

VARIATION OF MILK YIELD AND MILK COMPOSITION OF PIVSKA PRAMENKA SHEEP BREED THROUGH LACTATION

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Abstract

The aim of this paper is to present the research results on the milk traits and variation of milk composition during lactation of Pivska pramenka breed, as one of the most important autochthonous sheep breeds in Montenegro. Investigation was conducted on the family sheep farm located in the municipality of Žabljak, a typical rearing area of Pivska pramenka breed.

The following milk traits were studied: length of lactation, milk yield (daily milk yield – DMY and total milk yield - TMY) and milk composition (Fat, Protein, Lactose, Solid non-fat - SNF and Somatic cells count - SCC).

Based on the data of 68 completed lactations, average length of lactation was 178.5 days and average milk yield 94.1 kg. On the basis of 289 milk samples analysed in 5 consecutive milk recordings, average daily milk yield was 0.549 litres, with 5.71% of fat, 5.75% of protein, 4.47% of lactose, 11.04 % of solid non-fat and 600×10^3 SCC on average.

Differences in averages for milk composition among test days (days of milk recording) during lactation were significant ($P < 0.01$). The largest variation was for milk fat, from 2.95% in the first control to 9.42% in the fifth control, while variation of protein was between 4.5% in the first and 7.4 in the fifth control. The content of lactose exposed decreasing trend during lactation (from 4.7% in first to 3.1% in fifth control).

Key words: *lactation, milk composition, milk yield, Pivska pramenka*

Introduction

Milk is still an important product of sheep sector, in spite of dominance of meat market value. Europe is the main sheep milk producer in the world (2/3 of total production), with the Mediterranean countries (Italy, Spain, France and Greece) as the leading producers (Mioč et al., 2007). Sheep milk is mainly used for production of different types of cheese, then for sour milk products and to a smaller extent is directly consumed as fresh milk (Domaćinović et al., 2008).

Economic importance of sheep milk in the countries of Balkan Peninsula has been constantly decreasing, due to the fact that lamb meat production is in focus of farmers' orientation and

their breeding programs (Petrović et al., 2013). The same trend is present in Montenegrin sheep sector.

During the sixties of 20th century Montenegro had about 600,000 heads of sheep. Since that period, intensive industrialization led to a drastic reduction of the total sheep population. Only during the last 20 years sheep population decreased by 53%, from 480,000 heads in 1991 to 207,000 heads in 2012.

Sheep production is characterized by semi extensive system of rearing, focused on utilisation of grassland and pasture areas. Regarding breed structure, autochthonous breeds (Pramenka group of breeds) prevail with a number of breeds which are invaluable from the aspect of preservation of farm animal genetic resources (Markovic et al., 2008). Two autochthonous breeds are dominant: Pivska or Jezeropivska (approx. 20% in total) and Sjenička (approx. 25% in total). Breeds like Bardoka, Ljaba, Sora or Zetska Žuja are less numbered, and all together participate by 15% in the total. Share of crossbreds in the total population is very high, about 40% (Marković et al., 2011).

These autochthonous sheep breeds are for triple-purpose (milk, meat and wool). Since wool is nowadays practically without economic importance, thus ratio between market value of the main products is estimated as: meat 70-75%, milk 25-30%. This ratio depends on the region, way of production, milking capacities of sheep, as well as on working force available for hand milking (Adzić et al., 2004; Marković et al., 2011).

Production of sheep milk in Montenegro is highly seasonal due to the seasonality in lambing of ewes, usually from February to April. Milking of ewes mainly starts after three month suckling period and lasts until autumn. Milk is usually processed in household into traditional dairy products: local product called skorup or kajmak, different types of cheese, yogurt, jardum, etc.

Raw milk quality is one of the key prerequisites for the amount and quality of dairy products. Yield and composition of milk are influenced by breed, age of ewes, parity, litter size, nutrition, health of animals, environment, stage of lactation, etc. The last one – stage of lactation has a significant effect on milk traits (Pavić et al., 2002; Oravcova et al., 2007; Kuchtik et al., 2008).

Milk production is a function of the stage of lactation, usually presented in number of days in milk. The most common approach in lactation curve modelling is to fit suitable function of time, $y = f(t)$, to test-day records (Komprij et al., 2012). Two types of lactation curves can be found in sheep to describe the effect of stage of lactation on milk traits. The first one is common to the intensive production systems. Daily milk yield (DMY) is increasing from lambing to the peak of lactation appearing three to five weeks ahead. After that daily milk yield is gradually decreasing toward the end of lactation with different persistence, depending on rearing conditions and breed. The second type, known as an atypical lactation curve, appears in ewes kept in poor environment or in the extensive production systems where daily milk yield decrease continually from the start toward the end of lactation.

Most of the previous studies of milk traits of sheep in Montenegro were focused on total milk yield and lactation length measured individually, while milk composition (solids, butterfat, and milk protein) were determined only on the group milk samples, but not on milk records of individual ewes. The aim of this paper is to present the results of investigation of variation of

daily milk yield and milk composition during lactation of Pivska pramenka breed on the basis of test day records.

