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Essential minerals in milk and their daily intake through milk consumption

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Summary

Minerals occur in all foodstuffs as well as in milk and dairy products. The mineral content in milk is influenced by many factors ranging from environmental conditions during pasture, feeding, breeding, stage of lactation and climate to post-milking handling, transportation and processing. The aim of the study was to assess whether the intakes comply with Recommended Dietary Allowances (RDA), Adequate Intakes (AIs) or Tolerable Upper Intake Levels (ULs) for essential elements. Milk samples from different producers and with different fat content were purchased from Zagreb's market four times in year 2007 and analysed. Concentrations of ten minerals (Ca, P, Mg, Fe, Cu, Zn, Mn, Ni, K and Na) were determined by atomic absorption spectrometry. Mean values of mineral contents were in range with the literature data. The daily intakes of these minerals by school children selected in age-gender groups (school children 8-9 years old and adolescents 15-18 years old) through milk consumption were also estimated. The average daily intake of essential minerals ranged from a minimum of 1.36 % of manganese up to 35.27 for phosphorus, irrespective of age and gender of children.

Key words: milk, minerals, mineral intakes

Introduction

Minerals, like vitamins, are a group of important nutrients. Although they make up only 4 % of body weight they are a part of every tissue, fluid, cell and organ in the human body. There is significant evidence that minerals, by themselves and in proper balance to one another, have important biochemical and nutritional functions (Pike and Brown, 1984). There are twenty minerals that are considered to be nutritionally essential. Sometimes minerals are classified as macrominerals (sodium, potassium, chloride, calcium, magnesium and phosphorus) and as trace elements (iron, copper, zinc, manganese, selenium, iodine, chromium, cobalt, molybdenum, fluoride, arsenic, nickel, silicon and boron) and all of them are present in milk at some concentration (Cashman, 2006). The main elements are essential for human beings in amounts >50 mg/day, while trace elements are essential in concentration <50 mg/day and their biochemical actions have been elucidated (Belitz et al., 2004). Some minerals have no known beneficial biological function and long-term, high level exposures may be harmful to health. For instance, organic mercury compounds are neurotoxins, exposure to lead can be harmful to neuropsychological development, inorganic arsenic is a human carcinogen, cadmium can affect renal function and high concentrations of tin in food can cause stomach upsets. Some elements, such as copper, chromium, selenium and zinc are essential to health but may be toxic at high levels of exposure (Ministry of Agriculture, Fisheries and Food, 1998ab; Martino et al., 2000). Minerals are constituents of the bones, teeth, soft tissue, muscle, blood, and nerve cells. They are vital to overall mental and physical well-being. Minerals act as catalysts for many biological reactions within the body, including muscle

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response, the transmission of messages through the nervous system, and the utilization of nutrients in food (Anonymous 1, 2010).

The mineral concentration in raw cow's milk vary according to different factors, such as lactation period, animal species and health status, season, climate, dietary composition of animal feed, environmental contamination (Coni et al., 1994; Coni et al., 1995; Licata et al., 2004; Orak et al., 2000; Rodríguez Rodríguez et al., 2001). Also, processing conditions can have a significant effect on content and ratio of mineral compounds in milk (Coni et al., 1994; Coni et al., 1995; Zurera - Cosano et al., 1994; Licata et al., 2004; Lante et al., 2006). Minerals and trace elements in cow's milk occur as inorganic ions and form complexes with proteins, peptides, carbohydrates, fats and small molecules. The main mineral binder or chelators of calcium are the caseins, alphas 1-casein, alphas 2-casein, beta casein and kappa casein, but also whey proteins and lactoferin bind specific minerals like calcium, magnesium, zinc, iron, sodium and potassium (Vegarud et. al., 2000).

In the case of essential minerals this is the Recommended Dietary Allowances (RDA), a set of nutrient standards established by Committee on Dietary Allowances or Adequate Intakes (AIs) or Tolerable Upper Intake Levels (ULs). The RDA is the average daily intake of energy and nutrients considered adequate to meet the needs of almost all (97-98 %) healthy infants, children and people. RDAs and AIs may both be used as goals for individual intake. For healthy breastfed infant, the adequate intake (AI) is the mean intake. The AI for other life stage and gender groups is believed to cover the needs of all individuals in the group, but lack of data prevents ability to specify with confidence the percentage of individuals covered by this intake. The Tolerable Upper Intake Levels (ULs) is the highest level of daily nutrient intake that is likely to pose no risk of adverse health effects for almost all individuals (Anonymous 2, 2010).

