Factors affecting goat milk yield and composition

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Summary

The aim of this paper was to study the effects of breed, stage of lactation, season of kidding and parity on goat milk yield and composition. A total of 25255 records of daily milk production and 25065 records of fat percentage, 25382 records of protein percentage and 24810 records of lactose percentage were obtained, at approximately monthly intervals, from 3702 Alpine and 411 Saanen goats in Croatia. The analysed data were recorded during 2006. Saanen breed had significantly (P<0.01) higher lactation and daily milk yield than Alpine breed (720 kg and 2.63 kg/day versus 577 kg and 2.08 kg/day, respectively). The contents of protein and lactose were similar between investigated breeds, while Alpine goats had significantly higher (P<0.05) milk fat content than Saanen goats (3.47 % versus 3.25 %, respectively). Least square analyses showed significant effects of stage of lactation, season of kidding and parity on almost all variables. Milk lactose content tended to decline as the lactation period progressed and milk yield decreased. Milk protein content tended to increase with the lactation period. The lowest content of milk fat was established in the mid stage of lactation, whereas the highest fat content was recorded at the end of lactation. The effect of parity on total lactation and daily milk yield shows an almost steady growing trend from first to fourth lactation. Goats kidding early in the year had better milking performances (longer lactation period, higher milk yield, higher content of milk fat) than goats kidding in the spring. In order to improve lactation performances of their animals, the goat farmers should apply earlier mating season and use the appropriate breeding programmes.

Key words: Alpine, Saanen, lactation period, parity, season of kidding

Introduction

Goat milk production is appreciated by nutritionists and consumers. In Mediterranean countries goat milk is widely used to produce hard and soft

cheese and other typical dairy products (Carnicella et al., 2008). In Croatia, goat husbandry is primarily based on autochthonous goat breeds whose purpose is kid meat production. However, for the past twenty years the interest in the production of goat milk based on Alpine and Saanen breeds has increased. These goat breeds, so called «improver» breeds (Devendra and McLeroy, 1982) have been imported widely to Croatia in order to intensify goat milk production (Mioč et al., 2007). Thus, the Croatian goat breeders have been applying the model of the European countries with developed goat breeding to increase milk production. Nowadays, goat milk is mostly processed into cheese (industrially, or on family farms).

The information on factors affecting goat milk yield and composition such as breed (Sung et al., 1999), stage of lactation (Ciappesoni et al., 2004), parity (Antunac et al., 2001) and season of kidding (Crepaldi et al., 1999), are very important since they consequently influence the yield and quality of the final product (Fekadu et al., 2005). Therefore, the aim of this paper was to determine the effect of above mentioned factors on milk yield and milk composition in Alpine and Saanen goats in Croatia.

Materials and methods

The data relating to the official milk recording of the Croatian Livestock Centre for 3702 Alpine goats and 411 Saanen goats were used for this research. The analysed data were recorded during year 2006. The milk production control was performed using the AT method (ICAR, 2004) with a single milking by hand (morning or evening) once a month (every 28-34 days), with the measuring of the quantity of milked milk and by taking individual samples of milk for chemical analysis. The amount of milk (kg) was calculated by multiplying the quantity of milk shown in litres (L) with the average density of goat milk 1.030 (ICAR, 2004). Individual milk yield per lactation was calculated by summing monthly milk yields which were obtained by multiplying daily milk records by the number of days since kidding, for the first period, or by the number of days since the preceding milk recording day for subsequent recording days (Thomas et al., 1999). Only lactation with at least three monthly records was included in the analysis. Drying off took place when goats milk yield dropped to about 0.2 kg per day. Contents of fat, protein and lactose were determined by routine laboratory procedures using the automated infrared method (HRN EN ISO 9622:2001.).

The three stages of lactation, early, middle and late were 10-90, 91-180 and after 180 days, respectively. The kidding periods were grouped from December to February during winter (Season-I) and from March to May during spring (Season-II).

The original performance record database included 27038 test-day records. Poor quality data were excluded from the followings computations. A total of 25255 records of daily milk production and 25065 records of fat percentage, 25382 records of protein percentage and 24810 records of lactose percentage were analyzed using a General Linear Model (GLM) procedure of SAS statistical software (SAS, 1990). The mathematical model for the analysis of data included fixed effect due to breed (Alpine and Saanen), stage of lactation (early, middle and late), season of kidding (Season-I and Season-II), parity (1-5) and residual error. Effects were considered significant at 0.05 level or less.

