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Content of selected micro and macro elements in dairy cows' milk in Estonia

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Abstract. Milk and milk products are an important source of dietary minerals for consumers. The content of the micro and macro elements in food varies among and within countries. Information about concentration of micro and macro elements in Estonian food is limited. To get preliminary information about calcium (Ca), magnesium (Mg), selenium (Se), iron (Fe), zinc (Zn), cobalt (Co) and copper (Cu) content in raw milk, samples from 8 Estonian conventional and 2 organic dairy farms, as well as from 2 consumer milks produced by different dairies were analysed by using atomic absorption spectrometry (AAS). No suboptimal micro and macro element concentrations were found in raw milk samples. However, concentration of dietary minerals in consumer milk was lower than the concentration in raw milk except Fe, which was higher in consumer milk.

Key words: dietary minerals, micro elements, macro elements, cow, milk.

INTRODUCTION

Milk and milk products are an important source of dietary minerals in many European countries, accounting for 10–20% of daily dietary intake. However, the content of micro and macro elements in milk depends upon the content of these elements in soil and cattle feed, which varies considerably among and within countries. Information about the content of dietary minerals in the food chain in Estonia is limited, as systematic studies have never been done. Most of the studies are connected with Se, in which Se content is reported to be low in Estonian soils (Kevvai, 1994), cows (Pehrson et al., 1997) and the human population (Kantola et al., 1997; Rauhamaa et al., 2008). Information about other minerals is even more limited. Studies on the human population have shown Zn and Mg deficiency on healthy volunteers (Lindstöm et al., 2007).

To assure maximum productivity of animals or to prevent diet-responsive diseases and nutritional deficiency disorders in the animal and human populations, supplementing of the food-chain with micro and macro elements is a common practice. These nutrients are supplied by different sources such as fertilizers, organic or inorganic feed supplements and food supplements. However, both too low and too high content of micro and macro elements can cause adverse health effects in humans and animals; knowledge about dietary minerals in food is important.

In the current study we investigated the content of Ca, Mg, Se, Fe, Zn, Co and Cu in milk from Estonian conventional and organic dairy farms as well as from consumer milk available in food stores. Our aim was to get preliminary information about the content of selected elements in Estonian milk. Milk was selected, as it is a sensitive indicator reflecting the status of micro and macro elements in production.

MATERIALS AND METHODS

A total of ten dairy herds kept in loose housing cattle houses were selected from different regions of Estonia. Eight farms represented the conventional system, and 2 farms, an organic dairy farming system. The number of cows in conventional herds varied from 152 to 650. There were 80 and 210 cows in the organic dairy farms, respectively. Cows were milked at milking stations on all farms. Inorganic micro and macro element supplementations were used on all farms.

Bulk-tank milk samples were collected from all farms for analyses of Ca, Mg, Se, Fe, Zn, Co and Cu during the indoor season 2008–2009. In addition, milk samples produced by two different Estonian dairies were purchased for analyses of the same micro- and macro elements. Milk samples were stored at –20ºC until analysis.

Minerals were analyzed by the use of atomic absorption spectrometry (AAS). For the analysis, a 2 ml milk sample was mineralized by 5ml of concentrated HNO_3 and 2 ml of concentrated H_2O_2 in teflon bombs in a microwave oven (Anton Paar Multiwave 3000, Graz, Austria) at temperatures up to 180 ºC for 30 min. After cooling down, the solution in the bombs was transferred to volumetric flasks (15 ml) with Milli-Q water for the determination of the total concentration of the mineral element. In the HGAAS method, after cooling down the bombs, the solutions were transferred to the volumetric flasks (25 ml), added 5ml 30% HCl and heated at 80 °C for 45 min in a water bath. The solution was allowed to stay at room temperature and was diluted to 25 ml by 6M HCl before feeding samples into the HGAAS system. Each sample and two blanks were weighed at least two times per sample. For ETAAS and FAAS methods a Spectra AA 220Z and 220F (Varian, Mulgrave, Australia) atomic absorption spectrometers (AAS) equipped with a side-heated GTA-110Z graphite atomizer, Zeeman-effect background correction and integrated autosampler and graphite tubes coated with pyrolytic graphite were used. For Argon 99.998% purity and for FAAS acetylene of 99.998% purity was used. Instrumental parameters for the determination of Co, Cu, Zn, Fe, Ca, Mg and Se by ETAAS, FAAS and HGAAS are shown in Table 1.

Table 1. ETAAS, FAAS and HGAAS instrumental parameters for the determination of mineral elements.

