



## ORIGINAL PAPERS

## ANALYSIS OF FOOD WITH ADDED MINERALS AVAILABLE ON THE WARSAW MARKET

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## ABSTRACT

The development of the market voluntarily fortified foodstuffs with vitamins and/or minerals contributes to their increased supply, which may have an influence on the reduction of micro-nutrient deficiency. The aim of the study was to identify and describe products with added minerals on the food market in Warsaw and to assess the possibility of increasing the intake of those nutrients by including such products in the daily diet. Data were gathered using the information provided on labels from foodstuffs in 14 Warsaw supermarkets during March to October 2014. There were 301 food products with added minerals available on the Warsaw market. The number of minerals added to the products ranged from 1 to 7, and they were calcium, iron, magnesium, zinc, iodine, potassium, and selenium. The majority of the products were fortified with calcium (71.1%) and iron (46.5%), while magnesium was added to a smaller number of products (21.3%). Selenium, iodine, potassium and zinc were added only to a few products. Cereals (32.2%) and dairy products (19.9%) constituted the largest food groups. The addition of minerals also occurred in soya products, sweets, powdered instant cacao and non-alcoholic beverages. Owing to the wide range of products with added calcium, iron and magnesium available on the market, there is a possibility to increase daily intake of these minerals. Since a large part of analyzed foodstuffs also contained added sugar and/or salt and were simultaneously targeted at children and youth, some limitations should be developed regarding the enrichment of such products with nutrients as well as advertising them to young consumers as a key goal for improving public health.

**Keywords:** fortified foods, minerals, foodstuff market.

## INTRODUCTION

Minerals are essential for human health, for example calcium and magnesium are structural components of bone, a suitable amount of iron prevents anaemia, iodine affects the proper functioning of the thyroid and both zinc and selenium are intrinsically involved in the protection of a body by free radicals (FAO/WHO 2004). Although micronutrient malnutrition is particularly noticeable in developing countries, many studies suggest that some minerals, particularly calcium, iron, magnesium are often deficient in developed countries, in diets of specific age groups and of vulnerable populations, such as children (MENSINK et al. 2013), women of childbearing age (KNUDSEN et al. 2012), elderly people (LEBIEDZIŃSKA et al. 2013), and those of low socio-economic position (TEDSTONE 2008).

As defined by the World Health Organization (WHO) and the Food and Agricultural Organization of the United Nations (FAO), food fortification is the process of adding micronutrients (minerals and vitamins) to food regardless of whether they occur naturally in the product. Enrichment of food products in accordance with current legislation may be voluntary or mandatory (FAO/WHO 2004, ALLEN et al. 2006). Depending on the nutritional needs of consumers in different parts of the world and general nutrition policy, obligatorily enriched products differ from country to country. Obligatory fortification with minerals is less common than with vitamin(s). For example, many European countries are proponents of mandatory fortification of salt with iodine e.g. Austria, Denmark, Italy, while wheat flour has to be enriched with calcium and iron in the United Kingdom (TARABELLA, BURCHI 2012). Since the identification of iodine deficiencies in the Polish population, food manufacturers have been obliged to add iodine (i.e. potassium iodide or potassium iodate) to household salt so that 100g of salt contains 2.3 ( $\pm$  0.77) mg of iodine to compensate for shortages (*Regulation ...* 2010, SZYBIŃSKI 2012).

Uniform principles on the voluntarily food fortification with vitamins, minerals, and certain other substances in the European Union are defined in Regulation (EC) in 2006. Manufacturers may voluntarily enhance food product(s) with 16 minerals i.e. calcium, magnesium, iron, copper, iodine, zinc, manganese, sodium, potassium, selenium, chromium, molybdenum, phosphorus, fluoride, chloride and boron. Regardless of the purpose of mineral addition, a manufacturer is obliged to provide on the product label the overall content of the fortified nutrient in that food, both naturally occurring and added. The addition of mineral to 100 g (or 100 ml) of food product or to the portion suggested by the manufacturer (if it is smaller than 100 g or 100 ml) should be within the range of 15-50% of the nutrient reference values (NRVs) for nutrition labeling (*Regulation (EC)* 2006, *Regulation ...* 2010, *Regulation (EU)* 2011).

