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Chemical elements content in goat milk, whey, cheese and yogurt from an ecological and conventional farm in Slovakia

Obsah chemických pvkov v kozom mlieku, srvátke, syroch a jogurte z ekologickej a konvenčnej farmy

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ABSTRACT

Milk and dairy products are an important part of the human diet for numerous reasons. Goat milk is higher in the content of elements such as K and Ca. Nowadays, consumption of goat milk and goat dairy products increases because of better digestion and therapeutic value. However, goat milk can contain heavy metals and trace elements as well which can harm human health. The content of 22 elements in sixty-nine samples of goat milk, whey, three types of cheese, and yogurt from the ecological farm in region Orava and conventional farm in region Stredné Považie in Slovakia was measured in this study. The highest concentration of four elements Ca, K, Mg, and Na in samples of goat products was found. In our study, significant statistical differences ($P < 0.05$) were found only in levels of K, Ca, Li and Na when comparing milk samples from organic and conventional farm. Concentrations of K (1260.50 mg/kg), Li (0.02 mg/kg) and Na (293.46 mg/kg) were higher in samples from ecological farm, while concentration of Ca (1344.65 mg/kg) was higher in samples from conventional farm. Toxic elements were present in trace amounts or under the limit of detection. The consumption of goat milk and goat dairy products from monitored farms can be considered as safe and beneficial for human health regardless of the way of farming. According to the highest level of strontium in hard ripening cheese, frequent regular consumption should be considered for children as a preventive measure for development of bone health.

Keywords: goat milk, dairy product, essential elements, toxic elements, way of farming, Slovakia

ABSTRAKT

Mlieko a mliečne výrobky sú dôležitou zložkou v strave ľudí z viacerých dôvodov. Všetky typy mlieka sa skladajú z tých istých zložiek, ale ich množstvo je rozdielne. Kozie mlieko obsahuje vyššie množstvo draslíka a vápnika. V súčasnosti konzumácia ovčích mliečnych výrobkov stúpa kvôli ich ľahšej stráviteľnosti a terapeutickej hodnote, ktorá im je pripisovaná. Kozie mlieko a výrobky z neho avšak môžu v dôsledku environmentálneho znečistenia predstavovať aj zdroj ťažkých kovov, ktoré následne môžu pôsobiť nepriaznivo na ľudské zdravie. Obsah 22 prvkov v 69 vzorkách kozieho mlieka a výrobkov z neho bol stanovovaný v tejto štúdii. Vzorky pochádzali z ekologickej farmy z regiónu Orava a konvenčnej farmy, ktorá sa nachádza v regióne Stredné Považie. Najvyššie koncentrácie vo vzorkách kozích mliečnych produktov dosahovali prvky vápnik, draslík, horčík a sodík. Pri porovnaní vzoriek kozieho mlieka z ekologickej a konvenčnej farmy boli nájdené štatistické rozdiely (*P* < 0,05) len pri obsahu prvkov K, Ca, Li a Na. Vyššie koncentrácie prvkov draslíka (1260,50 mg/kg), lítia (0,02 mg/kg) a sodíka (293,46 mg/kg) sa našli vo vzorkách mlieka pochádzajúcich z ekologickej farmy, kým vyššia priemerná koncentrácia vápnika (1344,65 mg/kg) sa nachádzala vo vzorkách mlieka z konvenčnej farmy. Toxické prvky boli stanovené v stopových množstvách, alebo pod limitom detekcie. Na základe výsledkov môžeme považovať kozie mlieko a výrobky z neho z oboch fariem za bezpečné pre ľudskú spotrebu s možným priaznivým účinkom na zdravie bez ohľadu na spôsob hospodárenia. Častá a pravidelná konzumácia tvrdého zrejúceho syra malými deťmi je na zváženie, ako preventívne opatrenie podpory vývoja kostného zdravia, vzhľadom na najvyšší obsah stôp stroncia.

