Rocz. Nauk. Zoot., 45, 1 (2018) 89–98

SELENIUM CONTENT IN CONSUMER MKIL IN POLAND*

Franciszek Brzóska, Bogdan Śliwiński, Mariusz Pietras

National Research Institute of Animal Production, Department of Nutrition Physiology,
32-083 Balice near Kraków

The aim of the study was to determine selenium content of consumer milk in Poland. Samples for analyses were collected in three periods (spring, summer and autumn) from large-format food stores located in 16 cities of Poland. The milk samples originated from the 13 largest manufacturers of consumer milk. The study material consisted of UHT pasteurized milk with extended shelf life. In each store, 5 to 6 1-litre containers of milk with 0.5 to 3.2% fat were randomly chosen and purchased. A total of 95 milk samples were gathered. The results were reported according to location of purchase and milk producer (dairy cooperative/ dairy company). The average milk selenium content was 9.01±2.26 µg/litre (range from 4.67 to 16.60 µg/ litre). The highest selenium content was observed in the milk samples from Poznań (11.10±1.64 µg/litre) and the lowest in the milk samples from Kielce (6.93±1.97 µg/litre). In the Polish milk, selenium content was highest in 1 milk sample from the Dairy Cooperative in Krasnystaw (14.4±0.0 µg/litre). The highest selenium content was found in 3 samples of milk from France and unidentified European Union countries (14.4±2.81 µg/litre). Selenium content in the milk from 46 samples originating from the largest milk producers (Dairy Cooperative MLEKPOL in Grajewo and Dairy Cooperative MLEKOVITA in Wysokie Mazowieckie) was 7.6±1.19 and 8.3±0.90 µg/litre, respectively.

Key words: selenium, consumer milk, Poland, region, milk manufacturer

Selenium is a trace element released from the outer crust of the Earth. As a result of rock weathering, it penetrates to ground waters and agricultural soils together with precipitation and then is included to the trophic chain of plants, animals and humans. Selenoproteins play an important role in reproduction, metabolism of the thyroid gland, DNA synthesis as well as protection against oxidation processes and infections (Sunde, 2012). Selenium occurs in two forms: non-organic (selenates and selenites) and organic (Se-methionine and Se-cysteine). Both selenium forms were approved for human and animal nutrition (Sunde, 2006). As a component of selenoproteins, selenium plays an important biological function in organisms (Van Cauwenbergh et al., 2004), especially as a

* Studies were financed by the statutory grant of the Ministry of Science and Higher Education within the frames of a Scientific and Research Plan of the National Research Institute of Animal Production.

cofactor of glutathione peroxidase enzyme (GPx) that reduces lipid oxidation in cells by catalyzing the reduction of peroxides, including hydroxides (Navarro-Alarcon et al., 2005). Selenium is an element essential for life and strictly correlated with health of human populations (Navarro-Alarcon and Cabrera-Vique, 2008). Correlations between the occurrence of cardiopathies and low selenium level in the environment, diet and blood of patients were demonstrated. It was also shown that low selenium content in blood serum and plasma of patients was strictly associated with the occurrence of cardiovascular system diseases such as arterial hypertension, myocardial infarction, chronic myocardial diseases, coronary atherosclerosis or myocardial ischemia (Navarro-Alarcon and Lòpez-Martinez, 2000; Wei et al., 2004; Navas-Acient et al., 2008). It was observed that selenium, as an antioxidant, plays the protective role in prevention of neoplastic conditions (Donaldson, 2004). Low selenium content in daily diet, including milk and dairy products, had dangerous consequences for human health. The effects of low selenium level in blood, that is the occurrence of hepatopathy and liver neoplasms, were studied and described well (Navarro-Alarcon et al., 2002). Due to considerable milk consumption in the European Union, at the level of 150–240 litres per person, studies in search for possibilities of increasing selenium content in food, including consumer milk and dairy products, were developed.