Consuming foods with added nutrients is a strategy developed to prevent

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from/or treat nutritional deficiencies. The knowledge of foods with added vitamins and minerals accessible on the market is important for dieticians, nutritionists and all specialists involved in public health nutrition, as well as for consumers *per se* who may increase the intake of deficient nutrients, under the condition they are aware and well educated nutritionally.

The aim of the study was to identify and describe products with added minerals available on the Warsaw foodstuff market in 2014 and to assess the possibility of increasing the intake of those nutrients by incorporating such products to the daily diet.

## MATERIAL AND METHODS

The survey was conducted from March to October 2014 at 14 supermarkets in Warsaw; data collection was performed in each supermarket chain in two repetitions. Information on fortified products was gathered from labels on the packaging. Products that contained minerals added for technological purposes as food additives (e.g. phosphorus, sodium) were excluded from the study. Similarly, products intended for special nutritional purposes, such as foods for infants or small children were also excluded due to their entirely separate legislation. The article does not include mandatory enriched products, i.e. iodized salt.

The food products with added minerals were classified into categories defined by the FoodEx classification system (EFSA 2011, *Commission ...* 2012). The amounts of minerals given on the product labels were checked for compliance with the relevant regulations (*Regulation (EC) 2006, Regulation ...* 2010, *Regulation (EU) 2011*). Summary statistics of mineral content in food groups were presented as arithmetic mean, standard deviation, range and median.

Furthermore, the food products were examined and classified according to their sugar and salt content. The criteria used to define high and low levels of sugar and salt were based on the International Choices Program criteria (ROODENBURG et al. 2011). However, due to the lack of detailed information on the product packaging regarding the amount of sugar added to the product, the analysis concerned the total amount of sugar in the product specified on the label. The Choices Program has created a global front-of-pack nutrition logo system that helps consumers make healthier food choices and stimulates product reformulation.

## RESULTS AND DISCUSSION

### The characteristics of foodstuffs

There were 301 foodstuff products with added minerals identified on the Warsaw market in 2014. The largest groups were cereal (32.2%) and dairy products (19.9%). In addition, added minerals were also found in milk substitutes (17.6%) and sweets (15.6%). A smaller market share was observed for instant beverages (8.3%), as well as non-alcoholic beverages (5.6%). Information provided on product labels was in accordance with binding regulations. The chemical form of mineral added to foodstuffs was listed on 34% of product labels. Calcium carbonate, iron (II) lactate, magnesium lactate and magnesium sulphate were most often added to foodstuffs.

The number of minerals added to the products ranged from 1 to 7, and they were calcium, iron, magnesium, zinc, iodine, potassium and selenium (Table 1). Additionally, 83.4% of the products were simultaneously fortified with vitamins. The majority of the products were fortified with calcium (71.1%) and iron (46.2%). Magnesium was added to a smaller number of products (21.3%). The highest amounts of calcium, iron and magnesium were found in sweets at the levels of 63-148% of NRVs 100 g<sup>-1</sup> product, what complied with the regulations. Selenium, iodine, potassium and zinc were added only to a few products, and these ranged from 2 items for selenium to 12 foodstuffs for zinc.

Within the cereal products with added minerals, consumers have a wide variety of ready to eat breakfast cereals (88 items), instant semolina (7 items), and one wheat flour and pasta product. Cereal products contain mainly added iron (88.7%) and calcium (55.7%). In this group, there were also some products with added magnesium, zinc and 2 products fortified with selenium, i.e. ready to eat whole-grain cereal with dried fruits and oatmeal.

Among the fortified dairy products, there were 25 homogenized cottage cheeses and desserts, 22 yoghurts and 13 milk drinks. These products were fortified with calcium (93.3%) and occasionally with magnesium (6.7%).

Quite a large group of products fortified with minerals were sweets, over half of this group ( $n = 28$ ) were cereal bars and almost 40% biscuits with dried fruit or nuts. Two mineral additions were present in 31 foodstuffs (66%), and they represented iron accompanied with calcium or magnesium. Besides, zinc was added to three types of biscuits.

Minerals were also added to carbonated soft drinks and non-carbonated fruit beverages, mineral waters and flavored drinks based on water. Almost all products in this group (16 out of 17) were fortified with only one mineral, mainly with magnesium, iron or calcium, and less frequently with zinc or iodine.