The aim of this study was twofold: monitoring of minerals content in milk samples (pasteurised and sterilised milk samples from different producers and with different fat content) through one year (spring-winter 2007) and to assess whether daily intakes of 10 essential minerals by school children through milk consumption comply with RDAs, AIs and ULs.

Materials and methods

Cow's milk samples, pasteurised or sterilised, from different producers and with different fat content, were purchased on Zagreb's market four times (each season) through year 2007. The samples were labelled as follows: A - pasteurised milk samples with 2.8 % fat content; B - sterilised skimmed milk samples with 0.9 % fat content; C - sterilised partially skimmed milk samples with 1.6 % fat content; D - sterilised semi-skimmed milk samples with 2.8 % fat content; E - sterilised whole milk samples with 3.6 % fat content. The N was total number of analysed samples obtained by multiplying number of producers (2, 3 or 7) with number of sampling (4x).
A Muffle furnace was used for ash determination in milk samples. A flame atomic absorption spectrometry (AAS, Varian, SpectrAA 220) was used for determination of minerals content such as Ca, P, Mg, Fe, Zn, Cu, Ni, Mn, K, Na (AOAC, 2000ab).

Subjects were school children recruited from public primary and secondary schools, age 8-9 years and 15-18 years (Table 1). Parents were informed about the survey from the school principals and their consent was obtained. Food consumption as well as sterilised milk samples with 2.8 % fat content, were monitored with a specially designed completely quantified Food Frequency Questionnaire (FFQ) (Macdonald, 1991). The method was found useful in measuring intakes for a variety of nutrients (Pao and Cypel, 1990; Surrao et al., 1998; Cavadini et al., 1999; Moore et al., 2005).

The questionnaire contained a list of 83 different items and enough space for adding foods that are consumed but were not listed. Available frequencies of food consumption were: "Never", "At least once a month", "2-3 times a month", "1-2 times a week", "3-4 times a week", "5-6 times a week", "Once a day" and "More than once a day". Quantities were described as units of serving (piece, plate, cup, spoon, etc.). To determine the weight of portion sizes predefined measures were used (Colić, 1987). Records were converted to quantities by using own results of determination of mineral content in milk samples. The survey for children was obtained from parents who received the FFQ and were informed how to fill it and also received written instructions and pictures explaining portion sizes. Parental reports of children's diet using FFQ methods seem

Table 1. Subjects defined by the age and gender
Tablica 1. Ispitanici prema starosti i spolu

Parameters / Parametri	8-9 years/8-9 godina			15-18 years/15-18 godina		
	Boys / Dječaci	Girls / Djevojčice	Σ	Male / Muški	Female / Ženski	Σ
N (number)/N (broj)	52	48	100	51	57	108
Age (mean)/Uzrast (prosjek)	8.65	8.79	8.72	16.05	15.82	15.93

accurate enough to be useful in nutrition screening (Byers et al., 1993). Information from adolescents was obtained in a form of a personal interview with trained interviewers. Subjects were explained the importance of honesty and correct reporting of food intake. Such information seem to affect accuracy of food intake reporting (Vuckovic at al., 2000). Portion sizes were demonstrated with dish models and serving utensils. Each questionnaire required approximately 80 minutes to complete.

Results and discussion

Essential minerals are key factor in many biochemical and nutritional functions in human body. Depending on their concentration, of their mutual ratio they can act as nutrients, sometimes as poisons and their deficiency could result by some diseases (Anonymous 1, 2010; Belitz et al., 2004; Brewer, 2010). Milk is an important source of macronutrients (proteins, lipids and carbohydrates) and micronutrients (minerals, vitamins and enzymes). All minerals, considered to be essential to the human diet, are present in milk, so milk as major source of nutrients in child and adolescent nutrition is a good source of essential minerals (Whitney et al., 1990). In this research, pasteurised and sterilised cow's milk with different fat content were investigated. Mean values and standard deviation for concentrations of essential minerals in all investigated samples in period from spring to winter 2007 are given in Table 2. Among macrominerals, the highest concentration was found of potassium, followed by phosporus, calcium, sodium and magnesium. The trace elements were in concentrations almost lower than 1 mg/L with zinc exception (cca 3.5 mg/L). With

Table 2. Mineral content (mg/L) (x±σ) in all investigated milk samples collected in period spring - winter 2007.
Tablica 2. Udjel minerala (mg/L) (x±σ) u svim ispitivanim uzorcima mlijeka sakupljenih u razdoblju proljeće - zima 2007. godine