Kľúčové slová: kozie mlieko, mliečne výrobky, esenciálne prvky, toxické prvky, ekologická farma, konvenčná farma, Slovensko

INTRODUCTION

Because of having high biological value and being easily accessible and thought to have little health risk, milk and dairy products are highly preferred by consumers and considered as an important part of human diets (Licata et al., 2012). Milk and dairy products are a source of macronutrients and micronutrients, including minerals. Each type of milk (cow, goat, ewe) contains the same components, but in different amounts. Calcium, magnesium, zinc, and selenium are essential elements for human metabolism, growth, and development in general and children in particular (Oana et al., 2016; Zhou et al., 2017) and it is largely admitted that milk and dairy products are important sources of them (Gaucheron, 2011). Nowadays, the consumption of sheep and goat milk and cheeses is increasing, mainly at the local level, bought from small farmers (Kováčová et al., 2021). The peculiarity of goat´s milk is higher digestibility, higher buffering capacity, and therapeutic value in medicine and human nutrition also need to be mentioned (Zehra and Hasan, 2009; Zenebe et al.,2014). Smaller fat globules in comparison with those from cow milk and differences in the fatty acid content, higher percentage of short- and medium-chain fatty acids are reasons for better digestive function (Kondyli et al., 2007). Goat milk is reported to have a higher content of K, Ca, Cl, P, Se, Zn, and Cu in comparison with cow milk. As well as it improves the bioavailability of zinc (Zenebe et al., 2014) and its products can contribute significantly to the supply of macro and microelements in the human diet (Zehra and Hasan, 2009).

However, milk and dairy products may as well contain various amounts of different contaminants. Heavy metals are widely distributed in the environment. Toxic elements transferred through the food chain may harm human health. Lead and cadmium are elements that have attracted the main concern among other heavy metals (Zhou et al., 2017, Rahimi , 2013). On one hand, a higher intake of milk and dairy product for children is recommended, but children are more sensitive to the cumulative effects of cadmium and lead than adults, because toxic elements may be built up in the tissues Thus, serious adverse health effects may be caused by regular absorption of small amounts of certain elements (Rahimi, 2013). Therefore, it is important to monitor the level of trace elements in milk and dairy products which is a major source of nutrition, in childhood in particular. The presence of heavy metals in milk is controlled according to the EU's defined maximum level (EC No 1881/2006). Consequently, the concentration of elements in milk and dairy products indicates their safety and nutritional value (Zhou et al., 2017). Diet affects the composition of goat milk, contrast in the composition of milk from production systems based on grazing and browsing or from production system using harvested feedstuffs in confinement was found (Goetsch, 2011). Many differences in the composition of soft cheese made from milk of goats that were fed indoors compared with the ones grazing rangeland were found (Galina et al., 2007). The quality of organic goat milk comes from animal nutrition and organic production management in organic farming. Organic milk with higher dry matter and amount of nutrition represents a quality raw material to obtain products of exceptional nutritional and functional properties (Popovic-Vranješ et al., 2017). Important information is that goat feed may have big effects on the mineral content of milk (Zenebe et al., 2014).

Ecological production of goat milk due to lower productivity, seasonal variations, and the need for bigger animal herds is more expensive (Zenebe et al., 2014).

Moreover, organic dairy farms are characterized by lower concentrations of toxic heavy metals in whole raw milk compared with those from the conventional production system (Toman et al., 2020). There is not as much research on goat milk's nutritional value as there has been on cow milk (Kondyli et al., 2007). The content of chemical elements in goat milk is particularly lacking in studies. In the moment of writing this article, according to the Pubmed database, 16 987 studies have been published on cow milk, 1740 on chemical elements in cow milk, 883 on essential elements in cow milk and 6151 on heavy metals in cow milk. While 6061 studies have been conducted on goat milk,only 563 on chemical elements in goat milk, 40 on essential elements in goat milk and 136 on heavy metals in goat milk.

To the best of our knowledge, the research on concentrations of essential and toxic elements in goat milk and goat dairy products in Slovakia is rare at present. The aim of the study was to determine the content of essential and toxic elements in samples of goat milk and dairy products collected from farms in Slovakia, to monitor the current occurrence of elements in goat dairy products from selected areas, and to refer to the suitability of the usage for human consumption. The second goal of presented study was to compare goat milk and dairy products from ecological and conventional farms.

