The changes of microbiological and chemical composition of goat's milk during second lactation

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Summary

Individual milk samples from the evening and morning milking, of 10 Alpine goats, were taken twice a month from June to November 1999. The goats were in the third month of lactation. 200 milk samples were analysed for standard plate count, coliforms, proteolytic bacteria, sporeforms and chemical composition. Milk production was followed individually for each goat. Milk contained on average $5,65 \cdot 10^4$ cfu/ml of total count, $2,04 \cdot 10^3$ cfu/ml of coliforms, $3,57 \cdot 10^3$ cfu/ml of proteolytic bacteria and 20 cfu/ml of sporeforms. Daily milk production decreased during the first month of milking (the third month of lactation) and then remained constant. The average milk production was 1177 ml/doe/day. Concentration of all measured milk components (fat, total protein, solids non-fat and total solids), with the exception of lactose, increased slightly. Overall mean of chemical composition was 3.33 % fat, 2.69 % total proteins, 4.14 % lactose, 7.63 % solids non-fat and 10.96 % total solids.

Key words: goat's milk, milk composition, standard plate count, milk production.

Introduction

The production of the small ruminants milk has been increasing all over the world although at a lower rate than production of cow's milk. In Slovenia, goat's milk is produced by the two breads, Saanen and Alpine, that are included into the national breeding programme.

The composition and the quality of milk are very important, being a raw material for the production of the delicious products. Many factors influence the quality, composition and characteristics of the milk. These factors could be grouped as genetic (among different breeds, flocks and individuals), physiological (period of lactation, age, state of health) and environmental (nutrition, climatic conditions, season, the methods of milking, management with the animal). The composition of the milk determines its nutritional value, quality and suitability for the production of dairy milk products (Rogelj, 1996).

In Slovenia, all registered goat breeders are included in the programme called Origin and production control. Control of milk is going on in accordance with ICAR standard reference method A4: once a month a chemical composi-

tion of milk samples and milkiness is determined during the lactation period. The microbiological quality control of milk during the lactation period is not included in this programme.

The average composition of milk of Alpine breeds in Slovenia is 3.1 % fat, 2.8 % proteins, 4.2 % lactose and 10.8 % total solids (Kompan et al., 1999; Komprej et al., 2000).

As some breeders process milk at home, mostly into the cheese, the aim of our study was to determine the changing of microbiological and chemical composition of milk during lactation. The results of this study will help the breeders to optimise goat's milk processing and to achieve a high quality of the products during the entire production period.

Materials and Methods

Experimental animals:

Ten healthy milking does in their second lactation were randomly selected from the Alpine herd. The does were fed with a high grain and low fibre ratio during milking supplemented with hay, by night, and pasturage in the daytime. All experimental does were kidded in the early March and dried off in mid-November 1999.

Sample collection:

First sampling was made 3 weeks after the first milking (3 months after parturition). Individual milk samples of evening and morning milking procedures were collected twice a month till the end of lactation (June to November). Before sampling, the volume of milk from each goat was measured. 200 goat's milk samples were collected. Composite samples, made of equal volumes of evening and morning milk, were prepared for microbiological analysis.

Sample analyses:

Total bacteria counts (TBC) and coliforms (CFC) were determined according to standard plate count method (IDF 100B:1991; IDF 73A:1985). For the determination of proteolytic bacteria count (PBC) and sporeforming bacteria count (SBC), the methods described in Methodenbuch (Band VI, M7.3.3; M7.17.2) were used. The results were expressed as $\log_{10}$ of colony forming units in ml ($\log_{10}$(cfu/ml)). Milk components (fat, protein, lactose, solids-non-fat (SNF) and total solids (TS) were analysed by Milko-Scan 133B (Foss Electric).

Statistical analysis:

The obtained goat's milk data were analysed using Microsoft Excel program. Mean, standard deviation (SD) range and coefficient of variability were calculated.

Results and Discussion

The basic statistics of all tested variables of goat's milk samples collected during five months of lactation are summarised in Tables 1 and 2.

Table 1: Chemical composition of goat's milk and daily milk production (ml/doe) in second lactation (n=200).

Tablica 1: Kemijski sastav kozjeg mlijeka i dnevna proizvodnja mlijeka (ml/kozi) u drugoj laktaciji (n=200).

Variables Varijable	Mean Srednja vrijednost	Range Opseg	SD	CV %
Fat (%) Mast (%)	3.33	2.24-4.72	0.53	16.17
Proteins (%) Bjelančevine (%)	2.69	2.03-3.81	0.41	15.90
Lactose (%) Laktoza (%)	4.14	3.73-4.54	0.17	3.99
Solids non-fat (%) Suha tvar bez masti (%)	7.63	6.77-8.93	0.43	5.72
Daily milk production (ml/doe) Dnevna proizvodnja mlijeka (ml/kozi)	1177	500-1780	327.85	27.85

n number of samples / broj uzoraka
SD standard deviation / standardno odstupanje
CV coefficient of variability / koeficijent varijabilnosti

Table 2: Microbiological composition of goat's milk for 10 Alpina goat's in second lactation (n=100).