Samples / Uzorci	Ca	P	Mg	Fe	Cu	Zn	Mn	Ni	K	Na
	Mineral content/Udjel minerala (x±σ) (mg/L)									
A	901.2	930.6	110.8	0.70	0.19	3.22	0.050	0.0896	1560.7	490.1
N=28	±80.2	±49.4	±17.4	±0.27	±0.10	±0.23	±0.08	±0.01	±321.7	±87.1
B	886.3	1053.2	115.5	0.53	0.17	3.51	0.050	0.0959	1582.1	468.5
N=12	±82.9	±23.2	±21.8	±0.15	±0.01	±0.10	±0.07	±0.02	±289.1	±91.3
C	845.7	964.7	120.2	0.99	0.19	3.25	0.058	0.0837	1575.5	463.1
N=12	±30.6	±59.7	±12.1	±0.83	±0.06	±0.32	±0.13	±0.01	±232.6	±68.6
D	900.7	927.8	115.0	0.55	0.14	3.80	0.055	0.0724	1565.4	466.3
N=12	±139.4	±40.1	±27.4	±0.10	±0.04	±0.15	±0.09	±0.01	±247.4	±96.2
E	927.8	967.4	122.7	0.59	0.24	3.66	0.068	0.0965	1580	492.7
N=8	±27.1	±29.8	±15.3	±0.34	±0.03	±0.35	±0.11	±0.05	±231.0	±75.1

A - pasteurised milk samples with 2.8 % fat content/uzorci pasteriziranog mlijeka s 2,8 % m.m.; B - sterilised skimmed milk samples with 0.9 % fat content/uzorci steriliziranog obranog mlijeka sa 0,9 % m.m.; C - sterilised partially skimmed milk samples with 1.6 % fat content/uzorci steriliziranog djelomično obranog mlijeka sa 1,6 % m.m.; D - sterilised semi-skimmed milk samples with 2.8 % fat content/uzorci steriliziranog poluobranog mlijeka sa 2,8 % m.m.; E - sterilised whole milk samples with 3.6 % fat content/uzorci steriliziranog mlijeka sa 3,6 % m.m.

Table 3. Daily intake of semi-skimmed milk with 2.8 % milk fat (mL/day) (x±σ)
Tablica 3. Dnevni unos djelomično obranog mlijeka sa 2,8 % mliječne masti (mL/dan) (x±σ)

Age/Uzrast	Examinees Ispitanici	Milk quantity/Količina mlijeka (mL/dan) (x±σ)
8-9 years/8-9 godina	Males/Muški	463.7±230.3
	Females/Ženski	468.9±196.8
	Everybody/ Svi	466.2±214.1
15-18 years/15-18 godina	Males/Muški	505.8±285.1
	Females/Ženski	447.8±267.4
	Everybody/ Svi	475.2±275.7

some exceptions, these results are similar to those found by other investigators (Rodríguez Rodríguez et al., 2001; Cashman, 2006; Lante, 2006; Sola-Larranaga and Navarro-Blasco, 2009).

Daily intake and food sources of different nutrients were investigated (Kersting et al., 2001; Vuckovic at al., 2000; Moore et al., 2005; Yen et al., 2008). Among them milk and dairy products were present as a source of minerals, especially calcium (Colić Barić et al., 2001; Colić Barić and Brlečić, 2001; Panjkota Krbavčić and Sučić, 2007). The mean values and standard deviation for milk consumption by children from primary and secondary schools defined by age and gender are given in Table 3. The children 8-9 years of age consume 0.46 L of milk per day. Average daily milk consumption of an adolescent 15-18 years of age is similar (0.47 L/day) to children consumption, but not sufficient. Milk consumption by adolescent is usually lower than by children what is not rare (Crawly and Summerbell, 1998; Colić Barić, 2001; Colić Barić and Šatalić, 2002). Because of that, mineral intake of adolescents is also usually lower according to gender and age.

The mean values for concentrations of essential minerals detected in sterilised semi-skimmed milk samples with 2.8 % milk fat content and average daily intake of these minerals by milk consumption are given in table 4 for children 8-9 years of age and in table 5 for adolescents 15-18 years of age.