Parameter	ETAAS			FAAS		HGAAS	
	Co	**Cu**	**Zn**	**Fe**	**Ca**	**Mg**	**Se**
Wavelength (nm)	240.7	324.8	213.9	248.3	422.7	285.2	196
Current mode	Abs.	Abs.	Abs.	Abs.	Abs.	Abs.	Abs.

RESULTS AND DISCUSSION

In our study we analyzed the content of selected micro and macro elements in milk produced in Estonian conventional and organic dairy farms as well as in consumer milk available from food stores (Table 2). This was a preliminary study carried out to obtain information about selected minerals and trace elements in the Estonian food chain.

Table 2. Content of selected micro and macro elements in raw milk from 8 conventional and 2 organic Estonian dairy farms, as well as in consumer milk produced by 2 different dairies.

Milk samples	Ca (mg/l)	Mg (mg/l)	Cu (mg/l)	Zn (mg/l)	Fe (mg/l)	Se (μg/l)	Co (μg/l)
Conventional farm 1	1450	120	0.240	2.100	0.850	8.800	<LOD
Conventional farm 2	1350	102	0.210	2.800	0.400	5.820	<LOD
Conventional farm 3	1250	103	0.250	4.000	0.830	8.630	2.630
Conventional farm 4	1300	96	0.100	3.900	0.840	7.300	4.630
Conventional farm 5	1250	98	0.150	3.900	0.680	11.900	2.130
Conventional farm 6	1350	123	0.190	2.900	0.780	6.000	4.000
Conventional farm 7	1205	130	0.200	3.900	1.000	10.500	5.340
Conventional farm 8	1225	135	0.190	5.030	0.840	10.100	5.880
Mean for conv. farms (*n*=8)	**1298**	**113**	**0.191**	**3.566**	**0.778**	**8.631**	**4.102**
Organic farm 1	1200	117	0.190	3.900	0.650	8.750	2.030
Organic farm 2	1180	108	0.180	3.800	0.690	7.700	2.060
Consumer milk 1	1180	93	0.160	3.500	1.250	7.500	<LOD
Consumer milk 2	1050	100	0.160	3.300	2.650	6.300	<LOD
Mean (*n*=12)	1249	110	0.185	3.586	0.955	8.275	3.588
Median (*n*=12)	1238	106	0.190	3.850	0.835	8.165	3.315
Minimum (*n*=12)	1050	93	0.100	2.100	0.400	5.820	2.030
Maximum (*n*=12)	1450	135	0.250	5.030	2.650	11.900	5.880

Based on the results of our study there was no clear micro and macro element deficiency in studied herds as the concentration of micro and macro elements in raw milk was at a level which is reported to be optimal (Hermansen et al., 2005; Poikalainen, 2006; Sola-Larranaga & Novarra-Blasco, 2009).

There was a variation in some dietary minerals among conventional farms. Based on our results, Ca was higher in 2 conventional farms, Cu in 3 and Co in 6 out the 8 farms. Micro and macro element concentration in 2 organic milk samples was similar to each other (similarity 96.92%). When comparing micro and macro element concentration in raw milk samples collected from conventional and organic dairy farms we did not find a notable difference concerning most of the dietary elements. The similarity of concentration of the elements in conventional and organic milk was 96.18% except for Co concentration which was lower in the organic milk samples. However, comparing raw milk micro and macro element concentration collected from conventional farms with non-organic consumer milk, lower element concentrations were notable in consumer milk except Fe, which was 160.77% higher in consumer milk 1 and 340.84% higher in consumer milk 2. There is no organic consumer milk available in Estonia.

In the studied dairy farms the main health problems were udder diseases, fertility problems and foot diseases. There are various reports available about the influence of dietary minerals on the cattle's performance and health aspects such as claw integrity, fertility, lactation and immune function (reviewed by Siciliano-Jones et al., 2008; Andrieu, 2008; Spears, 2000; Spears & Weiss, 2008; Tomlinson et al., 2004). Because of the variation of micro and macro element concentrations in milk from conventional farms, the unbalanced feeding of dietary minerals can be connected with the prevalence of these diseases. More detailed studies are needed.

CONCLUSIONS

Summarised results of the experiment have shown that there was no suboptimal content of micro and macro elements in raw milk samples from conventional and organic dairy farms. However, the concentration of elements in consumer milk was lower than that in raw milk, except the concentration of Fe, which was higher in consumer milk. We also noticed a variation in mineral concentration among conventional herds, indicating the need for more detailed studies concerning feeding strategies.

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