Results and discussion

Least squares means for lactation length, lactation and daily milk yield by breed of goats, stage of lactation, season of kidding and parity are presented in table 1. Although lactation length between investigated breeds was similar, total lactation and daily milk yield were significantly affected (P<0.01) by breed, being higher for the Saanen goats than the Alpine goats. In comparison with our results, Antunac and Kapš (1995) reported higher mean daily milk yield for Saanen and Alpine breeds (4.16 kg per day versus 3.69 kg per day, respectively). Kompan et al. (1998) also reported higher lactation milk yield for the Saanen goats then the Alpine goats (584 kg versus 493 kg, respectively). Most kiddings (63 %) occurred in winter and season of kidding significantly affected lactation milk yield (P<0.01) and daily milk yield (P<0.05). Goats that kidded in winter season had higher milk yields, whereas goats that kidded in spring had lower yields. Generally, in the northern hemisphere kidding early in the year (i.e. January - February) is recognised as one of the main factors favouring milk production in goats (Crepaldi et al., 1999). The effect of parity (P<0.01) on lactation and daily milk yield shows an almost steady growing trend from first to fourth lactation. Goats in their fourth parity yielded approximately 686 kg compared with 499.91 kg (-20 %) in goats in their first parity. Lactation length, as well as milk yield, was primarily affected by season of kidding (P<0.01) and by parity (P<0.01). As expected, goats that kidded in winter (Season-I) had longer lactations what is in accordance with the statements of Crepaldi et al. (1999).

*Table 1: Least squares means (±S.E.) for lactation length, lactation and daily milk yield by breed of goats, stage of lactation, season of kidding and parity**

*Tablica 1: Dužina laktacije, ukupna laktacijska i dnevna proizvodnja kozjeg mlijeka s obzirom na pasminu, stadij laktacije, sezonu jarenja i redoslijed laktacije (LSM ± S.E.)**

	Lactation length (days) Dužina laktacije (dana)	Lactation milk yield Proizvodnja mlijeka u laktaciji (kg)	Daily milk yield (kg) Dnevna proizvodnja mlijeka (kg)
Breed Pasmina			
Alpine/Alpina	264.51±0.57	577.20±3.71[a]	2.08±0.01[a]
Saanen/Sanska	266.81±1.95	720.08±12.49[b]	2.63±0.04[b]
Stage of lactation Stadij laktacije			
Early/Rana	-	-	2.50±0.01[a]
Middle/Srednja	-	-	2.24±0.01[b]
Late/Kasna	-	-	1.86±0.02[c]
Season of kidding Sezona jarenja			
Season-I/Sezona-I	277.74±0.52[a]	627.75±4.06[a]	2.16±0.01[a]
Season-II/Sezona-II	229.73±0.85[b]	484.49±6.66[b]	2.01±0.02[b]
Parity Redoslijed laktacije			
First/Prva	256.39±0.91[a]	499.91±5.79[a]	1.87±0.02[a]
Second/Druga	273.43±1.19[b]	626.45±7.53[b]	2.20±0.02[b]
Third/Treća	271.46±1.46[b]	634.92±9.30[b]	2.23±0.03[b]
Fourth/Četvrta	268.42±1.67[bc]	686.75±10.61[c]	2.45±0.04[c]
Fifth and over Peta i više	263.55±1.24[c]	624.71±7.87[b]	2.25±0.02[b]

*Means within a sub-class of a column not followed by the same superscripts differ (P<0.05).
*Vrijednosti unutar pojedine subkolone s različitim oznakama se značajno razlikuju (P<0,05).

Least squares means for milk constituents by breed of goats, stage of lactation, season of kidding and parity are presented in table 2.

*Table 2: Least squares means (± S.E.) for milk constituents by breed of goats, stage of lactation, season of kidding and parity**

*Tablica 2: Kemijski sastav kozjeg mlijeka s obzirom na pasminu, stadij laktacije, sezonu jarenja i redoslijed laktacije (LSM ± S.E)**

	Fat/Mast (%)	Protein/Bjelančevine (%)	Lactose/Laktoza (%)
Breed Pasmina			
Alpine/Alpina	3.47±0.01[b]	3.08±0.004	4.54±0.002
Saanen/Sanska	3.25±0.03[a]	3.01±0.01	4.46±0.01
Stage of lactation Stadij laktacije			
Early/Rana	3.48±0.008[a]	2.98±0.003[a]	4.59±0.002[a]
Middle/Srednja	3.36±0.009[b]	3.06±0.004[b]	4.48±0.002[b]
Late/Kasna	3.71±0.01[c]	3.41±0.005[c]	4.47±0.003[b]
Season of kidding Sezona jarenja			
Season-I/Sezona-I	3.48±0.01[a]	3.07±0.004	4.53±0.003
Season-II/Sezona-II	3.39±0.02[b]	3.09±0.007	4.51±0.005
Parity Redoslijed laktacije			
First/Prva	3.45±0.01	3.11±0.001[a]	4.54±0.004
Second/Druga	3.46±0.02	3.08±0.001[ab]	4.53±0.006
Third/Treća	3.42±0.02	3.05±0.01[b]	4.50±0.007
Fourth/Četvrta	3.43±0.03	3.06±0.01[b]	4.53±0.008
Fifth and over Peta i više	3.47±0.02	3.04±0.001[b]	4.51±0.006

*Means within a sub-class of a column not followed by the same superscripts differ (P<0.05)
*Vrijednosti unutar pojedine kolone s različitim oznakama se značajno razlikuju (P<0,05)

The means for fat, protein and lactose contents in the milk of investigated breeds were within the range of estimates recorded for dairy goats (Mioč and Pavić, 1991; Kompan et al., 1998; Antunac and Samaržija, 2000). The contents of protein and lactose were similar between investigated breeds (table 2), while Alpine goats had significantly higher (P<0.05) milk fat content than Saanen goats (3.47 % versus 3.25 %, respectively). According to Sung et al. (1999) Alpine goats had also higher percentage of milk fat than Saneen goats, but with significantly lower protein and lactose content.