Milk product substitutes was another group commonly enriched with minerals and included 40 soy milks and desserts, 5 rice drinks, 2 oat-based

Table 1

Range, mean ( $x \pm SD$ ), median (Me) of mineral content in groups of voluntarily fortified products available on the Warsaw market in 2014

Groups of voluntarily fortified products {food categories of the food classification system FoodEx} (n = 301)	Minerals content per 100 g or 100 ml									
	Ca (mg)	Fe (mg)	Mg (mg)	Zn (mg)	I ( $\mu\text{g}$ ) <sup>*</sup>	K (mg)	Se ( $\mu\text{g}$ )			
<b>Cereal products</b> {1} (n = 97)										
$x \pm SD$	n = 54 341.0 $\pm$ 165.0	n = 86 7.44 $\pm$ 3.190	n = 10 178.0 $\pm$ 27.80	n = 3 4.160			n = 2 17.00			
min. - max.	113.0-647.0	2.100-14.80	131.0-216.0	4.160	-	-	17.00			
Me	400.0	7.000	188.0	4.160			17.00			
<b>Dairy products</b> {8} (n = 60)										
$x \pm SD$	n = 56 152.0 $\pm$ 35.80	-	n = 4 56.30 $\pm$ 0.470	-	-	-	-			
min. - max.	120.0-240.0	-	56.00-57.00	-	-	-	-			
Me	136.0	-	56.10	-	-	-	-			
<b>Sweets</b> {10} (n = 47)										
$x \pm SD$	n = 28 560.0 $\pm$ 301.0	n = 42 6.950 $\pm$ 3.230	n = 22 132.0 $\pm$ 49.50	n = 3 6.300						
min. - max.	120.0-1184	1.100-15.30	60.00-236.0	6.300	-	-	-			
Me	504.0	5.450	112	6.300						
<b>Fat spreads</b> {11} (n = 1)										
$x \pm SD$	n = 1 600.0	-	-	-	-	-	-			
min. - max.	600.0	-	-	-	-	-	-			
Me	-	-	-	-	-	-	-			
<b>Non-alcoholic beverages</b> {13} (n = 17)										
$x \pm SD$	n = 4 52.00 $\pm$ 50.10	n = 6 1.750 $\pm$ 0.540	n = 5 32.30 $\pm$ 13.70	n = 1 1.500	n = 1 15.00					
min. - max.	11.00-120.0	1.050-2.100	21.00-56.30	1.500	15.00	-	-			
Me	39.00	2.100	28.10	-	-	-	-			
<b>Milk product substitutes</b> ** {20} (n = 53)										
$x \pm SD$	n = 52 123.0 $\pm$ 27.10	n = 4 0.700 $\pm$ 0.390	n = 1 83.60	n = 4 0.750 $\pm$ 0.390	n = 4 13.50 $\pm$ 6.980	n = 4 135.0 $\pm$ 69.70				
min. - max.	44.50-220.0	0.400-1.090	83.60	0.400-1.090	7.420-19.50	74.20-195.0				
Me	120.0	0.750	-	0.750	13.50	135.0				
<b>Instant beverages</b> ** {20} (n = 25)										
$x \pm SD$	n = 18 42.00 $\pm$ 36.10	n = 1 1.110	n = 22 22.20 $\pm$ 11.00	n = 1 0.780		n = 1 42.30				
min. - max.	12.00-128	1.110	7.200-37.50	0.780	-	42.30	-			
Me	29.00	-	22.10	-	-	-	-			
<b>Other food</b> {20} (n = 1)										
$x \pm SD$	n = 1 120.00	n = 1 2.100	-	-	-	-	-			
min. - max.	120.00	2.100	-	-	-	-	-			
Me	-	-	-	-	-	-	-			
Number of products (% of total amount)	214 (71.1%)	140 (46.5%)	64 (21.3%)	12 (4.0%)	5 (1.7%)	5 (1.7%)	2 (0.7%)			

\* table salt fortified with iodine is not included; \*\* expressed per 100 g or per 100 ml of a product ready for use

drinks, 2 nut drinks and 4 tofu. Only one out of 53 products in this group was not fortified with calcium. In turn, all of them had the addition of some B vitamins and/or vitamin D.

