.e. AI (adequate intake) for Na and K and RDA (recommended daily allowance) for Ca and Mg (Jarosz 2012). The results were analysed by statistical methods using Statistica 6.0 software. The mean, minimum and maximum values and standard deviation (SD) were determined. Differences between mean values were computed by the single factor analysis of variance (Anova), where $P < 0.05$ was the significant level.

RESULTS AND DISCUSSION

Children's preferences

It was found that as many as 95% of children aged 7-9 and 88% of children aged 10-12 ate cereals, of which 60% consumed cereals every day (Table 1). Sweet cereals were the most popular type (respectively 80% and 90% of responses). Muesli and crunchy cereals were indicated as eagerly consumed by as many as 60% of parents of children aged 7-9 and nearly 50% of parents whose children were aged 10-12; however, this type of cereal was most frequently eaten as a dry snack. Cornflakes were eaten by 29.3% of younger and 48.8% of older children. Wholegrain cereal, being the most valuable cereal in terms of the content of minerals, was consumed by less than 30%. In order to improve the palatability of cereals, as many as 15% of parents of younger children and about 7% of parents of older children added sugar to these products.

Children are willing to eat breakfast cereal (Schwartz et al. 2010). Unfortunately, this group of consumers very frequently chooses cereals that are sweetened (Harris et al. 2011), which stems from both the natural preference of children to choose sweet food (Deshmukh-Taskar et al. 2010) and pervasive advertising of such products in the media, particularly appealing to children and adolescents (Schwartz et al. 2010, Borzekowski, Robinson 2001, Mazur et al. 2006). The consumption of products containing excessive amounts of monosaccharides, and in particular of sucrose, leads to creating bad eating habits and in consequence to excessive weight and obesity (Kavey 2010) as well as diseases accompanying such conditions (Gross et al. 2004, Ebbeling et al. 2002) or dental caries (Hujoel 2009). Cornflakes, a popular choice among children (Ishak et al. 2013), have a high glycemic index (Lavi et al.

2009), thus favouring excessive weight gain. Children should be encouraged to eat unsweetened, preferably wholegrain cereal, which effectively prevents excessive BMI owing to its high fibre content (Albertson et al. 2012, Cho et al. 2013). The taste preferred by children largely depends on the eating habits in their families (Kavey 2010), so they may learn to like more valuable and less sweet products. Studies revealed that children regularly eating sweets are more eager to choose other food products that taste sweet (Sullivana, Birch 1990).

Breakfast cereal as a source of macroelements

Sodium

The content of Na in the products we studied was highly varied. The highest content of Na was recorded in cornflakes: on average over 500 mg per 100 g of the product (Table 2). These were followed by sweetened cereals to which chocolate or honey or sugar was added during processing: on average 200 mg per 100 g of the product. The values were consistent with those measured by other authors (Schwartz et al. 2010). Consuming one serving of cornflakes with milk, a person would take more than 200 mg of Na, while a serving of sweetened cereal would provide nearly 125 mg of this element (Table 4). A particularly high content of Na in cornflakes can be attributed to the fact that this element is added in the course of production, which is indicated on the packaging. The highest amount of Na can be sourced from grain species and flavour flakes: approx. 8 - 8.5% AI (Figure 1).

RTE cereal is not a rich source of Na, admittedly an indispensible macroelement for humans, but harmful in excessive amounts since it increases the risk of hypertension, a condition recorded in 1-3% of the population of Polish children (Dukalska et al. 2006). Some authors claim that essential hypertension diagnosed in an adult originates in childhood and often in foetal life (Eriksson et al. 2000). The diets of children and adolescents contain excessive amounts of sodium (Rożnowski et al. 2007, Bouhlal et al. 2013) due to the fact that table salt is added to nearly every food product. According to current recommendations, the daily intake of salt should not exceed 5 g (WHO 2011). When 1 g of Na is consumed as much as 26 mg of Ca will be excreted in urine (Goluch-Koniuszy 2010), which is particularly worrying in the light of the widespread deficiency of Ca in diets (Rusińska et al. 2011, Goluch-Koniuszy 2010).