In some regions of Europe there are selenium deficits in plants and food and its content in food products on the entire continent ranges from low to moderate (Hartikainen, 2005). It was demonstrated that organic forms of selenium are better assimilable by animals and humans (Rayman et al., 2008; Hu et al., 2008). Analysis of components of human diet showed that products of animal origin, especially derived from animals that were fed cereal grain, leguminous plants and feeds of animal origin, contained more selenium (Pilarczyk et al., 2009). Among the products of animal origin, selenium content in consumer milk and milk-derived products is important for human diet. It is assumed that milk and dairy products constitute approximately 15-20% of human diet in moderate climate on the northern and southern hemisphere.

In the 1990s, selenium content in milk from cows in Poland ranged from 4.8 μg kg-1 to 14.4 μg kg-1 of milk (Dębski and Żarski, 1990). Further studies revealed that selenium content in milk primarily depends on selenium supply in feed ration for cows and may reach 20 μg Se/kg of milk (Brzóska and Brzóska, 2004; Wiewióra et al., 2004).

In the available literature there are fragmentary information on selenium content in milk in Poland, concerning few selected regions. Selenium level in consumer milk that is drunk in the entire country is not known. Analyses of milk collected from milking machines in Szczecin region revealed seasonal fluctuations in selenium content in milk, from 22 μg Se/kg (spring), through 13 μg Se/kg (summer), 34 μg Se/kg (autumn) to 25 μg Se/kg of milk (winter) (Mituniewicz-Małek et al., 2017). These concerned raw and unprocessed milk at the stage of collection.

The aim of monitoring studies was to determine selenium content in

consumer milk sold in 16 large-format food stores in the largest cities in Poland and in milk originating from 13 manufacturers of consumer milk in Poland as well as in milk imported from France and the European Union.

Material and methods

Gathering milk samples

Study material consisted of randomly selected UHT consumer milk samples with extended shelf life. Five to six 1-litre containers of milk with various fat content (from 0.5 to 3.2%) were purchased in large-format food stores located in each of 16 cities (table 1) and from 13 manufacturers of consumer milk in Poland, and 3 milk samples were imported from the European Union (table 2). The milk was purchased on 13 May, 23 August and 7 September 2014. On the same day or on the next day, milk samples were transported by car to the Central Laboratory of the National Research Institute of Animal Production (Aleksandrowice/Kraków), stored at 5ºC and immediately analysed for selenium content.

Table 1. Selenium content in consumer milk in relation to city of purchase

City of milk purchase	No. of samples	Selenium content (µg/litre milk)				
		Average	SD	CV%	Min.	Max.
Bydgoszcz	6	10.49	3.40	32.4	5.78	15.97
Gdańsk	6	8.44	1.60	19.0	7.50	11.09
Katowice	6	8.80	1.67	19.0	6.50	11.46
Kielce	6	6.93	1.97	28.4	5.14	10.28
Kraków	6	8.80	1.70	19.3		
Lublin	5	9.46	2.90	30.7	6.96	14.39
Łódź	6	8.84	3.84	43.4	6.61	16.60
Olsztyn	6	8.61	0.78	9.1	7.60	9.98
Opole	6	10.03	1.27	12.7	8.36	12.26
Poznań	6	11.10	1.64	9.4	9.32	12.56
Rzeszów	6	7.83	1.25	16.0	5.48	8.94
Siedlce	6	9.23	1.30	14.1	7.90	11.60
Szczecin	6	8.65	1.89	21.8	5.15	10.61
Warszawa	6	8.36	2.17	26.0	4.67	11.15
Wrocław	6	8.65	1.23	12.6	8.34	11.70
Zielona Góra	6	7.83	1.25	16.6	5.48	8.94
Total average	95	9.01				
SD			2.26			
CV%				25.1		
Range					4.67	16.60

Table 2. Selenium content in consumer milk in relation to location of the manufacturer