Among instant beverages fortified with minerals, there were 14 powdered cocoa, 6 coffee drinks and 5 puddings. Magnesium and calcium were minerals most commonly added to these products (88% and 72%, respectively). In 2014, there was also one margarine fortified with calcium and one tomato sauce fortified with iron and calcium available on the Warsaw market (Table 1).

The number of foodstuffs with added nutrients available on the Polish food market has increased significantly in recent years. Before 2001, according to the law, the manufacturer or importer of fortified foodstuff that wanted to place such product to the market had to obtain an approval by the National Food and Nutrition Institute, and also the acceptance by the Chief Sanitary Inspectorate in some cases. Those regulations significantly prolonged the time of placing a fortified product on the market. Consequently, therefore, there were only 28 products with added vitamins and/or minerals available on the Polish market in 1995 (SZPONAR et al. 2003), whereas in 2012 there were 588 products fortified with vitamins (SICIŃSKA et al. 2013). The market of foodstuffs with added vitamins and minerals is broad, although there are some changes observed from year to year as many new products come to the market and some disappear. Besides, the levels of added nutrients to the same products have changed over time what may pose some difficulties in nutritional studies on assessing the daily vitamins and minerals intakes. Generally, there were 690 products voluntarily fortified with vitamins and/or minerals available on the Warsaw market in 2014. The number of added nutrients ranged from one in 234 products to fourteen in 5 products. The largest groups were non-alcoholic beverages (24%) and cereal products (17%), unpublished data.

Currently, voluntary fortification exists in many countries, but the range of foodstuffs that may be fortified varies considerably from country to country. Some Scandinavian countries have a narrow range of fortified foods on the market, whereas the range of those products is much greater in the United States (ALLEN et al. 2006). In 1994, the German fortified food market was broader than the Polish food market at that time. There were 288 available foodstuffs fortified with vitamins and/or minerals within 6 different food categories: beverages, sweets, cereals, dairy products, powdered instant beverages and ready-to-eat meals. A total of 7 minerals were used for fortification, including sodium, potassium, chloride, calcium, phosphorus, magnesium and iron (KERSTING et al. 1995). Similarly, 262 products with added vitamins and/or minerals were recorded in the UK in 1999. Additional minerals were found in biscuits, bread, breakfast cereals, pasta, hot drinks, soft drinks, milks and yogurts. Iron and calcium were the most frequently added minerals, while a few products also contained added zinc, magnesium and iodine (BONNER et al. 1999). Likewise, in Austria in 2005, 470 enriched products

with vitamins and/or minerals were available, of which 105 had calcium addition (WAGNER et al. 2005).

### The nutritional context

There is a great possibility to increase the daily intake of calcium, iron and magnesium while consuming foods fortified with those minerals. Owing to the wide range of such products available on the market, the consumption of one average serving of a fortified product can provide from 6 to 37% of the reference value for these minerals (Table 2). Inclusion in the daily diet of products with added minerals by consumption of a glass of water or fruit

Table 2  
Calcium, iron and magnesium content in one serving of some foods fortified with those minerals, based on the Warsaw market study in 2014

Fortified foodstuffs	Weight of one average serving (g or ml)	Average mineral content per serving					
		calcium		iron		magnesium	
		(mg)	(%NRV*)	(mg)	(%NRV*)	(mg)	(%NRV*)
Breakfast cereal	cup (30 g)	101.0	12.60	2.300	16.10	56.00	15.00
Yoghurt	cup (180 ml)	216.0	27.00	-	-	101.0	26.90
Cacao instant	3 teaspoons (20 g)	65.00	8.100	-	-	54.00	14.40
Cereal bar	item (40 g)	249.0	31.10	3.400	24.60	24.00	6.400
Biscuits	2 items (25 g)	105.0	13.10	1.300	9.300	33.0	8.700
Fruit drink/water	glass (250 ml)	130.0	16.30	5.300	37.50	130.0	34.70
Soya pudding	cup (125 g)	150.0	18.80	-	-	-	-

\* NRV - nutrient reference value for nutrition labeling for adults – calcium 800 mg, iron 14 mg, magnesium 375 mg (*Regulation (UE) 2011*)

drink and a bowl of breakfast cereal with yogurt could increase calcium and iron intake of approximately 55% NRVs and magnesium of around 76% of NRV, which seems to be a manageable way to improve the nutritional status of a whole population. However, supplied amounts of other minerals with fortified products are negligible.