Potassium

The highest amount of K was found in bran (over 250 mg per 100 g of the product) – Table 2. Also, a high content of this element, i.e. more than 200 mg per 100 g of the product, was identified in wheat flakes enriched with milk during production (in this study referred to as “with an addition of milk”). Assuming that a child or a young person has one serving of such cereal with milk per day, the supply of K with such cereal would exceed

Table 4

Daily supply of minerals, mg/serving (1 serving size = amount of cereal recommended by the producer 30 g + 125 ml milk), mean, minimum and maximum values

Breakfast cereals	Na	K	Ca	Mg
Rice	68.37 (58.74 - 103.4)	199.8 (180.4 - 236.4)	151.0 (150.8 - 151.3)	24.43 (21.57 - 32.04)
Corn	207.6 (171.9 - 338.6)	190.8 (185.7 - 203.2)	152.2 (150.9 - 153.2)	23.55 (23.40 - 32.97)
Wheat	72.77 (58.47 - 103.4)	241.5 (120.7 - 272.5)	158.3 (152.6 - 175.8)	32.33 (30.90 - 93.33)
Oat	62.02 (58.72 - 66.93)	226.1 (205.8 - 279.8)	164.4 (153.5 - 173.8)	36.95 (36.96 - 55.98)
Mixes cereals	103.4 (68.13 - 106.4)	236.4 (210.1 - 236.4)	154.0 (151.8 - 160.2)	32.06 31.68 - 55.02)
Wholegrain	64.50 (62.04 - 65.71)	218.7 (205.7 – 218.8)	167.0 (153.2 - 213.8)	45.75 (30.90 - 58.64)
Cereals bran	60.19 (58.77 - 60.18)	248.0 (222.7 - 272.5)	167.1 (153.5 - 176.6)	74.75 (48.81 - 93.30)
Sweet cereals	124.4 (61.47 - 177.5)	203.1 (194.2 - 236.3)	160.8 153.3 - 196.8)	31.39 (26.88 - 35.64)
With dairy	85.13 (64.5 - 113.6)	237.3 (209.3 - 282.8)	164.3 (153.5 - 184.1)	28.12 (18.81 - 63.96)
Muesli and crunchy	81.73 (66.93 - 114.9)	231.1 (181.3 - 267.0)	161.8 (153.1 - 170.4)	40.30 (31.92 - 55.02)
Mean values				
Grain species	102.8^{c}	218.9	156.0	29.87^{a}
High fibre content	62.34^{a}	233.4	167.1	60.25^{c}
Flavour cereals	104.7^{c}	220.2	162.6	29.75^{a}
Muesli and crunchy	81.73^{b}	231.1	161.8	40.30^{b}

$^{a, b, c, d, \ldots}$ - significant differences between mean values

240 mg (Table 4). The authors' own studies revealed the least K in cornflakes, just 50 mg per 100 g of the product. No significant difference was found in the mean content of K in breakfast cereals (Table 4). One serving of breakfast cereals with milk per day would cover approx. 6% of the RDA for children (Figure 1).

Studies have demonstrated that children (Rożnowski et al. 2007, Tanase et al. 2011) and adolescents (Rusińska et al. 2011, Tanase et al. 2011, Araujo et al. 2013) consume insufficient amounts of K. A proper balance of K in a diet is particularly important considering that this element has an antagoni-