Milk cooperative	No. of samples	Selenium content (µg/litre milk)				
		average	SD	CV%	min.	max.
Łowicz	14	9.98	1.19	11.18	8.60	11.46
Raciąż	3	5.32	0.17	3.2	5.15	5.48
Grajewo	23	7.57	1.19	15.7	5.18	9.98
Radzyń Podlaski	1	9.04	-	-	9.0	9.0
Sieradz	4	9.89	1.15	12.6	8.72	11.37
Wysokie Mazowieckie	23	8.28	0.90	10.8	6.50	9.85
Nowy Targ	3	5.81	1.70	19.3	5.14	6.50
Krasnystaw	1	14.39	-	-	14.4	14.4
Gostyń	1	9.81	-	-	9.1	9.1
Kościan	2	10.76	2.69	25.1	8.76	12.56
Wyszyny	1	11.73	-	-	11.7	11.7
Jabłonowo Pomorskie	1	11.82	-	-	11.8	11.8
Rypin	13	9.68	1.23	12.7	7.68	12.16
Gdańsk	2	8.64	0.42	4.9	8.34	8.94
EU/France	3	14.39	2.81	19.5	11.15	16.06
Total average	95	9.81				
SD			2.45			
CV%				25.0		
Range					5.32	14.39

Method of assessment of selenium content in milk

Selenium content in milk samples was determined by atomic absorption spectroscopy method (AAS GBC model, Avanta company, Australia) with the use of hydride generation technique, after prior mineralization. The samples were mineralized in a mixture of nitric acid and perchloric acid, in a microwave digestion system (Ethos Plus, Milstone company, Italy), in Teflon cuvettes, in two mineralization cycles of 20 minutes each.

Statistical analyses

Results of selenium analyses were developed by the calculation of average values for experimental factors, standard deviation (SD), coefficient of variation (CV) and range for the average value (from – to). The results were reported according to location of purchase and milk manufacturer (dairy cooperative/dairy company).

Results

Selenium content in Polish consumer milk ranged from 4.67 to 16.60 µg/litre, whereas the average concentration amounted to 9.01 µg/litre. Coefficient of

variation, amounting to 25.1%, indicated large diversification in selenium content as well. The highest selenium content was detected in consumer milk samples from Poznań 11.10±1.64 μg/litre, Bydgoszcz 10.49±3.40 μg/litre and Opole 10.03±1.27 μg/litre. The lowest selenium content was observed in milk samples from Kielce (6.93±1.97 μg/litre), Rzeszów 7.83±1.25 μg/litre and Zielona Góra 7.83±1.25 μg/litre (table 1). High selenium content (14.4±2.81 μg/litre) compared to the Polish milk was noted in French milk (European Union) (table 2).

Among 13 dairy cooperatives and dairy companies, the highest selenium content was detected in consumer milk from the dairy cooperative in Krasnystaw and it amounted to 14.4±0.0 μg/litre. However, the lowest selenium content, amounting to 5.3±0.17 μg/litre, was observed in milk samples from Raciąż dairy cooperative (Mazowsze region). Selenium content in the milk from 46 samples originating from the largest milk manufacturers in Poland (Dairy Cooperative MLEKPOL in Grajewo and Dairy Cooperative MLEKOVITA in Wysokie Mazowieckie) was 7.57±1.19 and 8.28±0.90 μg/litre, respectively. Milk from both production plants constituted 50% of consumer milk samples gathered in Poland.

Discussion of the results

Selenium level in cow's milk is tightly correlated with its content in feed ration and thus in roughage feeds and compound feeds. Selenium level in fodder plants and grain of fodder cereals growing on the territory of Poland was analysed in the previous studies, on the basis of samples originating from the stations of the Research Centre for Cultivar Testing in Słupia Wielka, located in various soil and environmental conditions in the country. Selenium content in 115 samples of fodder plants (meadow fescue, orchard grass, white and red clover, corn for silage) originating from various regions of the country, in two following years amounted to on average 46.87 (0.07–123.56) μg of Se/kg of DM (Brzóska et al., 2003a). Analysis of 142 grain samples of fodder cereals (winter wheat, spring barley, winter rye, corn cobs) demonstrated the content of 70.96 (25.29–307.81) μg of Se/kg of DM (Brzóska et al., 2003b). Low selenium level in the seeds of leguminous plants and cereal grains was also revealed in the previous studies by Korol et al. (1987; 1992).