MATERIAL AND METHODOLOGY

Collections of samples

The occurrence of chemical elements in goat milk and dairy products was monitored at two farms in Slovakia. The Ministry of the Slovak Republic and the Slovak Environmental Agency has determined the environmental regionalization of Slovakia. The country is divided into three types of environmental quality: regions with a potentially undisturbed environment, region with a slightly disturbed and heavily disturbed environment as Pšenková and Toman (2021) described. Regions Orava and Stredné Považie are considered areas with potentially undisturbed environments (Klinda et al., 2016). While both farms come from undisturbed areas, the type of farming differs. Farm from region Orava represents an ecological way of farming and in a farm from the region, Stredné Považie conventional way of farming is provided. Both farms breed white short-haired goat breed, with a small representation of brown short-haired goat breed. Samples of milk, whey, soft ripening cheese, hard ripening cheese, and fresh lump cheese come from an ecological farm located in the region Orava. Origin of samples of milk, whey, and yogurt is a conventional farm in the region Stredné Považie. Goat dairy products used in the study are made exclusively from goat milk of the respective farm.

Sample preparation

Samples of goat milk and goat dairy products were collected during period of lactation (from May to October) in 2020 and 2021 from two farms. Samples were taken from tank milk containers or cut from bigger pieces of cheese and stored in freezers at -18 °C until analysis was carried out. A preanalytical procedure such as homogenization was made first. The weight of the experimental samples ranged from 1.0 to 2.0 g and was reflected in measurement. Together 69 samples were analyzed (11 samples of milk, 11 samples of whey, 9 samples of soft ripening cheese, 11 samples of hard ripening cheese, 11 samples of fresh lump cheese from the ecological farm and 10 samples of milk, 3 samples of whey and 3 samples of yogurt from the conventional farm).

Analysis of samples

The concentration of 22 selected elements (Ag, Al, As, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sr, Zn) in milk and dairy product were measured. In the beginning, samples were mineralized in the high-performance microwave digestion system Ethos UP (Milestone Srl, Sorisole, BG, Italy) in a solution of 5 ml HNO_3 ≥ 69.0% (TraceSELECT®, Honeywell Fluka, Morris Plains, USA), 1 ml H_2O_2 ≥ 30%, for trace analysis (Sigma

Aldrich, Saint–Louis, Missouri, USA), and 2 ml of ultrapure water 18.2 MΩ cm –1; 25°C, Synergy UV, Merck Millipore, France). The method of determination consists of heating and cooling phases. Analysis of the elements was carried out using an inductively coupled plasma–optical emission spectrometer (ICP OES 720, Agilent Technologies Australia (M) Pty Ltd.) with axial plasma configuration and with auto140 sampler SPS-3 (Agilent Technologies, Switzerland). Detections limits (µg/kg) of measured trace elements were follows: Ag 0.3; Al 0.2; As 1.5; Ba 0.03; Ca 0.01; Cd 0.05; Co 0.2; Cr 0.15; Cu 0.3; Fe 0.1; K 0.3; Li 0.06; Mg 0.01; Mn 0.03; Mo 0.5; Na 0.15; Ni 0.3; Pb 0.8; Sb 2.0; Se 2.0; Sr 0.01 and Zn 0.2. and wavelength of determination (nm) follows Ag 328.068; Al 167.019; As 188.980; Ba 455.403; Ca 315.887; Cd 226.502; Co 228.615; Cr 267.716; Cu 324.754; Fe 234.350; K 766.491; Li 670.783; Mg 383.829; Mn 257.610; Mo 204.598; Na 589.592; Ni 231.604; Pb 220.353; Sb 206.834; Se 196.026; Sr 407.771; and Zn 206.200. The legitimacy of the whole method was verified using the certified reference material. The same laboratory method and same instruments were used in a previous study by our research group (Toman et al., 2021).

Statistical Analysis

All results of this study were processed using Statistica Cz version 10 (TIBCO Software, Inc., Palo Alto, CA, USA). All obtained results are listed as mean values with standard deviation. Differences in concentrations of the analysed elements in goat milk and goat whey between the farms were compared by the ANOVA and student´s t-test. A probability level of $P < 0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

The obtained concentrations (mean ± SD) of detected elements in goat milk and whey, are presented in Table 1 and the obtained concentrations (mean ± SD) of detected elements in goat cheeses and yogurt are listed in Table 2.