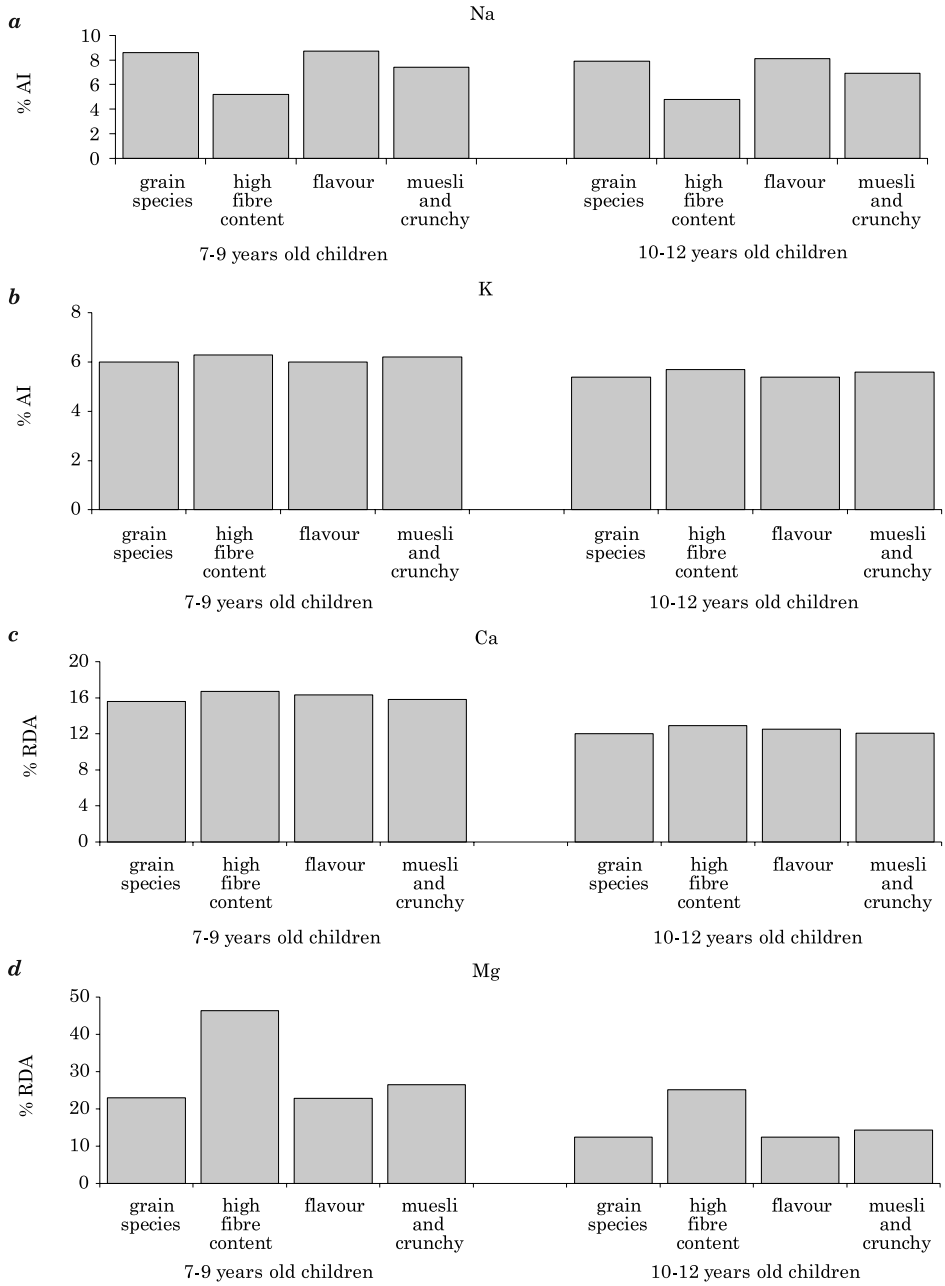

Fig. 1. % AI or % RDA for youth and children of school and early school age, following from the consumption of 1 serving of cereal (1 serving = 30g cereal + 125 ml milk), mean values

stic effect towards Na (McGill et al. 2008), which in turn is consumed in excessive amounts (Harton et al. 2012). Potassium is important for the nerves, muscles and heart to work properly (Sandhiya, Dkhar 2009, Li et al. 2006). Dairy products are a good source of K (McGill et al. 2008, Tanase et al. 2011), so children should be encouraged to consume cereals with milk.

Calcium

RTE cereal is not a rich source of Ca (Table 2), which can be basically attributed to the low content of this mineral component in grain. The highest content of Ca was found in bran and wholegrain cereals (approx. 57 mg per 100 g of the product) and in oats and cereals with milk (approx. 48 mg per 100 g of the product). Rice flakes and cornflakes contained no more than 10 mg of Ca per 100 g of the product. The high supply of Ca in one serving of flakes prepared with a dairy product (Table 4) was due to the high content of this macroelement in milk as 100 ml of 2% fat milk contains on average nearly 120 mg of Ca (Table 2), thus in a single serving more than 90% of Ca was derived from milk. The authors' own survey showed that children most often consumed cereals with milk (more than 85% of children aged 7-9 and 76% of children aged 10-12) or yoghurt (respectively 42% and 32% of indications) – Table 1. The highest amount of Ca can be sourced from high fibre content cereals: approx. 17% of the RDA for children aged 7-9 years and approx. 13% RDA for children aged 10-12 years (Figure 1).

