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Short Communication

Iodine concentration in raw sheep milk from Slovak farms – preliminary results

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The aim of the study was to assess iodine concentration in raw sheep milk from chosen farms in Slovakia and to evaluate the factors that are involved. The assessed factors were as follows: effect of farm, iodine supplementation, farming system (conventional/organic). The bulk milk samples were collected (June-August 2020) from seven sheep farms located in various districts of Slovakia. The analyses were carried out using the spectrophotometric method of Sandell-Kolthoff. The average milk iodine concentration of analysed bulk milk (26 samples) was 121.4 ±24.4 µg l^{-1}. The concentration of iodine in milk was significantly affected by the farm (P <0.05). There was observed large variability among the average milk iodine concentrations of samples ranging from 52.4 ±9.5 µg l^{-1} to 511.6 ±48 µg l^{-1}. Similarly, iodine supplementation via mineral licks in farms significantly affected milk iodine concentration (P <0.01). This might be demonstrated by the lowest values in milk from the unsupplemented farm, ranging from 23.0 to 74.6 µg $l.l^{-1}$, which indicate iodine deficiency. The farming system did not significantly affect the concentration of iodine in raw sheep milk. However, we observed lower milk iodine concentrations in organic farms as compared with conventional (94.4 ±25.9 µg l^{-1} vs 131.4 ±32.0 µg l^{-1}, respectively.). To conclude, our results might suggest the important role of iodine supplementation on milk iodine concentration, as well as the significant impact of the farm as an important source of milk iodine concentration variability, which deserves attention regarding milk products and human nutrition.

Keywords: iodine, concentration, raw, sheep, milk

1 Introduction

Iodine is a trace element necessary for the function of the thyroid gland and thyroid hormones production (Walther et al., 2018; Mikláš et al., 2021). Thyroid hormones, like triiodothyronine and thyroxine (Flachowsky et al., 2014), are essential for key metabolic processes, development of the brain and bones (Grau et al., 2015). Therefore, iodine is essential for humans as well as for animals (Flachowsky et al., 2014).

In this respect, milk iodine concentration is also a valuable indicator of iodine intake in dairy animals (Trávníček and Kursa, 2001), as for instance 30–40% of iodine intake in feeds is transferred into cows' milk (Flachowsky et al., 2007). Moreover, Grace et al. (2001) observed that sheep in similar feeding conditions, produce milk with higher iodine concentration compared to dairy cows. In terms of sheep, milk iodine concentration above 100 µg l^{-1} might indicate sufficient intake in feeds (Schöne and Rajendram 2009). Therefore, milk might be also considered as an important source of iodine in human nutrition (van der Reijden et al., 2019; Mikláš et al., 2021).

Nevertheless, it is important to control the iodine intake in dairy animals, not only to ensure their sufficient intake, but also to avoid overconsumption or deficient intake in the human population. It is even more important

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to consider the relatively small difference between recommended (150 μg day^{-1}) (WHO, 2007) and upper tolerable iodine intake for adults (600 μg day^{-1}) (SCF, 2002).

Because of the aforementioned facts, the aim of the study was to monitor iodine concentration in sheep milk and to determine the factors affecting the iodine concentration in sheep milk.

2 Material and methods

Twenty-six samples of raw sheep milk were collected between June and August 2020 from 7 Slovak farms, located in various districts (Figure 1). On each farm, bulk milk samples were collected into 50 ml polypropylene vessels and frozen at temperatures from -18 to -20 °C. Before the analysis, the samples were defrosted at room temperature. The total amount of iodine in milk was analysed using Sandell-Kolthoff method (1937), which was modified by Bednář et al. (1964). It is a spectrophotometric method, utilizing alkaline ashing, based on the measurement of colour changes caused by the reduction of Ce^{IV} to Ce^{III}.

Sheep on every farm in our study were kept most of the day on pasture. In nearly all cases, except for one farm, the sheep were also offered mineral licks enriched with iodine (Table 1). The concentrations of iodine in the mineral licks were ranging from 80 (Námestovo) to 200 mg kg^{-1} (Považská Bystrica). The farms were also divided into two groups according to the farming system (conventional/ organic) (Figure 1). The farms were referred as organic if they complied with the Commission Regulation (EC) No 834/2007 on organic production.