Results of the previous studies suggest that selenium content in fodder plants and cereal grains in Poland fluctuates in a wide range, indicating a high variability of selenium content in Polish soils. Higher selenium content may be expected in food products derived from monogastric animals that are fed cereal diets, such as broiler chickens and fattening pigs, as well as from dairy cows administered with feed rations with higher content of compound feeds containing mineral feed additives. In monitoring studies by Korol et al. (2013), selenium level in compound feeds for cows amounted to on average 0.23 mg/kg (0.08–0.58). Selenium content in vitamin and mineral compound feeds for cows, declared by their manufacturers, amounts to 30-50 mg of Se/kg of feed (Korol et al., 2013).

Selenium requirement in dairy cows was estimated to be 0.200 mg/kg of dry mass of feed ration, and its maximum level was established at 0.500 mg/kg (MAFF, 1984). It means that a cow in full lactation, with annual milk yield of 8-12,000 kg of milk per lactation, consuming 24-28 kg of dry mass per day, should receive 4.8–5.6 mg of selenium per day. Red and white lowland cows were administered with doses containing 0.12; 0.24 and 0.48 mg of sodium selenate/kg of DM at consumption of approximately 20 kg of DM/day and daily yield of 25 kg of milk, which meant that they received 2.4; 4.8 and 9.6 mg of Se/day that caused an increase in milk selenium level up to 14.5; 18.96 and 21.09 μg of Se/kg of milk, respectively. Cows that were given feeds without selenium received 0.40 mg of Se and selenium level in their milk amounted to 10.2 μg of Se/kg (Brzóska and Brzóska, 2004). In the other studies, 8-week administration of organic selenium (Se-methionine and Se-cysteine) to Simental cows, in the amount of 1, 2, 4 and 6 mg of Se/cow/day (with selenium content of 0.42 mg of Se at the dose without Se addition) increased selenium level in cow's milk up to 31, 53, 81 and 94 μg of Se/kg of milk (Csapò et al., 2015). Six weeks after withdrawal of selenium administration, selenium level in milk decreased to the level before the experiment. Results of these studies indicate that organic selenium forms are better assimilated by cows compared to our national studies, in which sodium selenate was used as an additive, and that stopping the supplementation of dairy cows leads to a decrease in selenium content in milk in a short time (Brzóska and Brzóska, 2004). A close correlation between selenium level in feed ration and selenium content in milk measured by correlation coefficient, where r2 ranged between 0.96–0.99, was demonstrated (Givens et al., 2004). A comparison of the results of previous studies (Brzóska and Brzóska, 2004) and the currently obtained results indicated that 11 manufacturers of consumer milk in Poland do not use vitamin and mineral feed premixes containing selenium, because in the above-mentioned studies, selenium content in milk corresponded to the control group not receiving selenium.

Selenium content in milk of cows from the European countries falls within a wide range. In Finland, before the introduction of selenium to fertilization of agricultural crops, selenium level in cow's milk amounted to 25 μg/litre (Aro et al., 1995), whereas after the introduction of selenium fertilization it increased to 67–110 μg/litre (Anttolainen et al., 1996). In other countries, selenium concentration in cow's milk amounted to: 110 μg/litre in Greece (Bratakos et al., 1990), 41-90 μg/litre in Hungary (Alfthan et al., 1992), 12-43 μg/litre in England (Barclay et al., 1995) and 30-60 μg/litre in Scotland (MacPherson et al., 1997; Shortt et al., 1997). These data indicate that selenium level in cow's milk in the selected European countries is significantly higher compared to the level observed in Poland.

