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The effect of feeding change on nutrients and minerals composition of goat's milk

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Abstract

The aim of this study was to analyse the effect of change of feeding realised by beginning of grazing on composition of goat milk at ecological farm RD Pod Skalkou, Tvrdošín from middle April to end of June in 150 goats in different parities. For indoor feeding meadow hay (*ad libitum*) with grain feed and protein concentrate was used. Outdoor feeding using pasture and the same feed mixture like in indoor feeding was realised (0.2 kg crimped oat + 0.3 kg mixture of barley and corn in ratio 2:1 and 0.1 kg protein concentrate). Goats were milked twice a day using machine milking system. In all milk samples basic nutrients - according to standard laboratory methods, gross energy using Leco AC500, and minerals using CotrAA®700 were determined. Except fat, lactose, ash, all analysed parameters of goat milk were significantly ($P<0.05$ resp. $P<0.01$) affected by beginning of grazing. Concentration of Ca, P, Mg, Na and Mn was highest in goat milk fed only indoors, whereas concentration of Cu, Fe and Zn was highest on 7th day after start of grazing. Described changes of basic nutrients, gross energy and minerals of goat milk confirm significant effect of beginning of grazing on milk composition.

Keywords: goat, gross energy, milk nutrients composition, minerals content

Introduction

Goat milk is an alternative source of proteins for the creation of milk diets for infants and young children. In overall composition of crude protein, crude fat and lactose are similar, there are known some differences between cow and goat milk in terms of their digestion characteristics and the nutrition they provide (Farrell et al., 2004). On average, mineral elements account for 4% of total body mass and part of every tissue, liquid, cell and organ in human body. Minerals, both independently or in proper balance with other minerals, have structural, biochemical and nutritional functions that are very important for overall human health, both mental and physical (Vahčić et al., 2010). Mineral elements occur in milk and dairy products as inorganic ions and salts, as well as a part of organic molecules, such as proteins, fats,

carbohydrates and nucleic acids. The chemical form of mineral elements is important because it determines their absorption in the intestine and their biological utilization (Zamberlin et al., 2012). The quantity and quality of milk production as well as the concentration of nutrients and minerals in milk depends on many factors such as the genetic (Miluchová et al., 2014; Trakovická et al., 2015); lactation stage (Kuchtík et al., 2015; Pavlata et al., 2016); health status (Vlček et al., 2016); bud the main factor is nutrition (Pajor et al., 2014; Tudisco et al., 2014). Nowadays the concentration of minerals in food is an important factor of human nutrition and health. Milk is rich source of these substances and therefore, the aim of this research was to determine the effect of beginning of grazing on basic nutrients and minerals composition of goat milk.