The data were evaluated using the SAS® software (SAS Studio 3.8, 2018). The normality of distribution was tested by the Shapiro-Wilk test. The effect of farming system, use of iodine enriched mineral licks and farm on milk iodine concentration was investigated using the nonparametric Wilcoxon's rank-sum test and Kruskal-Wallis test (PROCNPAR1WAY). The values of observed parameters were reported as LSmeans.

3 Results and discussion

The mean iodine concentration in the collected samples was 121.4 ±24.4 μg l^{-1} and the median value was 89.6 μg l^{-1}. These results are comparable with the study of Paulíková et al. (2008), who examined samples of raw sheep milk in Slovakia, and found the average milk iodine concentration in their studied samples was 186.7 μg l^{-1}. Data in our study showed a significant effect of farms on iodine concentration in sheep milk (P <0.05). This fact could be caused by various factors, already investigated in dairy cows, like feeding (Konečný et al., 2019; Rezaei Ahvanooei et al., 2020), goitrogens in feeds (Franke et al., 2009), management practices (van der Reijden et al., 2017), etc. In that context, the average iodine concentrations in milk showed quite large variability ranging from 52.4 ±9.5 μg l^{-1} in Tvrdošín district to 511.6 ±48 μg l^{-1} observed in district Námestovo (Table 1). In this respect, Trávníček and Kursa (2001), Paulíková et al. (2008) also observed considerable variability among the analysed samples of sheep milk.

An important factor causing milk iodine concentration differences in sheep might be the iodine intake (Trávníček et al., 2010). The effect of iodine intake in feeds of dairy cows on their milk iodine concentration was observed in several studies (Rezaei Ahvanooei et al., 2020; van der Reijden et al., 2019). Nevertheless, studies focused on iodine concentration in sheep milk are very sparse (Flachowski et al.,2014). In this respect, we observed

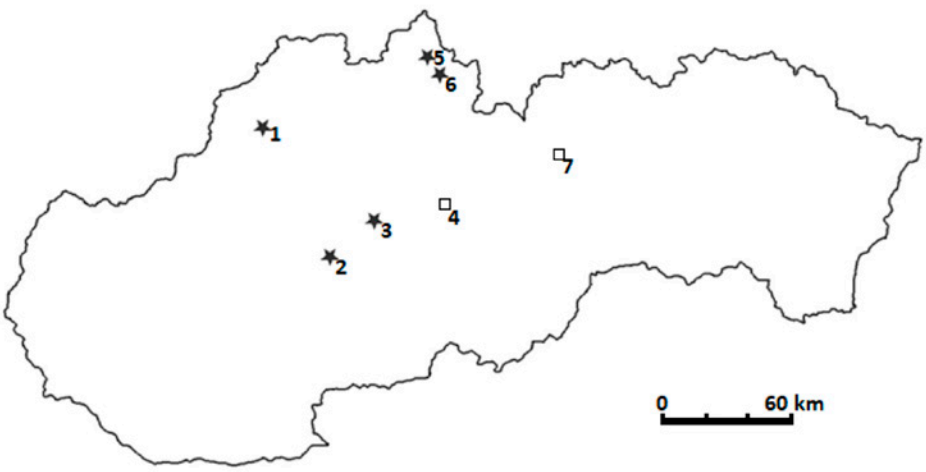

Figure 1 Locations of examined Slovak sheep farms
★ – conventional, ☐ – organic

Table 1 Iodine concentration in raw sheep milk (LSmeans) from several districts

Farm no.	District	Breed*	Iodine supplementation	Iodine concentration in milk (µg l^{-1})					
				n	estimate	StdErr	min	max	median
1	Považská Bystrica	TSxLCxEF	+	4	77.4	15.2	32.5	97.9	89.6
2	Žiar nad Hronom	TS	+	4	134.7	9.2	107.4	147.7	141.9
3	Banská Bystrica	LCxIV	+	4	90.6	13.8	49.3	106.9	103.0
4	Brezno	TSxIV	+	4	104.3	47.3	34.1	243.8	69.7
5	Námestovo	IV	+	2	511.6	48.0	463.6	559.6	511.6
6	Tvrdošín	TSxLCxEF		5	52.44	9.5	23.0	74.6	50.2
7	Poprad	AS	+	3	81.3	8.2	72.9	97.7	73.3