The recommended levels of human selenium requirement depend on age and range between 15 and 55 μg of Se/day (from the newborns to women and men at the age of 55), 60 μg of Se/day in pregnant women and 70 μg of Se/day in breast-feeding women (U.S. Department of Health and Human Services). In this context,

the average selenium content in consumer milk in Poland, amounting to 9.01 μg of Se/kg, is very low and in people consuming 250 ml of milk or other dairy products it covers the daily requirement only at the following levels: 15.0% in newborns, 4.1% in adults, 3.8% in pregnant women and 3.2% in breast-feeding women. Assuming the average selenium content in milk for the entire country, coverage of inhabitant requirement for selenium is low, since in 10 out of 16 cities in Poland it was lower than the mean level for the country by on average 16%. Dębski et al. (2001) demonstrated that selenium deficit is present on 77% of the territory of Poland, whereas 23% corresponds to an area of satisfactory Se level in food, 42% represents moderate deficiency and 12% – significant deficit. Regions of significant selenium deficiency in the European Union include Finland (Hartikainen, 2005) and Hungary (Csapò et al., 2015). Soil fertilization with addition of mineral selenium in Finland increased selenium level in milk, eggs and meat by 2 to 8 times (Hartikainen, 2005). After stopping selenium fertilization, its content in post-glacial soils and fodder plants quickly decreased and after 3-4 years became the same as on the areas that had not been fertilized before. Selenium content in milk may fluctuate in a wide range, depending on the spring-summer and autumn-winter seasons. This relation was described in a study by Mituniewicz-Małek et al. (2017), where in autumn-winter period, selenium level in milk was by approximately 41% higher compared to spring-summer period.

Selenium content in milk in Poland is a result of moderate selenium content in fodder plants and cereals (Brzóska et al., 2003a, b) as well as low selenium supply in feed rations for cows (Pilarczyk et al., 2009). Compound feeds manufactured by industrial methods contain mineral ingredients essential for cows, including selenium. Manufacturers of vitamin and mineral compound feeds for cattle declare that selenium content in their products amounts to 40-50 mg of Se/kg, whereas the recommended dose is 100-200 g/day (Korol et al., 2013). This means that cows take 4-5 mg of selenium. Administration of vitamin and mineral compound feeds (premixes) covers selenium requirement of high-yielding dairy cows. In the light of the previous studies (Brzóska and Brzóska, 2004), this level of selenium supply for lactating cows should guarantee a 2-fold higher selenium level in milk than the level that was detected in milk in Poland. In cow's milk, selenium mainly occurs in the form of selenoproteins, so it is present in dairy products containing proteins, such as cottage cheese, ripened cheese, kefir, powdered milk and yoghurt. Monitoring studies on selenium content in food in the north-western region of Poland (Szczecin), including dairy products, revealed the following selenium content: 20 μg/litre in milk; 12 μg/litre in kefir; 10 μg/litre in yoghurt; 72 μg/kg in cottage cheese; 88 μg/kg in Edamski cheese; 22 μg/kg in smoked cow cheese and 28 μg/kg in unsmoked cheese (Pilarczyk et al., 2010). In our study, results on selenium content in milk verify the data presented above in relation to the entire country and various manufacturers of consumer milk.

In Poland, production of compound feeds for ruminants, mainly cows, amounts to approximately 1 million tons per year, which is a quite low value for 2 million

cows. A characteristic feature of cow feeding in Poland, especially in case of smaller herds that are prevailing in the general cow population, is the fact that farmers make compound feeds themselves, based on their own cereals, soybean or rapeseed meal and feed phosphates, salt and fodder chalk derived from free sale, neglecting the use of feed premixes, containing among others iodine and selenium, in cow feeding. Salt licks (briquettes) contain iodine, but they do not contain selenium. The attempts of adding selenium to salt licks in the Kłodawa Salt Mine were abandoned due to excessive selenium loss during the process of pressure pressing of salt briquettes, which posed a danger of excessive selenium absorption by people working near the presses (Brzóska – author's own information). Many cows in Poland are deprived of trace elements, which from the consumers point of view has a negative effect on their health condition and milk quality.