The concentrations of essential elements in raw goat milk and goat dairy products were within the recommended levels and concentrations of toxic elements were under the permissible limits and limits of detection. Cadmium is a highly toxic element and the main route of exposure is contaminated water or food. It accumulates in the liver, kidneys, muscles and even a low exposure has for children very toxic effect and can cause serious disorders. High exposure to cadmium and lead can cause carcinogen effect, endocrine disruption, neurodevelopmental toxicity, hepatotoxicity, nephrotoxicity (Bansal, 2020; Bocquet et al., 2021). Elements Ag, As, Cd, Co, Cr, Mo, Ni, and Pb were not detected in any sample. The occurrence of Ba, Cu, Mn, and Sr was found only in the ecological farm while Sb was detected only in samples from conventional farm. Aluminum was found only in one sample of whey from a conventional farm, one sample of soft ripening cheese, and one sample from fresh lump cheese. Levels of essential elements for human health in milk from ecological farming were found in decreasing order as follows: K > Ca > Mg > Na > Fe > Cu. In milk samples from conventional farming were small changes in the order as follows: Ca > K > Na > Mg > Zn > Fe. Calcium, potassium, and magnesium or sodium are elements that dominate in goat´s milk in other studies too (Chen et al., 2020).

Due to the high level of variability (wide ranges and high standard deviations over the mean values) in mineral contents, it may be a little more demanding to compare milk and dairy products from different species, areas, and ways of farming. It is related to the fact that mineral contents in milk are affected by diet, breed, individual animal, season, stages of lactation, environmental conditions, etc (Navarro-Alarcón et al., 2011).

Goat milk

The bioavailability of goat milk calcium is similar to calcium chloride, which means it is as high as in cow milk (Raynal- Ljutovac et al., 2008) The mean calcium level in milk samples from the conventional farm was 1344.65 mg/kg which is significantly higher than in samples from the ecological farm (923.02 mg/kg). The level of calcium from the conventional farm is in agreement with concentrations of goat milk from other studies in France (Raynal- Ljutovac, 2008), Turkey (Zehra and Hasan, 2009) Tenerife (Garcia et al., 2006), Austria (Mayer at Fiechter.,

Table 1. Comparison of content of elements in goat´s milk and whey from ecological and conventional farms (mg/kg)

	Milk		Whey	
	Ecological farm	Conventional farm	Ecological farm	Conventional farm
Ag	< 0.0003*	< 0.0003*	< 0.0003*	< 0.0003*
Al	< 0.0002*	< 0.0002*	< 0.0002*	0.876
As	< 0.0015*	< 0.0015*	< 0.0015*	< 0.0015*
Ba	0.09±0.02	< 0.00003*	0.03±0.04	< 0.00003*
Ca	923.02±102,58	1344.65±338.10[a]	417.70±343.61	218.01±36.13
Cd	< 0.00005*	< 0.00005*	< 0.00005*	< 0.00005*
Co	< 0.0002*	< 0.0002*	< 0.0002*	< 0.0002*
Cr	< 0.00015*	< 0.00015*	< 0.00015*	< 0.00015*
Cu	0.12±0.02	< 0.0003*	0.07±0.02	< 0.0003*
Fe	1.68±1.40	1.74±0.33	1.30±0.44	1.431±0.118
K	1260.50±93.08[a]	915.77±203.85	1229.99±149.03	1140.70±312.27
Li	0.02±0.005[a]	0.008±0.008	0.02±0.007	0.003±0.001
Mg	100.64±25.46	109.07±25.32	77.85±31.36	60.839±14.293
Mn	0.06±0.05	< 0.00003*	0.02±0.01	< 0.00003*
Mo	< 0.0005*	< 0.0005*	< 0.0005*	< 0.0005*
Na	293.46±49.79[a]	204.82±66.98	330.60±94.22	293.10±85.24
Ni	< 0.0003*	< 0.0003*	< 0.0003*	< 0.0003*
Pb	< 0.0008*	< 0.0008*	< 0.0008*	< 0.0008*
Sb	< 0.002*	0.24±0.10	< 0.002*	0.14±0.04
Se	< 0.002*	< 0.002*	< 0.002*	< 0.002*
Sr	0.45±0.07	< 0.00001*	0.19±0.21	< 0.00001*
Zn	<0.0002*	2.35±1.46	<0.0002*	< 0.0002*