*1TS – Tsigai; LC – Lacaune; EF – East Friesian; IV – Improved Valachian; AS – Assaf

Table 2 Impact of iodine supplementation on milk iodine concentration (LSmeans) in sheep

Iodine supplementation	Iodine concentration in milk (µg $l^{-1)}$					
	n	estimate	StdErr	min	max	median
Iodine supplementation	21	137.8	29.1	32.5	559.6	97.9
No supplementation	5	52.44	9.5	23.0	74.6	50.2

Table 3 Effect of farming system on sheep milk iodine concentration (LSmeans)

Farming system	Iodine concentration in milk (µg l^{-1})					
	n	estimate	StdErr	min	max	median
Conventional	19	131.4	32.0	23.0	559.6	97.9
Organic	7	94.4	25.9	34.1	243.8	72.9

a significant effect of supplementation with iodine enriched mineral licks on milk iodine concentration in sheep (P <0.01). As we found that bulk milk samples from sheep farms with iodine supplementation had higher iodine concentration compared to milk samples from the unsupplemented farm (Tvrdošín district) (Table 2). Moreover, all the samples from the farm with no supplementation had milk iodine concentration below 80 µg l^{-1}, which might indicate the deficient iodine intake in the examined herd (Paulíková et al., 2008).

In this regard, several authors reported a positive correlation between iodine concentration in feeds and milk iodine concentration in cows (Rezaei Ahvanooei et al., 2020; Franke et al., 2009). Interestingly, in our study, we observed much higher milk iodine concentration in sheep (Námestovo) that were offered mineral licks with the lowest milk iodine concentration (80 mg kg^{-1}) compared to the sheep farm (Považská Bystrica) where mineral licks with the highest iodine concentration (200 mg kg^{-1}) were available. However, after additional investigation, we found out that sheep in the Námestovo district were offered during milking also mineral premixes (120 mg I.kg^{-1}) mixed with grains. This presumably caused higher milk iodine concentration in their milk. Therefore, our data could be considered as comparable with the observations of the aforementioned authors.

Some authors reported also a significant effect of the farming system on milk iodine concentration in dairy cows (Hanuš et al., 2008; van der Reijden et al., 2017). However, we did not confirm this effect in sheep, similarly as Vorlová et al. (2014) in dairy cows. This might be caused by the utilization of grazing in conventional as well in organic sheep farms and by smaller differences in management practices between conventional and organic sheep farms. On the other hand, we found higher milk iodine concentrations in conventional farms compared to organic farming systems (Table 3).

4 Conclusions

Monitoring of iodine concentration in sheep milk is a useful tool for assessment of iodine intake on sheep farms and it is also the first step in regulating it according to the needs of animals. In this respect, our findings of milk iodine concentration suggest the important role of iodine supplementation for ensuring sufficient iodine intake by sheep, as already examined in dairy cows by other authors. Moreover, regulation of iodine intake in sheep is important not only for themselves but it is also relevant for their offsprings and necessary for providing sheep milk with safe iodine concentration in milk products in relation to consumers.

Nevertheless, our results might suggest that there are also other factors on sheep farms responsible for milk iodine variability, as the concentration of iodine in milk did not always reflect the amount of iodine available in mineral licks. In this respect, several studies observed a number of factors affecting dairy cows' milk iodine concentration (Flachowsky et al., 2014). However, there are only a few studies focused on factors affecting iodine concentration in sheep milk. Therefore, further investigation is needed to understand these factors and to ensure sufficient nutrition for sheep as well as consumers.

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