The studies have shown that selenium content in milk in Poland varied depending on the region of purchase and localization of consumer milk manufacturer. Selenium content in consumer milk originating from Podlasie region (Dairy Cooperative MLEKPOL in Grajewo and Dairy Cooperative MLEKOVITA in Wysokie Mazowieckie) and in the cities where milk from these manufacturers were sold, was particularly low. The analysis of milk samples randomly selected in shops has shown that milk originating from Podlasie region constituted more than 50% of the analysed milk samples.

Cardiac conditions and neoplastic diseases are the main factor of premature deaths of inhabitants of Poland. Increasing selenium content in cow's milk in Poland is a significant element of improvement of consumer milk influence on health condition of inhabitants in a population scale.

Conclusions

The performed studies enabled to conclude that:

– Selenium values in cow's milk in Poland are low, which can be a result of very low selenium content in soils and low selenium supply in feed rations.

– Milk manufacturers should be aware that if dairy cows are not administered with vitamin and mineral compound feeds, the so-called feed premixes containing selenium, their milk yield is lower and the period of dairy use is shorter.

– Low selenium level in consumer milk in Poland may result in serious conditions in consumers of milk and dairy products.

References

Alfthan G., Bogye G., Aro A., Peher J. (1992). The human selenium status in Hungary. J. Trace Elem. Electrolytes Health Dis., 6: 233-238.

Anttolainen M., Vaista L.M., Alfthan G., Keemola P., Salminen I., Tamminen M. (1996). Effect of extreme fish consumption on dietary and plasma antioxidant levels and fatty acid composition. Eur. J. Clin. Nutr., 50: 741-746.