Considering the content of Ca in breakfast cereal and the supply of this component, one should take into account the assimilability of mineral components reduced by substances naturally occurring in plant products, in particular fibre and phytic acid (Aguilar et al. 2012). The highest content of such substances is found in bran and wholegrain cereals (Bohn 2008, Gani et al. 2012) which, as shown by the studies presented here, are most abundant in Ca, thus it is milk and not cereal that should be considered as the main source of Ca in children's diets. Meanwhile, wholegrain cereals contain healthy active substances such as polyphenols, carotenoids and phytosterols (Gani et al. 2012).

The diets of children and adolescents are deficient in Ca in relation to the needs of a growing body (Eriksson et al. 2000, Goluch-Koniuszy 2010), which is mainly due to the insufficient consumption of milk (Black et al. 2002, Stefańska et al. 2012). According to Black et al. (2002), the reason for milk avoidance implicated by 42% of American children was a bad taste. Studies by Ortega et al. (1998) revealed that most often milk is consumed by children only for breakfast; therefore, this meal has a significant share in the total daily intake of Ca. Although cereal itself contains little Ca, when mixed with milk or yoghurt it becomes a good source of this macroelement.

Magnesium

The highest content of Mg was found in bran (on average nearly 180 mg per 100 g of the product). This component was also abundant in wheat flakes (more than 120 mg); in contrast, rice flakes and cornflakes contained the least of Mg (Table 2). A serving of high fibre content cereals, most abundant in Mg, prepared with milk provides approximately 60.3 mg of Mg (Table 4), accounting for nearly 46% of RDA in children aged 7-9 and 25% of RDA in children aged 10-12 years (Figure 1). At the same time, the supply of Mg from one serving of children's favourite choice, that is sweetened cereal (with sugar, chocolate or honey), is less than half of the above shares (Table 4).

Studies show that children and adolescents in Poland consume too little Mg compared to the amount required (Harton et al. 2012, Goluch-Koniuszy 2010). Absorption of Mg increases, among other circumstances, in the presence of protein (Bohn 2008), and therefore serving cereal prepared with milk or yoghurt is most expedient. However, it should be remembered that just 20-60% of Mg in food is absorbed, and the percentage is lower when wholegrain cereals are eaten, due to their high content of fibre, among other factors (Bohn 2008).

Orzáez Villanueva et al. (2000) found that Mg is a deficit element in RTE cereals, although it must be noted that the content of Mg depends on ingredients in such cereals and the method of grain processing. Analysis of cereals performed by Leśniewicz et al. (2008) revealed that they contained 7-82 mg of Mg 100 g^{-1} of the product. Studies carried out in the United States demonstrated that the supply of Mg and Ca in children eating RTE cereals regularly was higher than in children who did not eat such products (Schwartz et al. 2010, Birch, Fisher 1998).

CONCLUSIONS

Although RTE cereals are not a rich source of Na, K, Ca and Mg for school-age children, when prepared with milk they have a considerably better value, at the same time ensuring a higher consumption of milk. In the population of children in Poland and in other countries, there is an insufficient supply of dairy products, which is a fundamental reason for the deficiency of Ca in diets. Cornflakes, which turned out to be the richest source of Na, were also the least valuable product in terms of the content of the macroelements, in which they resembled rice flakes. Cornflakes, popular among children (Ishak et al. 2013), have a high glycemic index (Lavi et al. 2009), thus fostering excessive weight gain. The taste preferred by children largely depends on the eating habits in their families (Kavey 2010), which means that they can learn to like more valuable and less sweet products. Children should be encouraged to eat unsweetened cereals (Harris et al. 2011), prefe-

rably wholegrain and bran ones, because - as demonstrated above - a serving of such cereal provides the highest amount of Ca and Mg to young bodies, while keeping the supply of Na at the lowest level.

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