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Goat milk composition at morning and evening milking

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ABSTRACT

The differences in milk quantity and milk composition between morning and evening milking were studied in a model where the effects of administration of alpha linoleic, eicosapentanoic, and docosahexaenoic fatty acids, individual animal and lactation period were included. The effects of animal and lactation period significantly influenced all variables. Added fatty acids didn't influence fat in milk. The percentage of milk ingredients (fats, proteins, lactose, dry matter without fats and total dry matter) did not differ between morning and evening milking. Average time period between morning and evening milking was thirteen hours and the quantity of milk and milk ingredients was larger at evening, but the production of milk ingredients per time period was faster in the shorter night period.
(Keywords: goats, milk, morning milking, night milking, milk composition)

INTRODUCTION

Differences in milk composition and milk quantity between morning and evening milking are known for longer time. Reduction of costs for production control with only one control per day were the main reason for studying of this phenomena in cows (e.g. *Halgrove et al*., 1984; *Everett et al.,* 1970) and sheep (*Sanna et al*., 1994). *Drobnič et al*. (2000) studied milk quantity and milk composition of goat milk in morning and evening milking from Slovenian herds in production control. The quantity of milk was nearly the same (1.121 g at morning in comparison to 1.106 g at evening milking). No differences in protein and lactose percentage were observed between morning milk (2.98% of proteins and 4.24% of lactose) and evening milk (2.96% of proteins and 4.23% of lactose). Fat concentration in goat milk was much higher in evening (3.50%) than in morning milk (3.13%). Recalculated in absolute production, the total production of fat was 3.62 g larger in daylight period comparing to night period. On the opposite, total production of proteins was 0.67 g and of lactose 0.75 g larger in daylight than in night period. Because the time interval between two controls is unknown, the interpretation of results is difficult. *Simos et al*. (1991) studied milk composition of native Greek goats. The concentration of proteins (3.58% vs. 3.54%) and lactose (4.76 vs. 4.72) at the morning was nearly the same as at the evening. The fat concentration has had other pattern as in the study of *Drobnič et al*. (2000). In the morning, the concentration of fat was 5.30% comparing to 5.06% in the evening.

Different composition of morning and evening milk from morning and evening milking can be interesting for milk consumers. If the differences exist, morning milk might be more suitable for certain use (e.g. fresh use or production of cheese) than the evening milk.

MATERIALS AND METHODS

Sixty-two goats of Saanen and Alpine breed were included in the experiment. The experiment consisted of three time periods. The first, adapting period lasted for 10 days. All animals were treated on same procedure and fed with basic diet. Milk was sampled and analyzed on composition (fat, proteins and lactose) every day. In the second period of the experiment the animals were divided into four groups: first group (EPA) was fed with an extra dosage of 20 g of oil, reach in eicosapentanoic fatty acid (94.93%) and second group (ALPHA) with 20 g of oil per day, reach in alpha linoleic acid (57.84%). Third group (DHA) was fed with 20 g of oil per day, which was reach in docosahexaenoic acid (74.75%). The fourth group was the control group (C), which was fed with basic diet. Basic diet was the same for all four experimental groups. This period lasted for five days. As in the first period, milk was sampled and analyzed every day. Third period lasted for five days. The period started the day after the second period. Animals were fed with standard (basic) diet. Milk was sampled and analyzed every day. Last period started on day fifth after the third period. Animals were treated the same as in period three, but milk quantity was measured only every fifth day nine times until the end of the experiment. At the same time milk was sampled and analyzed.

Basic diet consisted of two kilograms of hay and 700 or 1.000 grams feed mixture with 11.6% ob crude proteins per day. The quantity of feed mixture depended on milk production of the animal. Special vitamin-mineral mixture with 220 g of Ca, 1.5 g of Zn, 88 g of P, 1 g of Fe, 65 g of Na, 1 g of Mn, 3 g of Mg, 20 mg of Cu, 400.000 I.E. of vitamin A, 3 mg of Co, 40.000 I.E. of vitamin D3, 9 mg of I, 1 g of vitamin E, 10 mg of Se per kg was on disposal to animals.

For statistical evaluation of data two statistical models were used. Milk quantity in grams, the quantity of fat (g fat/milking), proteins (g proteins/milking), lactose (g lactose/milking), and dry matter without fat (g DM/milking) and with fat (g TDM/milking) were evaluated with model 1:

$$Y_{ijklm} = \mu + T_i + A_{ij} + M_k + P_l + e_{ijklm},$$

where:

Y_{ijklm} : was the observed trait, μ was mean of the model,
T_i : was treatment (EPA, ALFA, DPA, C),
A_{ij} : was the effect of animal nested within the treatment,
M_k : was the effect of time of milking (morning, evening milking),
P_l : was the experimental period (first or adapting period, second or treatment period, third period and fourth period),
e_{ijklm} : was the individual deviation of every measurement.