A r o A., A l f t h a n G., Va r o P. (1995). Effects of supplementation of fertilizers on human selenium status in Finland. Analyst, 120: 841-843.
B a r c l a y M.N.I., M a c P h e r s o n A., D i x o n J. (1995). Selenium content of a range of UK foods. J. Food Comp. Anal., 8: 307-318.
B r a t a k o s M.S., K a n a k i K., Va s i l i o v - Wa i t e A., I o a n n o u P. (1990). The nutritional selenium status of healthy Greeks. Sci. Total Environ., 96: 161-176.
B r z ó s k a F., B r z ó s k a B. (2004). Effect of dietary selenium on milk yield of cows and chemical composition of milk and blood. Ann. Anim. Sci., 4 (1): 57-67.
B r z ó s k a F., B r z e z i ń s k i W., B r z ó s k a B. (2003a). Mineral nutrients in Polish feedstuffs. Part 1.Fodder plants. Ann. Anim. Sci., 3 (1): 115-126.
B r z ó s k a F., B r z e z i ń s k i W., B r z ó s k a B. (2003b). Mineral nutrients in Polish feedstuffs. Part 2. Cereal grains. Ann. Anim. Sci., 3 (2): 311–321
C s a p ò J., H o l l ò G., H o l l ò I., S a l a m o n R.V., S a l a m o n Sz., T o r ò Sz. (2015). Production of selenium-enriched milk and dairy products. Acta Univ. Sapientiae, Alimentaria, 8: 5-29.
D ę b s k i B., Ż a r s k i T. (1990). Rola selenu u bydła i owiec. Prz. Hod., 9–10: 15-17.
D ę b s k i B., Z a c h a r a B., W ą s o w i c z W. (2001). Próby oceny poziomu selenu w Polsce oraz jego wpływ na zdrowotność ludzi i zwierząt. Folia Univ. Agric. Scien. Zootechnica, 224 (42): 53-62.
D o n a l d s o n M.S. (2004). Nutrition and cancer: a review of the evidence for an anti-cancer diet. Nutr. J., 3: 19-31.
G i v e n s D.I., A l l i s o n R., C o t t r i f f B., B l a k e J.S. (2004). Enhancing the selenium content of bovine milk through alteration of the form and concentration of selenium in the diet of the dairy cow. J. Sci. Food Agric., 54 (8): 811-817.
H a r t i k a i n e n H. (2005). Biogeochemistry of selenium and its impact on food chain quality and human health. J. Trace Elem. Med. Biol., 18: 309-318.
H u Y., M c I n t o s h G.H., L e L e u R.K., Wo o d m a n R., Yo u n g G.P. (2008). Suppression of colorectal oncogenesis by selenium-enriched milk proteins: apoptosis and K-ras mutations. Cancer Research, 68: 4936-4944.
K o r o l W., M a t y k a S., R ą c z k i e w i c z J. (1987). Zawartość selenu w nasionach roślin strączkowych grubonasiennych. Annales UMCS, Sectio E, vol. XLII, 23: 255-259.
K o r o l W., M o j e k E., G r a b o w s k i C. (1992). Zawartość selenu w ziarnie zbóż. Biul. Inf. Przem. Pasz., 31 (2): 37-44.
K o r o l W., R u b a j J., B i e l e c k a G. (2013). Zawartość selenu, kobaltu i molibdenu w krajowych mieszankach paszowych. Rocz. Nauk. Zoot., 40 (1): 55-64.
M a c P h e r s o n A., B a r c l a y M.N.I., S c o t t R., Ya t e s R.W.S. (1997). Loss of Canadian wheat imports lowers selenium intake and status of the Scottish population. Fisher P.W.F., L'Abbe M.R., Cockell K.A., Gibson R.S. (Eds). Trace Elements in Man and Animals-9, NRC Research Press, Ottawa (1997), pp. 203–205.
MAFF, DAFS, DANI, UKASTA, BVA Working Party Report (1984). Mineral, trace element and vitamin allowances for ruminant livestock, pp. 113–141.
Mituniewicz-Małek A., Pilarczyk B., Tomza-Marciniak A., Pilarczyk R., Bąkowska M. (2017). The content of selenium in cow milk from milk machines in Szczecin in accordance to a season. Act Sci. Pol. Zoot., 16 (3): 53-56.
N a v a r r o - A l a r c o n M., C a b r e r a - V i q u e C. (2008). Selenium in food and the human body: A review. Science of the Total Environment, 400: 115-141.
N a v a r r o - A l a r c o n M., L ò p e z - M a r t i n e z M.C. (2000). Essentiality of selenium in the human body: relationship with different diseases. Sci. Total. Environ., 249: 347-371.
Navarro-Alarcon M., Lopez G., de la Serrana H., Perez-Valero V., Lopez Martinze M.C. (2002). Selenium concentrations in serum of individuals with liver diseases (cirrhosis or hepatitis): relationship with some nutritional and biochemical markers. Sci. Total Environ., 291: 135-141.
N a v a r r o-A l a r c o n M., G i l H e r n á n d e z F., G i l H e r n á n d e z A. (2005). Selenio, manganeso, cromo, molibdeno, yodio i otros oligoelementos minoritarios. Gil Hernández A. (Ed.), Tratado de Nutritiòn Torno I: Bases fisiològicas y Bioquimicas de la Nutritiòn, Acciòn Medica, Madrid (2005), pp. 997–1036.
N a v a s - A c i e n t A., B l e y s J., G u a l l a r E. (2008). Selenium intake and cardiovascular risk: what is new? Curr. Opin. Lipidol., 19: 43-49.

Pilarczyk B., Balicka-Ramisz A., Mituniewicz-Małek A., Ramisz A., Sablik P., Dmytrów I. (2009). Selengehalte in Blutserum, in der Kuhmilch und in ihren Produkten in Westpommern. Tierärztl. Umschau, 64: 327-331.