Materials and methods

This experiment at an ecological farm RD Pod Skalkou, Tvrdošín, Slovakia (49° 19' 14.6293897" N, 19° 32' 38.8314056" E) from middle April to end of June with 150 goats in different parities with average milk production 2 litres was realised. Pooled milk samples were taken before start of grazing and then in different time periods after start of grazing. For each feeding phase 6 partial samples for gross sample were collected. After that the gross sample was reduced and homogenized into laboratory samples. During experiment (from middle of April to end of June) goats were milked twice a day, morning (3 samples) and afternoon (3 samples). For milking the machine milking system was used. In gained milk samples gross energy, basic nutrients and minerals composition were determined. During indoors phase, were goats fed with meadow hay (*ad libitum*) with grain feed and protein concentrate in amount of 0.6 kilogram per head (0.2 kg crimped oat + 0.3 kg mixture of barley and corn in ratio 2:1 and 0.1 kg protein concentrate). The concentration of dry matter in hay was 864 $g*kg^{-1}$, crude protein 107 $g*kg^{-1}$, crude fat 19.9 $g*kg^{-1}$, crude fibre $g*kg^{-1}$ and ash 59.9 $g*kg^{-1}$. In the pasture, the dry matter content 201 $g*kg^{-1}$, crude protein 209 $g*kg^{-1}$, crude fat 31.8 $g*kg^{-1}$, crude fibre 150 $g*kg^{-1}$ and ash 104 $g*kg^{-1}$ was determined. From 22nd of April to end of June goats stayed all day long on the pasture, however the feeding with grain feed and protein concentrate during milking, as well as *ad libitum* feeding with meadow hay during night remained. Samples from each feed ingested by goats during experiment in Laboratory of Quality and Nutritive Value of Feeds at Department of Animal Nutrition (SUA in Nitra, Slovakia) were analysed. For analysis of organic (crude protein, crude fat, crude fibre) and inorganic nutrients (ash) were used standard analytical methods (AOAC, 2000). The content of dry matter (DM) was determined gravimetrically by drying of sample to constant weight by temperature 103 ± 2 °C (predrying by t = 60 °C). Crude protein using the micro – Kjeldahl method, crude fat: extraction by Soxhlet, crude fibre: gravimetrically as the residue remaining after extraction in acid and neutral reagent, ash: ashing with the use of a muffle furnace by 530 ± 20 °C were measured. Meadow hay and pasture were analysed as well for minerals concentration. The concentration of minerals (Ca, Mg, K, Na, Cu, Fe, Mn, Zn) was determined by High Resolution Continuum Source Atomic Absorption Spectrometer, ContrAA®700 (Analytik Jena, Germany) and concentration of phosphorus was determined by 6400 Spectrophotometer (Jenway, UK). Results were statistically evaluated by one-way ANOVA (description statistics, SEM and effect of feeding either only with meadow hay indoors, or with meadow hay

plus pasture grazed between morning and afternoon milking on goat milk composition) in program IBM SPSS v. 20.0. Differences of means between sampling periods were tested by Tukey HSD test. P<0.05 was considered as significant.

Results

Goat milk is rich source of basic nutrients, energy and minerals. Concentration of almost all the nutrients in goat milk is affected by diet composition. After start of grazing ingested goats during night hay and during day concentrates and fresh pasture. This change in nutrition of goats affects composition of milk. Significant effect of start of grazing was found in dry matter (P<0.01), protein (P<0.01) and gross energy (P<0.05) concentration (Table 1).

Table 1. Nutritive value and mineral composition of goat milk during experiment

	OI (n = 6)	7DoP (n = 6)	37DoP (n = 6)	67DoP (n = 6)	Range	SEM	P
Dry matter (%)	14.8^{Aa}	13.3^{Bb}	11.9^{Bc}	11.7^{Bc}	11.5-15.7	0.42	**
Crude Protein (%)	4.03^{Aa}	3.17^{ABb}	2.94^{Bb}	2.81^{Bb}	2.69-4.53	0.172	**
Crude Fat (%)	4.72	4.6	3.5	3.48	3.28-5.84	0.25	
Lactose (%)	5.37	4.92	4.8	4.73	4.54-6.5	0.155	
Ash (%)	0.7	0.59	0.66	0.67	0.41-0.96	0.037	
GE ($MJ \cdot kg^{-1}$)	3.44	3.09	2.69	2.68	2.68-3.94	0.123	*
Ca ($g \cdot kg^{-1}$)	1.37^{a}	1.07^{b}	1.18^{ab}	1.1^{b}	1-1.52	0.044	**
P ($g \cdot kg^{-1}$)	1.35^{A}	1.07^{B}	0.91^{C}	0.92^{C}	0.88-1.41	0.054	**
Mg ($g \cdot kg^{-1}$)	0.13^{A}	0.11^{B}	0.11^{B}	0.11^{C}	0.11-0.13	0.003	**
K ($g \cdot kg^{-1}$)	1.44	1.7	1.96	1.88	0.76-2.18	0.129	
Na ($g \cdot kg^{-1}$)	0.48^{A}	0.36^{B}	0.35^{B}	0.37^{B}	0.35-0.55	0.019	**
Cu ($mg \cdot kg^{-1}$)	0.56^{a}	0.64^{a}	0.33^{b}	0.33^{b}	0.22-0.69	0.042	**
Fe ($mg \cdot kg^{-1}$)	1.32^{ab}	1.46^{b}	0.85^{a}	0.88^{a}	0.82-1.63	0.082	**
Mn ($mg \cdot kg^{-1}$)	0.09^{A}	0.07^{AB}	0.07^{B}	0.05^{B}	0.04-0.11	0.005	**
Zn ($mg \cdot kg^{-1}$)	5.34^{Aa}	6.03^{Bb}	4.81^{Ac}	4.77^{Ac}	4.65-6.1	0.131	**