Tablica 2: Mikrobiološki sastav kozjeg mlijeka od 10 Alpina koza u drugoj laktaciji (n=100).

Variables Varijable	Mean Srednja vrijednost	Range Opseg	SD	CV %
Total bacteria counts (log_{10}(cfu/ml)) Mezofilne aerobne bakterije (log_{10}(cfu/ml))	4.75	3.40-5.49	0.61	12.86
Coliforms (log_{10}(cfu/ml)) Koliformne bakterije (log_{10}(cfu/ml))	3.31	0.00-4.26	1.16	35.15
Proteolyts (log_{10}(cfu/ml)) Proteolitičke bakterije (log_{10}(cfu/ml))	3.55	0.00-4.64	0.60	16.78
Sporeforms (log_{10}(cfu/ml)) Spore (log_{10}(cfu/ml))	1.30	0.00-2.92	0.64	48.85

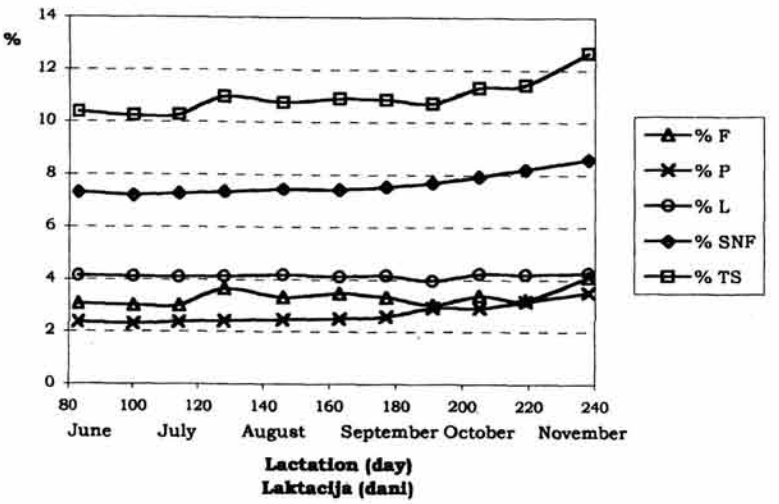
n number of samples / broj uzoraka
SD standard deviation / standardno odstupanje
CV coefficient of variability / koeficijent varijabilnosti

The Alpine goat's milk, analysed in our experiment contained on average 3.33 % of fat (Table 1), which agreed with the values reported by Zeng and Escobar (1996a), but was lower than the values for Alpine goat's in Greece (3.44 %) reported by Voutsinias et al. (1990) and Alpine goat's in USA (3.73 and 3.94 %) reported by Zeng and Escobar (1995, 1996b) and Park (1991). Calamari et al. (1990), Jaubert (1996), Pasquini et al. (1996), Rogelj et al. (1998) and Zeng et al. (1997) reported lower fat values for the same breeds. At the end of the third month of the lactation, milk contained 3.01 % of fat. During lactation two rises were observed. First in the beginning of the fifth month of lactation and the second at the end of lactation when the highest content of fat (4.01 %) was determined (Figure 1).

Protein content of milk increased progressively with advancing lactation (Figure 1). A similar trend was observed by Voutsinias et al. (1990). Other workers reported that protein concentration decreased during the first four months of lactation, and then increased till the end of lactation (Zeng and Escobar, 1995; 1996a; 1996b, Danków et al., 1996). In this experiment the milk samples during the first two months of lactation were not taken as the producer started with milking after this period of sucking. The average protein content was higher than the value reported by Calamari et al. (1990), but lower than the value reported by the other authors (Zeng et al. 1997, 1996a,

Figure 1: Chemical composition of goat's milk during second lactation: percentage of fat (% F), protein (% P), lactose (% L), total solids (% TS) and solids non-fat (% SNF).

Slika 1: Kemijski sastav kozjeg mlijeka tijekom druge laktacije: postotak mliječne masti (% F), bjelančevina (% P), laktoze (% L), suhe tvari (% TS) i suhe tvari bez masti (% SNF).



1996b; Jaubert et al. 1996; Park 1991; Pasquini et al. 1996; Pizzillo et al. 1996; Voutsinias et al. 1990 and Zeng and Escobar 1995. The initial protein content in the fourth month of lactation was 2.37 %. During the following period, protein content increased up to 3.51 % in the last sample. From the technological point of view (milk is designed for cheese production) the protein content was absolutely too low till the seventh month of lactation. Low protein content in goat's milk was highly effected by genetic factors, while unbalanced nutrition was responsible as well.

Lactose content was relatively constant throughout the lactation (Figure 1). The average value of lactose was 4.14 %, which agrees with the values reported by Zeng et al. (1997). It was lower than the values reported by Jaubert et al. (1996), Voutsinias et al. (1990), by Pasquini et al. (1996), Rogelj et al. (1998) and Zeng and Escobar (1995, 1996a, 1996b); and higher than the values reported by Calamari et al. (1990).