Materials and methods

Investigation was conducted on the family sheep farm located at village Javorje, Žabljak Municipality. It is at the foot of the Mountain Durmitor, at an altitude of 1500 meters, what is typical rearing area of Pivska pramenka breed. Milk is mostly used for production of well-known traditional dairy products "skorup" and cheese "prljo". This breed is well adapted to the conditions of a cold mountain climate. Feeding of sheep is primarily based on pasture, while during wintertime the hay is the main feed, supplemented by grain during lambing season. During summer season (from May to end of September) the farmers usually remove flocks from the permanent settlements to mountain pastures.

The investigations were carried out during 2013. Due to a very long and cold winters lambing season starts in the second part of March and ends in the middle of April. Suckling period, when lambs are permanently with their mothers, lasted 2.5 months. One of the characteristics of sheep sector in this region is growing of lambs at the pasture until the age of 6-7 months. Due to the lack of enough workers, after the weaning the lambs stay with their mothers during the day as well, thus having possibility to suck ewes. Lambs are separated only during the night and ewes are milked regularly only in the morning.

Milk recording was done in accordance with the ICAR guidance at five consecutive terms, starting in April. First two recordings were done during suckling period, and the rest during the period of milking of ewes. Milk yield was determined by measuring cylinder graduated at 20 ml. Individual samples of milk for chemical analyses were taken from each of the recorded animal, thus total of 289 milk samples was collected and delivered to the lab for analyses.

Chemical composition of milk was analysed in the Dairy Laboratory of Biotechnical Faculty, in the following way: fat (F), protein (P), lactose (L) and solid non-fat (SNF) by the IC spectrophotometry (IDF 141C: 2000), somatic cells – $10^3/\text{ml}$ (SSC) by flow cytometry METI EN ISO 13366-2-2011 (IDF 148-2) using MilcoScan 120FT.

All data were analysed by using one-way analysis of variance (ANOVA) in the statistical package Statistica 12.

$$Y_{ijkl} = \mu + C_i + e_{ij}$$

where:

μ = overall mean

C_i = fixed effect of test day ($i = 1, \dots, 5$)

e_{ij} = random residual error.

Results and discussion

The obtained results on 68 ewes of Pivska pramenka breed (Table 1) show that the average milk yield was 94.11 kg during 178.5 milking days on average. Very wide range of variation in TMY, from 50 kg to 200 kg, indicates that this breed has a genetic potential for higher milk

production. Milk yield in this research is slightly lower than the previous one for this breed of sheep (Ljumović and Adžić 1987; Mitić 1987), while similar to the results obtained by Adžić et al. (1992).

Pivska pramenka has similar milk yield to Sjenička breed, but higher than the other breeds from the Pramenka group: Zetska Žuja and Ljaba from Montenegro, Pirotka from Serbia and Vlasicka from Bosnia and Herzegovina (Ljumović and Adžić, 1987; Mitić, 1987; Petrović et al., 2002 and 2006). However, autochthonous breeds from Croatia produced higher milk quantity in the lactation (Pandek et al., 2005).

Average daily milk yield (DMY) and milk components: fat, protein, lactose, SNF – solid non-fat and somatic cells count – SCC were determined on 289 individual measurements and on the same number of milk samples taken in five consecutive visits during milking.

Average daily milk yield was 0.549 l. It was the highest at first recording (0.720 l), then it has been constantly decreasing till the last (fifth) test day (0.280 l), Table 2. All differences in milk yield among test days (days of recording) were significant ($P < 0.01$), except for the difference between the first and second recording which was not significant ($P > 0.05$).

Table 1. *Statistical parameters for milk traits of Pivska pramenka breed*

Parameter	N	\bar{X}	SD	CV (%)	Range
Lactation length, days	68	178.53	24.11	13.50	126.0 – 230.0
TMY - Lactation milk yield, l	68	94.11	25.41	27.00	50.20 – 198.90
DMY - daily milk yield, l	289	0.549	0.24	43.7	0.10 – 2.40
Fat, %	289	5.71	2.55	44.6	1.85 – 12.42
Protein, %	289	5.75	1.18	20.51	3.79 – 10.36
Lactose, %	289	4.47	0.67	14.99	1.86 – 5.46
SNF, %	289	11.69	0.82	7.02	9.00 – 14.72
SCC, 10^3	278	600.52	1085.50	180.70	37 - 5311

Fat is the milk component with the highest variation through the lactation. Average fat content was 5.71%, and contrary to the milk yield it has had significant increase from 2.95% in the first up to 9.42% in the fifth recording. The differences among the test days were significant ($P < 0.01$).

Variation of fat content through lactation and the effect of stage of lactation on fat content are in accordance with the results of Pavić et al. (2002); Kuchtik et al. (2008); Komprej et al. (2012). However, the average fat content in milk is lower than in majority of the results of other researchers. One of the reasons for this may be incomplete milking; thus the last milk is retained.

Protein, lactose and SNF are milk components with much smaller range of variation than milk fat. Similar to fat content, protein has been increasing from the first recording (4.51%) up to the fifth (7.36%), while lactose content exposed the opposite trend, but at smaller scale, from 4.72% in the first to 3.11% in the fifth recording, Graph 1.