The average time difference between morning and evening milking was thirteen and between evening and morning milking was eleven hours. Because it was interesting to estimate the effects of treatment, animal, milking period and experimental period on production rate of observed traits, the quantities of milk and milk ingredients were recalculated in grams produced per hour. Since the exact time of precedent milking for every individual animal was not known, the evening quantity of milk or milk ingredient in milk quantity was divided with eleven and morning quantity was divided with thirteen. The variables are milk production per hour, protein production per hour, fat production per hour, lactose production per hour, DM (dry matter without fats)

production per hour and TDM (total dry matter) per hour. The traits were evaluated with model 1.

Observed traits percentage of fat (% fat), percentage of proteins (% proteins), percentage of lactose (% lactose), percentage of dry matter without fats (% DM) and percentage of total dry matter (% TDM) were evaluated with model 2:

$$Y_{ijklm} = \mu + T_i + A_{ij} + M_k + P_l + b\left(x_{ijklm} - \bar{x} \right) + e_{ijklm},$$

where T_i, A_{ij}, M_k, P_l and e_{ijklm} have the same meaning as in the model 1.

Regression coefficient b estimates the effect of milk quantity on percentage of fat, proteins, lactose, DM and TDM in milk. Statistical evaluations were done with procedure GLM (proc GLM) included in statistical package SAS/STAT 8.02.

RESULTS AND DISCUSSION

Results of analysis of variance are shown in *Table 1*. Model 1 explains observed traits relatively good. Coefficients of correlation in model 1 are relatively high. Except for quantity of fat and for production of fat per hour, all the R^2 are higher than 0.7. Individual differences between animals are the most important effect. They influenced all the dependent variables in both statistical models.

Treatment with essential polyunsaturated fatty acids influenced all the observed variables except the total fat quantity in milk and production of fat in grams per time unit. The quantities of milk and milk ingredients like the production of milk ingredients per time unit and percentage of milk ingredients depended on lactation period.

R^2 values in model 2 are much lower than in model 1. That means, that the correction on milk quantity doesn't explain the percentage of milk ingredients as in model 1.

Milking time – morning and evening milking doesn't explain variability in percentage of fat, percentage of DM and TDM. The quantity of milk rather than milking time (morning/evening) explains variability in milk composition. Larger part of variance remains unexplained in model 2.

LSM values for milking period (morning – evening) are shown in *Table 2*. As expected, the larger quantity of milk was earned at evening milking (787 vs. 682 g), where the period between two milking was for two hours longer than between evening and morning milking. The same can be concluded for quantities of fat, proteins, lactose, DM and TDM. Total production of fat was in daylight period for 13% higher than in night period. The differences in total protein, lactose, DM and TDM production were in daylight period still larger – around 15% than production of fat. On the other hand, the period between morning and evening milking was on average 18% longer than the period between evening and morning milking. Production of milk ingredients, expressed as production of milk ingredient in grams per hour shows faster production of all studied components. All differences between the groups were statistically significant according to model 1. There were no proven differences in percentage of fat, DM and TDM between morning and evening milking, but statistically significant larger percentage of proteins and lactose was observed in morning than in evening milk. All regression coefficients were positive and different from zero. Larger amount of milk doesn't mean lower concentration of milk ingredients. In this case larger milk amount rather means higher concentration of fat, proteins, lactose, DM and TDM.