* Concentrations with this index are below the LOD (limit of detection); [a] $P < 0.05$

2012) and Greece (Kondyli et al., 2007). In the study by Rolinec et al. (2018), the content of calcium from the ecological farm in Orava region (Slovakia) was a little bit higher than now (1000 mg/kg). Lower levels of calcium (520 mg/kg) in goat milk were found in China (Chen et al., 2020). The mean level of K (1260,50 mg/kg) in milk samples from the ecological farm was significantly higher ($P < 0.05$) than in milk samples from the conventional farm (915.77 mg/kg). It has been revealed that goat and sheep milk contain higher levels of K than other cattle, observed in decreasing order as goat > sheep > cow > camel > buffalo > human (Miedico et al., 2016). In the comparison of K concentration in goat milk from an ecological farm in our study from region Orava and ewe milk samples from the same region (Toman et al., 2021), the content of K in goat milk samples is two times higher. However, the measured content of K is lower than found in France (Raynal- Ljutovac et al., 2008), Greece (Kondyli et al., 2007), China (Chen et al., 2020), similar to Tenerife (Garcia et al.,2006) and higher than in Turkey (Zehra and Hasan, 2009). In a Slovak study by Rolinec (2018) in the same farm, results of measured samples were in range from 760 mg/kg to 2180 mg/kg. The level of Mg in goat milk from France (Raynal- Ljutovac et al., 2008) is slightly higher than our results as well as results from Tenerife (Garcia et al., 2006), China (Chen et al., 2020) while the content of magnesium in results from Turkey (Zehra and Hasan, 2009) was 5- times higher. Zehra and Hasan (2009) stated higher content of Mg may be caused to sudden physiological changes in the animal body, mammary gland, metabolism, diet, lactation stage, environmental temperature, or water intake. As Kandhro et al. (2022) described the levels of Fe were significantly lower in milk samples of all selected cattle (cow, buffalo, goat, sheep and camel) used in his study than in other food commodities, but among the cattle species, goat milk had the highest level of diffusible Fe. Raynal-Ljutovac (2008) mentioned it seems that iron bioavailability is higher in goat milk than cow milk, but ewe milk has the highest Fe level. The content of Fe in milk samples was 1.68 mg/kg for an ecological farm and 1.74 mg/kg for a conventional farm which is higher than in Italy (Miedico et al., 2016), China (Zhou et al., 2017; Chen et al., 2020), and lower than in Turkey (Zehra and Hasan, 2009). As mentioned, lead and cadmium were not detected in any samples of milk in this study. Concentrations of cadmium in milk were below the limit of detection in Italy too (Licata et al., 2012) while goat milk samples from the Czech Republic (Hejtmankova et al., 2002) were reported to have Cd contents between 0.001 and 0.003 mg/kg and Pb in the range of 0.02–0.04 mg/kg. In general, lead and cadmium concentrations in sheep milk were significantly higher than those in cow and goat milk, respectively. These results, confirm the hypothesis that cadmium and lead are mainly associated with the protein fraction (casein fraction) (Oana et al., 2016). In the Slovak study, the content of Cd in sheep milk was also below the LOQ (Pšenková et al., 2022). In this study, zinc was not detected in samples from ecological farm, while in the past Rolinec (2018) described that the range of zinc concentration was between 4.65-6.1 mg/kg which is also higher than the results of zinc in goat milk from the conventional farm. A trace amount of strontium (mean 0,45 mg/kg) was found in milk samples from the ecological farm as well.

Goat whey

Milk whey is the liquid substance remaining after cheese production. Whey is currently an underutilized ingredient but with growing potential to supplement food with macro and micronutrients (Hoac et al., 2007). Very similar order of elements was present also in samples of whey from ecological farm (K > Ca > Na > Mg > Fe > Sr) and samples of whey from conventional one (K > Na > Ca > Mg > Fe > Sb). No significant differences in concentrations of elements were found in samples of whey. The mean K and Na concentrations in whey were three times higher, four-time lower than Fe, similar to Ca and Mg in our study than that observed in the study by Garcia et al. (2006). While in mentioned study concentration of Cu was not detected, in samples of whey in the presented study Zn and Se were under the limit of quantification. Whey contains high amounts of soluble mineral nutrients, particularly the acid and casein types (Tratnik, 2003). The major content of Ca is bound with casein protein (Holt, 2004) and one-third of calcium in all samples is in the diffusible form, in the whey of milk detected. (Kandhro et al., 2022). In our samples from ecological farm, one-half of calcium content remained in whey while in samples from conventional farming only 25% of this element was present.