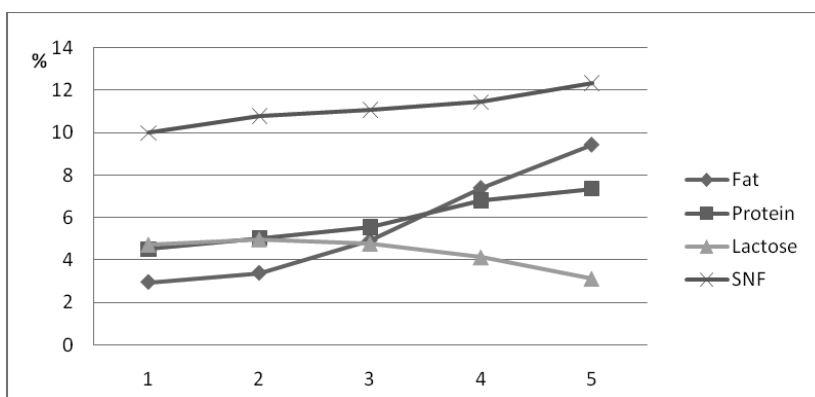
Table 2. Variation of daily milk yield (DMY) and chemical composition of sheep milk in different stages of lactation

Parameter	I	II	III	IV	V
Daily milk yield, l	0.72±0.04 ^a	0.67±0.03 ^a	0.58±0.02 ^b	0.420±0.02 ^c	0.28±0.02 ^d
Fat, %	2.95±0.09 ^a	3.38±0.09 ^a	4.91±0.12 ^b	7.38±0.20 ^c	9.42±0.34 ^d
Protein, %	4.51±0.51 ^a	5.03±0.04 ^b	5.54±0.06 ^c	6.80±0.10 ^d	7.36±0.19 ^e
Lactose, %	4.72±0.02 ^a	4.98±0.03 ^b	4.77±0.02 ^a	4.12±0.06 ^c	3.11±0.10 ^d
SNF, %	9.99±0.06 ^a	10.78±0.05 ^b	11.07±0.06 ^b	11.44±0.2 ^c	12.32±0.16 ^d
SCC, 10 ³ /ml	563±302 ^{ab}	206±41.2 ^b	342±75.4 ^b	1113±284 ^{ac}	2067±819 ^d

^{a,b,c,d} - different letter in subscript means statistical significant differences (P<0.05)

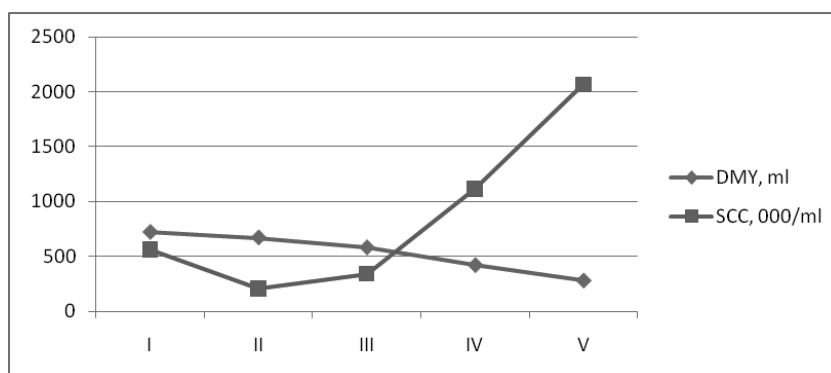
Similar to protein, SNF had a mild growing trend from the first (9.99%) to the fifth recording (12.32%). Stage of lactation had a significant influence on SNF content, thus all differences among test days (recordings) were significant (P<0.01), except for the difference among the second and third test day which was not significant (P>0.05).

Somatic cell count - SCC in sheep milk is important as parameter of udder health status (mastitis indicator) as well as for the processing of milk (indicator of quality). Average SCC was 600,520/ml. SCC amounted to 563,000 at the beginning of lactation (first recording) then during the middle of lactation (second and third recording) went down and significantly increased reaching 1,113,000 in the fourth recording and even 2,067,000 cells in the fifth recording.



Graph 1. Variation of the milk components through lactation

Increasing of SCC during the second half of lactation, parallel with decreasing of daily milk yield is in accordance with the results of Gaicone et al. (2005). SCC curve goes to the opposite direction in comparison to the shape of DMY curve, Graph 2.



Graph 2. Variation of DMY and SCC through lactation

Conclusion

The stage of lactation had a significant effect on the daily milk yield and the content of all studied milk components.

A wide range of milk yield indicates the plasticity of the genome of Pivska pramenka and good capacity for improvement by implementation selection in the existing breed.

Content of fat in milk has been increasing in parallel with the decreasing of milk yield.

From April to October protein and SNF content increased in parallel, but lactose decreased slightly.

The results of milk yield and milk composition of Pivska pramenka sheep breed show that there are still quite a lot of possibilities to improve the milk yield and fat content. Nutrition, maintenance and state of health can contribute to improve the production and to influence a rearing success.

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