Calcium and phosphorus are major milk minerals (Table 2). Average content of calcium in our milks (900 mg/L) which was in some cases close or lower than those found in literature (970-1650 mg/L) (Sola-Larranaga and Navarro-Blasco, 2009; Tratnik, 1998; Rodríguez Rodríguez et al., 2001; Cashman, 2006; Lante, 2006). Phosphorus average content (970 mg/L) was in accordance with the same literature data. Calcium and phosphorus are required for growth and development of bones and teeth. In milk, they are mostly incorporated with casein in the casein micelles. Calcium helps the brain, nerves, muscles and heart to function properly. It has been associated with the prevention of osteoporosis, bowel and intestinal cancer and high blood pressure. The main source of calcium is milk and dairy products. Phosphorus is important for energy production, helps muscle contraction, prevents osteoporosis and is important for major biochemical reactions in the body. Deficiency of calcium or phosphorus can cause serious disorders (Anonymous 1, 2010; Belitz et al., 2004; Marenjak et al., 2006). It was determined that children and adolescents have the highest intake of those two minerals. Intake of calcium through milk consumption was 32 % of AIs for children and around 33 % of AIs for adolescents, while intake of phosphorus was 35 % RDA and 35 % RDA, respectively (Tables 4 and 5).

Magnesium acts as an activator of many enzymatic reactions like glycolysis, fat and protein metabolism, adenosine triphosphate hydrolysis; it is the regulator of the membrane stability and neuromuscular, cardiovascular, immune and hormonal functions. Magnesium deficiency alters calcium metabolism and the hormone that regulates calcium (Lukaski, 2004; CNS, 2001). In investigated samples, average value for magnesium was about 115 mg/L in milk (Table 2). It was determined that intake of magnesium by milk consumption achieved 22 % of RDA for children, and 13 % of RDA for adolescents what is almost half less than children's intake (Tables 4 and 5).

Copper and iron are essential but in excess they contribute to the production of oxidant radicals excess what results with some diseases in age over fifty (Brewer, 2010). Therefore, milk is not a good source of iron and copper; average content was 0.670 mg/L, and 0.190 mg/L, respectively (Table 2). Iron is a key trace element required for the delivery of oxygen to tissues. It serves as a functional component of iron containing proteins including haemoglobin, myoglobin, cytochromes and specific iron-containing enzymes. It plays an important role in energy use during the work. Anaemia occurs when there is not enough iron in the red blood cells (Lukaski, 2004). The iron requirement depends on the age and gender of the individual (Belitz et al., 2004). The data in tables 4 and 5 show that intake of iron was 3.25 % of RDA for children, while intake for adolescents was lower, 2.55 % of RDA for males and only 1.66 % of RDA for females (Tables 4 and 5). Copper aids in the formation of bone, haemoglobin, and red blood cells. It works with vitamin C and zinc to form elastin. It is involved in: energy production, hair and skin colour, taste sensitivity and formation of collagen (Anonymous 1, 2010). It is also a component of a number of oxidoreducting enzymes (Belitz et al., 2004). According to obtained data, the intake of copper by milk consumption was 10 % of RDA for children and 8 % of RDA for adolescents (Tables 4 and 5).

Zinc has a lot of functions in the human body. It is required for the structure and activity of more than 300 enzymes, for nucleic acid and protein synthesis, cellular differentiation and replication, glucose use and insulin secretion, exerts regulatory actions in various aspects of hormone metabolism. Adequate zinc is needed for the integration of many physiologic systems such as immunity, reproduction, taste etc. (Lukaski, 2004). Zinc deficiency in animals causes serious disorders, while high zinc intake for humans is toxic (Belitz et al., 2004). Average content of zinc in investigated milk samples was 3.5 mg/L (Table 2). Consumption of around 0.5 L of milk per day (Table 3), resulted in intake of zinc for children about 22 % of RDA while intake of zinc for male and female adolescents was 16.5 % and 20 % of RDA, respectively (Tables 4 and 5).