$^{aA...}$ Means within a row bearing different superscripts differ significantly at: small letters - P<0.05, capitals - P<0.01; SEM – standard error of the mean; **P<0.01; *P<0.05; OI – middle of April, goats fed only indoors with hay and concentrates; 7DoP – end of April, goats were 7 days on pasture; 37DoP – end of May, goats were 37 days on pasture; 67DoP – end of June, goats were 67 days on pasture.

Moreover, significant differences in mean values of dry matter and crude protein between times of sampling were also determined. In general, after start of grazing the concentration of dry matter, protein, fat, lactose and gross energy decreased and then to the end of experiment continue in fall of values. Then, concentration of ash decreased after start of grazing and then slightly increased. The highest concentration of Ca, P, Mg, Na and Mn contained milk from goats fed only indoors. In the case of Cu, Fe and Zn the highest concentration was detected in milk of goats that were 7 days on pasture. Differences between the milk from goats fed with hay only indoors and milk of goats which were 7 days on pasture were found in decreased concentration of Ca, P, Mg, Na and Mn and increased content of the K, Cu, Fe and Zn. The effect of change of feeding on concentration of minerals was detected by all the analysed minerals, except potassium (Table 1).

Discussion

Similar as in this study, Tudisco et al. (2014) found higher concentration of lactose in months April 4.78% and May 4.76% compared to June 4.64%. On the other hand, the same authors found higher concentration of milk protein in months May 3.6% and June 3.55% compared to April 3.3%. In months April to June (4.38 to 4.5% respectively) determined Tudisco et al. (2014) higher concentration of milk fat than it was in this study. Kędzierska-Matysek et al. (2015) took milk samples from goats during winter feeding on roughage and summer feeding on pasture. They determined in goat milk from winter vs. summer feeding lower content of dry matter (11.46 vs. 11.86%), protein (2.85 vs. 3.12%), fat (3.43 vs. 3.7%) as well as of lactose (4.48 vs. 4.33%) compared to first two sampling periods of this experiment. Pajor et al. (2014) determined in milk of goats on pasture higher concentration of fat and protein (3.7 and 3.22%). Decrease of nutrients concentration (Table 1) is in accordance with statement, that concentration of dry matter, protein and fat is high in early lactation and decrease as lactation peaks (Kuchtík et al., 2015). Same reason for decrease of nutrients concentration, for example lactation stage and change of feeds quality published Pavlata et al. (2016). Changes in the milk fat and protein yields could be result of lesser availability of vegetation and fiber reduction in pasture diet during pasture season (Meľuchová et al., 2008). Similar development of Ca, Mg, K and Na concentration published Kędzierska-Matysek et al. (2015). Barłowska et al. (2013) confirmed effect of season on mineral elements of goat milk. They determined higher concentration of Ca, Na, Mg and Cu in the autumn-winter season and higher concentration of K in the spring-summer season. Similar as in this study Pavlata et al. (2016) found effect of season and lactation stage on Cu, and Zn concentration in goat milk. Slačanac et al. (2011) published reasons for different concentrations of minerals in goat milk: different locality where the studies were performed, different conditions of dairy goats, different farming and dairy goat's diet, different season of production, etc.

Conclusions

Start of grazing of dairy goats affects nutritive and mineral composition of goat milk. Thus, dry matter, protein, fat, lactose and energy content decreased linearly and continuously from the indoor feeding (highest concentrations) to 67 days of pasture (the lowest concentrations). However, ash content in goat milk fluctuated between the sampling periods, but the highest concentrations during the indoor feeding were found. Then, start of pasture period caused the highest concentrations of copper, iron and zinc compared to indoor feeding. Furthermore, similar decreasing trend between indoor feeding and pasture days in minerals content was found, except of potassium.

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