Variation in milk yield and milk constituents with stage of lactation followed the general pattern observed in goats (Zygoyiannis and Katsaounis, 1986; Antunac et al., 2001). Protein content increased with advancing stage of lactation, while lactose content had a reverse trend. The lowest content of milk fat was established in the mid stage of lactation, whereas the highest fat content was recorded at the end of lactation. The influence of season of kidding on protein and lactose contents was not important, however, there was a small increase (P<0.05) in milk fat content in winter than in spring. According to Prasad et al. (2005) seasonal effects in milk composition may arise from the diet that may vary with the fodder consumed by the goats, which is mainly dependant on the climatic conditions of the area. There was no specific trend due to parity while protein and lactose content were highest in the 1st parity. Opposite to our results, Antunac and Kapš (1995) reported that parity had a significant effect on fat content in milk of Alpine and Saanen goats in Croatia.

Table 3: Correlation amongst different milk constituents and daily milk yield

Tablica 3: Korelacije između pojedinih sastojaka mlijeka i dnevne proizvodnje mlijeka

Parameters Parametri	Daily milk yield Dnevna proizvodnja mlijeka	Milk fat Mliječna mast	Protein Bjelančevine	Lactose Laktoza
Daily milk yield Dnevna proizvodnja mlijeka	-	-0.24**	-0.21**	0.10*
Milk fat Mliječna mast	-0.24**	-	0.39**	-0.09*
Protein Bjelančevine	-0.11*	0.39**	-	-0.04

*P<0.05
**P<0.01

The phenotypic correlations among the variables studied are shown in table 3. Correlations were high and negative between milk yield and composition variables (r=-0.24 to -0.21), except for the lactose content which had a positive correlation with milk yield (0.10) and negative correlations with other milk constituents. High and positive correlations were found between the contents of protein and fat (0.39) that is in accordance with the results given by other authors (Prasad et al., 2005; Sung et al., 1999).

Conclusions

The Saanen breed had higher daily and lactation milk yield but lower percentage of milk constituents than Alpine breed. Fat and protein increased with advancing stage of lactation, while lactose had a reverse trend. Goats kidding early in the year produce more milk and have longer lactations than goats kidding in the spring. In order to improve lactation performances of their animals, the goat farmers should apply earlier mating season and use appropriate breeding programmes.

ČIMBENICI PROIZVODNOSTI I SASTAVA KOZJEG MLIJEKA

Sažetak

Cilj ovog istraživanja bio je utvrditi utjecaj pasmine, stadija i redoslijeda laktacije te sezone jarenja na proizvodnju i sastav kozjeg mlijeka. Ukupno je, od 3702 alpske i 411 sanskih koza uzgajanih u Hrvatskoj, prikupljeno 25255 podataka dnevnih kontrola mliječnosti te 25065 podataka prosječnog udjela mliječne masti, zatim 25382 podatka o sadržaju bjelančevina, kao i 24810 podataka o sadržaju laktoze. Analizirani podaci prikupljeni su u približno jednakim mjesečnim razmacima tijekom 2006. godine. Sanske koze su ostvarile značajno (P<0,01) veću laktacijsku i dnevnu proizvodnju mlijeka (720 kg i 2,63 kg/dan) nego alpske koze (577 kg i 2,08 kg/dan). Udjel bjelančevina i laktoze u mlijeku istraživanih pasmina bio je podjednak, dok je mlijeko alpskih koza sadržavalo značajno (P<0,05) više masti (3,47%) u odnosu na mlijeko sanskih koza (3,25%). Statističkom analizom podataka utvrđen je značajan utjecaj stadija i redoslijeda laktacije te sezone jarenja na gotovo sve analizirane pokazatelje. S odmicanjem laktacije prosječna dnevna proizvodnja mlijeka se smanjivala, uz smanjenje udjela laktoze, dok se udjel bjelančevina povećavao. Najniži udjel mliječne masti je utvrđen sredinom

laktacije, dok je njegov najviši postotak utvrđen u posljednjem stadiju laktacije. Ukupna laktacijska i dnevna proizvodnja mlijeka imale su konstantan rast od prve do četvrte laktacije. Koze ojarene tijekom zimske sezone (prosinac-veljača) imale su bolje mliječne odlike (dužu laktaciju, veću proizvodnju mlijeka, viši udjel mliječne masti) nego koze ojarene u proljeće. U svrhu poboljšanja proizvodnih odlika životinja, uzgajivači koza bi trebali primjenjivati raniji pripust uz odgovarajuće uzgojne postupke.

Ključne riječi: alpina, sanska, laktacija, redoslijed laktacije, sezona jarenja

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