Table 4. Average daily intake of minerals and degree of compliance (%) with RDA, AIs and ULs values by examinees aged 8-9 years

Tablica 4. Prosječni dnevni unos minerala i stupanj slaganja (%) sa RDA, AIs i ULs vrijednostima kod ispitanika starih 8-9 godina

Minerals/Minerali (mg)	Level/Razina	Examinees 8-9 years/Ispitanici 8-9 godina					
		Boys/Dječaci (n=52)		Girls/Djevojčice (n=48)		Everybody/Svi (n=100)	
		Intake (mg/Day) Unos (mg/Dan)	%	Intake (mg/Day) Unos (mg/Dan)	%	Intake (mg/Day) Unos (mg/Dan)	%
Calcium/Kalcij	1300[(2)]	417.65	32.13	422.34	32.49	419.91	32.30
Phosphorus/Fosfor	1250[(1)]	430.22	34.42	435.05	34.80	432.54	34.60
Magnesium/Magnezij	240[(1)]	53.33	22.22	53.92	22.47	53.61	22.34
Iron/Željezo	8[(1)]	0.26	3.25	0.26	3.25	0.26	3.25
Copper/Bakar	0.7[(1)]	0.06	8.60	0.07	10.00	0.07	10.00
Zinc/Cink	8[(1)]	1.76	22.00	1.78	22.25	1.77	22.13
Manganese/Mangan	1.9/1.6[(2)a]	0.03	1.58	0.03	1.88	0.03	1.58/1.88[a]
Nickel/Nikal	0.6[(3)]	0.03	5.0	0.03	5.0	0.03	5.0
Potassium/Kalij	4500[(2)]	725.88	16.13	734.02	16.31	729.79	16.22
Sodium/Natrij	1500[(2)]	216.22	14.41	218.65	14.58	217.39	14.49

[a]Males/Females (Muško/Žensko), [(1)]Recommended Dietary Allowances (RDA) (mg/day)/Preporučeni dnevni unosi (RDA) (mg/dan), [(2)]Adequate Intakes (AIs) (mg/day)/Adekvatni unosi (AIs) (mg/dan), [(3)]Tolerable Upper Intake Levels (ULs) (mg/day)/Maksimalno dozvoljeni dnevni unosi (ULs) (mg/dan)

Table 5. Average daily intake of minerals and degree of compliance (%) with RDA, AIs and ULs values by examinees aged 15-18 years
Tablica 5. Prosječni dnevni unos minerala i stupanj slaganja (%) sa RDA, AI i UL vrijednostima kod ispitanika starih 15-18 godina

Minerals Minerali	Level Razina	Examinees 15-18 years/Ispitanici 15-18 godina					
		Male/Muški (n=51)		Female/Ženski (n=57)		Everybody/Svi (n=108)	
		Intake (mg/Day) Unos (mg/Dan)	%	Intake (mg/Day) Unos (mg/Dan)	%	Intake (mg/Day) Unos (mg/Dan)	%
Calcium/Kalcij	1300(2)	455.57	35.04	403.33	31.03	428.01	32.92
Phosphorus/Fosfor	1250(1)	469.28	37.54	415.47	33.24	440.89	35.27
Magnesium/Magnezij	410(1)	58.17	14.19	51.50	12.56	54.65	13.33
Iron/Željezo	11/15(1)a	0.28	2.55	0.25	1.66	0.26	2.36/1.73a
Copper/Bakar	0.89(1)	0.07	7.87	0.06	6.74	0.07	7.87
Zinc/Cink	11/9(1)a	1.92	17.45	1.70	18.89	1.81	16.45/20.10a
Manganese/Mangan	2.2/1.6(2)a	0.03	1.36	0.02	1.88	0.03	1.36/1.88a
Nickel/Nikal	1.0(3)	0.04	4.00	0.03	3.00	0.03	3.00
Potassium/Kalij	4700(2)	791.78	16.85	700.99	14.91	743.88	15.83
Sodium/Natrij	1500(2)	235.85	15.72	208.81	13.92	221.59	14.77

[a]Males/Females (Muško/Žensko), (1) Recommended Dietary Allowances (RDA) (mg/day)/Preporučeni dnevni unosi (RDA) (mg/dan), (2) Adequate Intakes (AIs) (mg/day)/Adekvatni unosi (AIs) (mg/dan), (3) Tolerable Upper Intake Levels (ULs) (mg/day)/Maksimalno dozvoljeni dnevni unosi (ULs) (mg/dan)

Manganese is a cofactor for a number of important enzymes, including arginase, cholinesterase, phosphoglucomutase, pyruvate carboxylase, mitochondrial superoxide dismutase and several phosphates, peptidases and glycosyltransferases. In certain instances, Mn^{2+} may be replaced by Co^{2+} or Mg^{2+}. Inadequate manganese intake has been associated with parenteral nutrition, resulting in dermatitis, changes in hair pigmentation and slowed hair growth. Excess manganese interferes with the absorption of dietary iron. Long-term exposure to excess levels may result in iron-deficiency anaemia. Increased manganese intake impairs the activity of copper metalo-enzymes (Blaurock - Busch, 2010). Average manganese content in investigated milk samples was 0.06 mg/L (Table 2). Among determined minerals, intake of manganese was the lowest. Adequate intakes for children were 1.6 % of AIs for boys and 1.9 % for girls, while among adolescents they were 1.4 % of AIs for males and 1.9 % of AIs for females (Tables 4 and 5).