Table 1

Results of analysis of variance according to model 1 and model 2

			model				T_i		A_{ij}		M_k		P_l		$b(x_{ijklm}-x)$	
			df	F.	P	R^2	df	P	df	P	df	P	df	P	df	P
1	model 1	milk quantity	65	171.18	<0.0001	0.7945	3	<0.0001	58	<0.0001	1	<0.0001	3	<0.0001		
2		g fat/milking	65	89.18	<0.0001	0.6682	3	0.1588	58	<0.0001	1	<0.0001	3	<0.0001		
3		g proteins/milking	65	125.72	<0.0001	0.7395	3	0.0036	58	<0.0001	1	<0.0001	3	<0.0001		
4		g lactose/milking	65	150.27	<0.0001	0.7724	3	<0.0001	58	<0.0001	1	<0.0001	3	<0.0001		
5		g DM/milking	65	141.88	<0.0001	0.7622	3	<0.0001	58	<0.0001	1	<0.0001	3	<0.0001		
6		g TDM/milking	65	134.39	<0.0001	0.7522	3	<0.0001	58	<0.0001	1	<0.0001	3	<0.0001		
7		g milk/hour	65	170.70	<0.0001	0.7940	3	<0.0001	58	<0.0001	1	<0.0001	3	<0.0001		
8		g fat/hour	65	87.78	<0.0001	0.6647	3	0.1563	58	<0.0001	1	<0.0001	3	<0.0001		
9		g proteins/hour	65	123.77	<0.0001	0.7365	3	0.0026	58	<0.0001	1	0.0001	3	<0.0001		
10		g lactose/hour	65	148.53	<0.0001	0.7704	3	<0.0001	58	<0.0001	1	0.0014	3	<0.0001		
11		g DM/hour	65	140.67	<0.0001	0.7606	3	<0.0001	58	<0.0001	1	0.0002	3	<0.0001		
12		g TDM/hour	65	132.93	<0.0001	0.7501	3	<0.0001	58	<0.0001	1	<0.0001	3	<0.0001		
13	model 2	% fat	66	34.00	<0.0001	0.4396	3	<0.0001	58	<0.0001	1	0.6222	3	<0.0001	1	<0.0001
14		% proteins	66	76.54	<0.0001	0.6384	3	<0.0001	58	<0.0001	1	0.0016	3	<0.0001	1	<0.0001
15		% lactose	66	35.03	<0.0001	0.4469	3	<0.0001	58	<0.0001	1	0.0367	3	<0.0001	1	<0.0001
16		% DM	66	105.64	<0.0001	0.7093	3	<0.0001	58	<0.0001	1	0.0793	3	<0.0001	1	<0.0001
17		% TDM	66	82.46	<0.0001	0.6558	3	<0.0001	58	<0.0001	1	0.5566	3	<0.0001	1	<0.0001

Table 2

LSM values for morning and evening milking according to model 1 and model 2 and regression coefficients for effect of milk quantity according to model 2

	model	trait	LSM			regression	
			morning	evening	P	b	P
1	1	milk quantity	682.42	786.84	<0.0001		
2		g fat/milking	19.94	22.49	<0.0001		
3		g proteins/milking	20.98	24.16	<0.0001		
4		g lactose/milking	30.52	35.33	<0.0001		
5		g DM/milking	56.94	65.61	<0.0001		
6		g TDM/milking	76.88	88.06	<0.0001		
7		g milk/hour	62.20	60.32	<0.0001		
8		g fat/hour	1.82	1.72	<0.0001		
9		g proteins/hour	1.91	1.85	0.0001		
10		g lactose/hour	2.78	2.71	0.0014		
11		g DM/hour	5.19	5.03	0.0002		
12		g TDM/hour	7.01	6.75	<0.0001		
13	2	% fat	2.98	2.97	0.6222	0.000425	<0.0001
14		% proteins	3.17	3.21	0.0016	0.000556	<0.0001
15		% lactose	4.51	4.49	0.0367	0.000245	<0.0001
16		% DM	8.48	8.50	0.0793	0.000310	<0.0001
17		% TDM	11.45	11.47	0.5566	0.000735	<0.0001

It can be concluded, that the night production of milk and milk ingredients was faster than the daylight production. Because of unequal time periods between morning and evening and between evening and morning milking the differences in milk composition might not be correctly expressed, since the dynamics of production of milk and milk ingredients is not known within those time periods. The difference cannot be only the consequence of resting of animals during the night period, but it is also the consequence of longer time period as such. No benefits of morning or evening milk were found.

CONCLUSIONS

In the experiment with 62 goats of Saanen and Alpine breed the effect of individual animal, the effect of longtime administration of EPA, ALFA and DHA fatty acids, the effect of lactation period and the effect of morning/evening milking on milk quantity, on milk ingredients production and milk composition was studied with two statistical models. The quantities of milk, milk ingredients and production of milk ingredients per time unit were explained with very high R^2. On the other side, R^2 values in models, where milk ingredients were expressed in percentage, were much lower. The effects of animal and time period influenced all the dependent variables. Administration of special fatty acids didn't influence fat quantities or percentage in milk and the explanation of variability in milk ingredients was low where they were expressed in percentages. The quantities of milk and milk ingredients were generally higher at evening milking, but the production of milk and milk ingredients per time unit was faster in the shorter night period.

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