High intake of sugar and salt has negative influence on consumers' health and it is associated with an increased risk of obesity, cardiovascular diseases, hypertension and some kind of cancers (GROPPER, SMITH 2013). It was identified that 240 out of 301 products (79.7%) contained high levels of sugar and/or salt, particularly in the group of cereal and dairy products as well as sweets. No added salt was determined only in the group of non-alcoholic beverages (Table 3). Similarly to our study, sugar was added to 56% of

Table 3  
 Classification of the products with added minerals according to their sugar or salt content based on the International Choices Program criteria  
 (ROODENBURG ET AL. 2011)

Groups of products	Number of products <i>n</i> = 301	The classification criteria		Number (%) of products that does not meet the criteria		
		sugar content	sodium content	sugar	sodium	sugar and/or sodium
Cereal products	97	≤ 20 g 100 g <sup>-1</sup>	≤ 500 mg 100 g <sup>-1</sup>	81 (83.5)	34 (35.1)	88 (90.7)
Dairy products	60	≤ 5 g 100 g <sup>-1</sup>	≤ 100 mg 100 g <sup>-1</sup>	51 (85.0)	4 (6.7)	51 (85.0)
Sweets	47	≤ 20 g 100 g <sup>-1</sup>	≤ 400 mg 100 g <sup>-1</sup>	45 (95.7)	0	45 (95.7)
Fat spreads	1	no added	≤ 1.3 mg kcal <sup>-1</sup>	0	0	0
Non-alcoholic beverages	17		≤ 20 mg 100 g <sup>-1</sup>	8 (47.1)	0	8 (47.1)
Milk products substitutes*	53	≤ 5 g 100 g <sup>-1</sup>	≤ 100 mg 100 g <sup>-1</sup>	19 (35.9)	16 (30.2)	22 (41.5)
Instant beverages*	25		≤ 20 mg 100 g <sup>-1</sup>	25 (100)	21 (84.0)	25 (100)
Other food - ketchup	1	na	≤ 750 mg 100 g <sup>-1</sup>	1 (100)	0	1 (100)
Number of products (% of total number)				230 (76.4%)	75 (24.9%)	240 (79.7%)

\* expressed per 100 g or per 100 ml of the product ready for use; na – not applicable

products on the German fortified food market (KERSTING et al. 1995). In the UK, 76% of fortified products were deemed to be too high in either fat or sugar or salt in one or more combinations (BONNER et al. 1999).

Voluntary fortification has become common, although it most often stems from commercial interests rather than from public health needs. Fortification can make products more attractive to some customers, and this in turn may misguide consumers in believing that those products are recommended in a balanced diet and are good for health. Based on the general appearance as well as the media advertisements of those products, it can be concluded that they are especially targeted at younger generations. The use of animated characters or a happy child consuming a product on the packaging and/or in advertisement, might suggest that this product is appropriate and even recommended for children. In our study, there were 135 out of 301 (45%) products fortified with minerals suggested for consumption by children, and especially numerous groups were composed of sweets and breakfast cereals (82% and 63%, respectively). Among those 135 products targeted at children, 122 (90%) had too much sugar and /or salt. In the above studies performed in the UK (BONNER et al. 1999), 30% of products appeared to be especially targeted at children and 83% of those products were high in fat, sugar or salt.

In the view of the increasing frequency of obesity in populations, it seems to be critical that governments develop an appropriate degree of control over voluntary fortification through food legislation, e.g. the agreement to fortify only the foods of a beneficial nutrition profile. Regulatory controls should be focused on fortified foodstuffs targeted at children, especially in regard to lowering the content of sugar, salt and fat, as well as constraints on advertising.

## CONCLUSIONS

1. There were 301 foodstuff products with added minerals on the Warsaw market in 2014. The majority of the products were fortified with calcium and iron, and also with magnesium. Owing to a wide range of fortified foodstuffs available on the market, it is possible to increase the daily intake of those commonly deficient minerals.

2. In almost 80% of fortified products, high levels of sugar and/or salt was declared by the manufactures on the product labels, particularly in the group of cereal and dairy products as well as sweets. Therefore, some limitations should be developed in respect of enriching “unhealthy” foods, like sweets, candies, sweetened beverages with nutrients as well as advertising them to young consumers, and this should become as a key goal for improving public health.

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