Nickel is the activator for number of enzymes, it enhances insulin activity (Belitz et al., 2004). Nickel has a great affinity for cellular structures such as chromosomes and ion channels, but its influence on them at normal tissue concentrations is not known. Nickel deficiency disease has not been described for humans. Excessive nickel in tissues is pro-oxidant (damaging chromosomes and other cell components) and alters hormone and enzyme activities, movement of ions through membranes and immune function. Under some conditions, large amounts of nickel may precipitate magnesium deficiency or cause accumulation of iron or zinc (Kenney, 2010). Average nickel concentration was around 0.06 mg/L of milk (Table 2). Intake of nickel through milk consumption was 5 % and 3 % of ULs (0.6 mg/day) for children and adolescents, respectively (Tables 4 and 5).

Potassium regulates osmotic pressure within the cell, balances water and acid in the blood and body tissues, and is involved in: cell membrane transport, building muscle and metabolizing protein and carbohydrate. Potassium deficiency is associated with number of symptoms like fatigue, slow reflexes, muscle weakness and dry skin (Belitz et al., 2004). In investigated samples, there was around 1570 mg/L of potassium. Intake of potassium within children and adolescents was almost the same (16 % of AIs).

Sodium is the predominant extracellular cation and maintains osmotic pressure of extracellular fluids. Excess dietary sodium is excreted in the urine. The mineral is very efficiently reabsorbed by the kidney when intakes are low or losses are excessive. Sodium acts in consort with potassium, to maintain proper body water distribution and blood pressure, and also is important in maintaining the proper acid-base balance and in the transmission of nerve impulses (Johnson, 2010). In addition sodium activates some enzymes such as amylase (Belitz et al., 2004). Data in Table 2 shows that the average content of sodium was around 480 mg/L of milk. Intake of sodium was similar within children and adolescents, about 15 % of AIs.

Conclusion

The content of ten mineral components was determined during the year in milk samples with different fat content and produced by different manufacturers. Given the proportion of fat there were no significant differences in the determined minerals proportion. Although, in comparison with literature, the data may reveal that some differences in order of magnitude of determined minerals were the same. Specially designed, completely quantified Food Frequency Questionnaire was made. The subjects were children aged 8-9, and adolescents aged 15-18 years. Based on daily consumption of about 0.5 L of milk, it was shown that the consumption of milk does not meet the daily requirements for determined minerals. Most significant was the intake of calcium and phosphorus while the lowest intake was for manganese.

Esencijalni minerali mlijeka i njihov dnevni unos konzumiranjem mlijeka

Sažetak

Minerali se nalaze u svim namirnicama pa tako i u mlijeku i mliječnim proizvodima. Na udjel minerala u mlijeku utječu mnogi faktori, od uvjeta zaštite okoliša za vrijeme ispaše, hranjenja, uzgoja, stadija laktacije i klime do postupaka nakon mužnje, transporta i obrade. Cilj istraživanja bio je procijeniti je li unos esencijalnih minerala u skladu s vrijednostima za Preporučene dnevne unose (RDA), Adekvatne unose (AIs) ili Maksimalno dozvoljene dnevne unose (Uls) za esencijalne elemente. Analizirani su uzorci mlijeka različitih proizvođača, s različitim udjelom masti, a nabavljeni su na zagrebačkom tržištu četiri puta tijekom 2007. godine. Udjeli deset minerala (Ca, P, Mg, Fe, Cu, Zn, Mn, Ni, K and Na) određeni su pomoću atomske apsorpcijske spektrometrije. Srednje vrijednosti udjela minerala bile su u skladu s literaturnim podacima. Također je procijenjen dnevni unos navedenih minerala putem mlijeka, kod djece školskog uzrasta (školska djeca u dobi 8-9 godina i adolescenti u dobi 15-18 godina) podijeljene u grupe obzirom na godine i spol. Prosječni dnevni unosi esencijalnih minerala kretali su se od minimalno 1,36 % za mangan do maksimalno 35,27 % za fosfor, bez obzira na dob i spol djece.

Ključne riječi: mlijeko, minerali, unos minerala

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