Goat cheese

Cheese is considered as concentrate of milk compounds (Filho et al., 2022). The highest concentrations of Ca, Mg, Na, and K were found in samples of cheese in our study. Content of Ca was in following order: hard ripening cheese (8212.40 mg/kg) > fresh lump cheese (4845.51 mg/kg) > soft ripening cheese (2454.31 mg/kg). In the study by Garcia et al. (2006) fresh cheeses presented higher concentrations of Ca, Fe, and Zn than semi-hard cheeses. In the presented study, concentrations of Ca and Zn had decreasing order for hard ripening cheese, fresh lump cheese, and soft ripening cheese. In cheeses, mineral content depends mainly on their processing procedures. The Ca content is strongly related to the acidification step. Moreover, if acidification is associated with the draining step, the Ca content in the cheese will be reduced. Thus, the Ca content varies in the following increasing order: milk/fermented milk/fresh cheeses < soft cheeses < semi-hard cheeses < hard cheeses (Galina et al., 2007). The highest concentration of Fe was found in soft ripening cheese and the lowest in fresh lump cheese. However, Rodríguez et al. (2002) specified losses of Ca, Fe and Zn are usually produced during the ripening. The highest mean concentration of Na represents 4139.28 mg/kg. In one sample of mentioned cheese, the level of Na was measured over range, while the highest measured concentration was 5617.32 mg/kg. The NaCl content in cheeses depends on the salting of the curd (Galina et al., 2007). Not only essential elements have concentrated levels in cheese, but the concentration of strontium in samples of cheese is also higher than in milk. Strontium is considered an antagonist of calcium and can accumulate in bones, which is unpleasant mainly if happening during childhood (ATSDR, 2020; Saribal, 2020). In a study from Croatia concentration of Ca, Mg, and Zn in goat white cheese was lower and the concentration of Fe higher than our results (Slačanac, 2011).

Goat yogurt

Samples of goat yogurt from conventional farm contain most of K and Ca. Concentrations of major elements (Se, Na, Ca, P, Mg, Fe, Zn) in strained and salted yogurts were significantly higher than in milk in the study by Zehra and Sanal (2009). The higher content of these elements is caused by the increase of the total solids during the manufacturing process. The content of Na in products is influenced due to quantity of NaCl added. The concentration of Fe is higher and Ca, Mg, and Zn are lower in our study than in goat yogurt from Croatia (Slačanac, 2011). Zehra and Sanal (2009) reported that Ca contents in goat yogurt were significantly higher than those measured in cow yogurts. Stelios and Emmanuel (2004) reported higher content of Ca, Mg, and Na in goat yogurt made from milk of the Alpine goat breed or local goat breeds. In the Spanish study, the content of Ca was twice higher and the content of Mg twice less in fermented goat products (yogurt in samples included) than in our yogurt from the conventional farm (Navarro-Alarcón et al., 2011).