Pilarczyk B., Tomza-Marciniak A., Mituniewicz-Małek A., W ieczorek M., Pilarczyk R., Wójcik J., Balicka-Ramisz A., Bakowska M., Dmytrów I. (2010). Selenium content in selected products of animal origin and estimation of the degree of cover daily Se requirement in Poland. Inter. J. Food Sci. Technol., 45: 186-191.

R a y m a n M.P., G o e n a g a H., S a r g e n t M. (2008). Food chain selenium and human health: spotlight on speciation. Br. J. Nutr., 100: 238-253.

Shortt C.T., Duthie G.C., Robertson J.D., Morrice P.C., Nicol F., Arthur J.R. (1997). Selenium status of a group of Scottish adults. Eur. J. Clin. Nutr., 51: 400-404.

S u n d e R.A. (2006). Selenium. In: Present Knowledge in Nutrition. Bowman B., Ryssell R. (Eds). 9th Ed. Washington D.C; International Life Science Institute, pp. 480–497.

S u n d e R.A. (2012). Selenium. In: Modern Nutrition in Health and Disease. Ross A.G., Caballero B., Cousins R.J., Tucker K.L., Ziegler T.R. (Eds). 11 ed. Philadelphia, PA: Lippincott Williams & Wilkins, pp. 225–37.

U.S. Department of Agriculture, U.S. Department of Health and Human Services. Dietary Guidelines for Americans (2010). 7th Edition. Washington.

Van Cauwenbergh R.V., Robberectht H., Va Vlaslaer V. (2004). Comparison of the serum selenium content of healthy adults living in the Antwerp region (Belgium) with recent literature data. J. Trace Elem. Med. Biol., 18: 99-112.

We i W.G., A b n e t C.C., Q i a o Y.L., D a w s e y S.M., D o n g Z.W., S u n X.D. (2004). Prospective study of serum selenium concentrations and esophageal and gastric cardia cancer, heart disease, stroke and total death. Am. J. Clin. Nutr., 79: 80-85.

W i e w i ó r a W., B r z ó s k a F., B r z ó s k a B., P i e t r a s M. (2004). Iodine and selenium concentration in cow's milk and plasma and its relations to milk yield, mineral content and selected metabolic parameters. Ann. Anim. Sci., 4 (1): 79-90.

Accepted for print on 7 August 2018

FRANCISZEK BRZÓSKA, BOGDAN ŚLIWIŃSKI, MARIUSZ PIETRAS

Selenium content in consumer milk in Poland

SUMMARY

The aim of the study was to determine selenium content of consumer milk in Poland. Samples for analyses were collected in three periods (spring, summer and autumn) from large-format food stores located in 16 cities of Poland. The milk samples originated from the 13 largest manufacturers of consumer milk. The study material consisted of UHT pasteurized milk with extended shelf life. In each store, 5 to 6 1-litre containers of milk with 0.5 to 3.2% fat were randomly chosen and purchased. A total of 95 milk samples were gathered, including 3 samples of milk from the European Union, one of which came from France. The results were reported according to location of purchase and milk producer (dairy cooperative/ dairy company). The average milk selenium content was 9.01±2.26 μg/litre (range from 4.67 to 16.60 μg/ litre). The highest selenium content was observed in the milk samples from Poznań (11.10±1.64 μg/litre) and the lowest in the milk samples from Kielce (6.93±1.97 μg/litre). In the Polish milk, selenium content was highest in 1 milk sample from the Dairy Cooperative in Krasnystaw (14.4±0.0 μg/litre). The highest selenium content was found in 3 samples of milk from France and unidentified European Union countries (14.4±2.81 μg/litre). Selenium content in the milk from 46 samples originating from the largest milk producers (Dairy Cooperative MLEKPOL in Grajewo and Dairy Cooperative MLEKOVITA in Wysokie Mazowieckie) was 7.6±1.19 and 8.3±0.90 μg/litre, respectively.

Key words: selenium, consumer milk, Poland, region, milk manufacturer