Conventional vs ecological farm

The type of goat´s diet does not seem to have a great influence on the concentrations of mineral and trace elements in the milk samples. But the changes in bioavailability and quality of pasture throughout the year may be attributed to seasonal variation in milk composition (Garcia, 2006). However, Zenebe et al. (2014) presented the goat feed may have big effects on the mineral content of the milk. Kučevic et al. (2016) stated nutritional factors make a great impact on the general composition of goat´s milk and special consideration should be given to access to fresh grazing, silage type, and cereal feeding. The standard chemical composition of organic and conventional goat milk has been compared in numerous studies and thereby highly opposing results were obtained. No significant results were found, or higher content of fat, proteins, or non-fat dry matter in organic milk was presented (Popovic- Vranješ et al., 2017; Wannaiatie et al.,2019). Unfortunately, as Slačanac (2011) stated, there is poor scientific evidence about mineral and trace element concentrations in dairy products from goat milk in general, in comparison to ways of farming in particular. The way of production seems to have no significant variability according to the findings of the presented study. In our study, significant statistical differences ($P < 0.05$) were found only in levels of K, Ca, Li and Na when comparing milk samples from organic and conventional farms as listed in Table 1. Concentrations of K (1260.50 mg/kg), Li (0.02 mg/kg) and Na (293.46 mg/kg) were higher in samples from ecological farm, while concentration of Ca (1344.65 mg/kg) was higher in samples from conventional farm. Rolinec et al. (2018) mentioned start of grazing dairy goats affects the nutritive and mineral composition of goat milk. The highest concentration of Cu, Zn, and Fe was detected in milk goats after 7 days on pasture, while the highest concentrations of Ca, P, Mg, Na, and Mn were found in milk from goats that were fed only indoors. The experiment was made at an ecological farm in the region Orava, the same where samples of this study came from. With organic goat production animal welfare, protection of the environment, and sustainability of rural life styles can be improved, but there are challenges connected to controlling intestinal parasites of animals or achievements of adequate nutritional management. The development of nutritional technology and disease prevention will eventually improve the production efficiency of organic farming (Lu et al., 2010).

Table 2. Content of elements in goat cheeses from ecological farm and yogurt from conventional farm (mg/kg)

	Ecological farm			Conventional farm
	Soft ripening cheese	Hard ripening cheese	Fresh lump cheese	Yogurt
Ag	< 0.3*	< 0.3*	< 0.3*	< 0.3*
Al	13.87	< 0.2*	11.44	< 0.2*
As	< 0.0015*	< 0.0015*	< 0.0015*	< 0.0015*
Ba	0.45±0.35	1.57±0.30	1.43±0.35	< 0.00003*
Ca	2454.31±2213.93	8212.40±1362.89	4845.51±2895.84	887.64±190.12
Cd	< 0.00005*	< 0.00005*	< 0.00005*	< 0.00005*
Co	< 0.0002*	< 0.0002*	< 0.0002*	< 0.0002*
Cr	< 0.00015*	< 0.00015*	< 0.00015*	< 0.00015*
Cu	0.58±0.12	0.99±0.25	0.47±0.19	< 0.0003*
Fe	4.84±2.60	2.43±0.52	2.05±0.75	1.59±0.01
K	1510.00±377.56	1348.87±227.56	1159.99±108.97	1043.78±271.38
Li	0.04±0.04	0.05±0.01	0.02±0.004	0.005±0.002
Mg	170.45±60.98	371.50±52.67	302.07±130.86	96.38±22.54
Mn	0.26±0.06	0.33±0.06	0.290±0.08	< 0.00003*
Mo	< 0.0005*	< 0.0005*	< 0.0005*	< 0.0005*
Na	895.10±537.01	4139.28±923.17	647.07±463.98	256.92±71.75
Ni	< 0.0003*	< 0.0003*	< 0.0003*	< 0.0003*
Pb	< 0.0008*	< 0.0008*	< 0.0008*	< 0.0008*
Sb	< 0.002*	< 0.002*	< 0.002*	0.15±0.005
Se	< 0.002*	< 0.002*	< 0.002*	< 0.002*
Sr	1.66±1.22	6.35±1.20	4.00±1.46	< 0.00001*
Zn	18.61±0.49	30.70±8.82	22.55±6.88	1.09±0.52

* Concentrations with this index are below the LOD (limit of detection).

CONCLUSION

The present research confirmed the quality of environment in monitored area. Goat milk and goat dairy products from selected farms are rich in content of essential elements, mainly Ca, Mg, K and Na. Levels of toxic elements were very low or under limit of detection. Concentrations of analyzed major and minor minerals in analyzed samples were proportionally increased with the corresponding density of prepared milk products. All the mineral concentrations were in the normal range for each type of dairy product described by literature. The highest content of calcium was found in hard ripening cheese, however the highest content of strontium as well. Frequent regular consumption of this cheese for children is not recommended, because strontium is considered to be an antagonist of calcium and can be accumulated in bones during childhood development. According to our results, there is no huge difference among products from ecological or conventional way of farming, concentrations of K, Li and Na were significantly higher ($P < 0.05$) in samples from ecological farm, while concentration of Ca was higher in samples from conventional farm. No significant differences between samples of goat whey from both farms were found. Further research with bigger number of samples is needed.

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