The solids non-fat and total solids content increased throughout lactation (Figure 1). The average SNF and TS content was 7.63 % and 10.96 %, respectively. The same value for TS content was observed by Calamari et al. (1990). The values reported by other authors are lower (Rogelj et al., 1998; Zeng et al., 1997) or higher (Pizzillo et al. 1996; Voutsinias et al. 1990; Zeng and Escobar, 1995, 1996a, 1996b).

The overall milk production during lactation is illustrated in Figure 2. Daily milk production was high at the end of the third month of lactation (1780 ml/doe) and during the forth month decreased to the value of 1227 ml/doe. Milk

Figure 2: Average daily milk production per doe during sampling period.
Slika 2: Prosječna dnevna proizvodnja mlijeka po kozi tjekom uzimanja uzoraka.

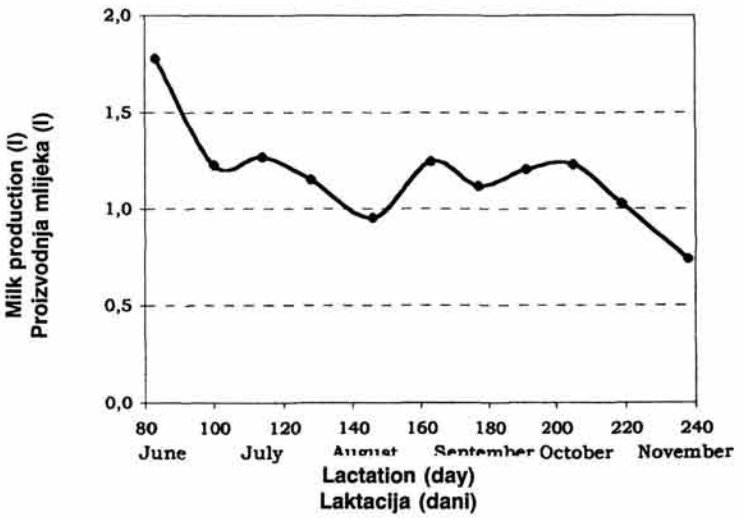
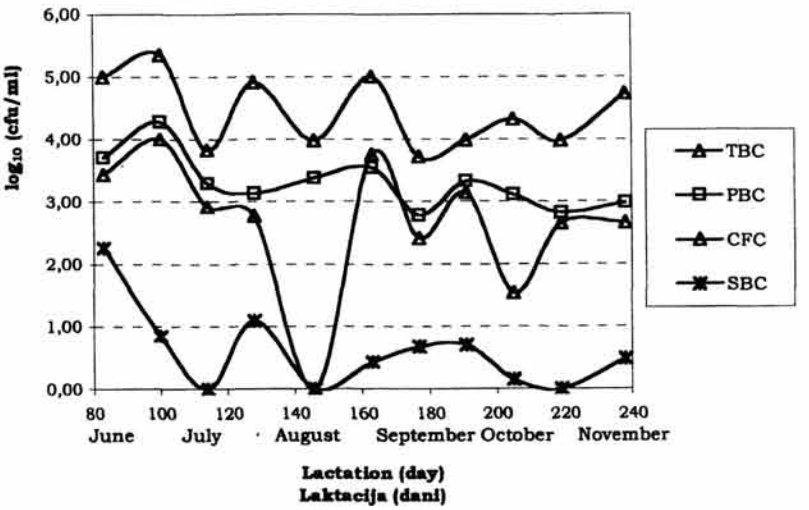


Figure 3: The changes of total bacteria (TBC), proteolytic (PBC), coliform (CFC) and sporeforming bacteria count (SBC) during second lactation, expressed as log_{10} cfu/ml.

Slika 3: Promjene ukupnog broja bakterija (TBC) i broja proteolitičkih (PB), koliformnih (CB) i sporogenih bakterija (SB) tijekom druge laktacije, izražene kao log_{10} cfu/ml.



production between the fourth and seventh month of lactation remained constant (on average 1200 ml/doe per day) and afterwards started to decrease continuously till the end of lactation. In August, milk production was only 955 ml/doe per day. That was probably due to weather conditions. The mean daily milk production during 5.5 months of lactation (from the end of the third month till the end of lactation) was 1177 ml.

Total bacteria count, as well as proteolytic, coliforms and sporeforming bacteria in goat's milk are shown in Table 2 and Figure 3. TBC of goat's milk was under the permited regulation level of $1.0x10^5$ cfu/ml throughout the lactation. The total bacteria count as well as the counts of all other determined groups of bacteria slowly decreased during the lactation. This was probably due to increased hygienic conditions of milking caused by our regular control.

Conclusions

The results of the analysis show that the concentration of milk components change markedly during lactation. The concentration of fat, protein, solids non-fat and total solids increased from the third month of lactation till the end of lactation. From the technological point of view the chemical composition of goat's milk was poor till the sixth month of lactation. Such variability of milk composition makes impossible standard quality cheese production without tech-

nological process improvements. Besides, the change of the kidding system will be indispensable. The microbiological quality of milk was good. The slight reduction of bacterial count during lactation was probably caused by our regular control.

PROMJENE MIKROBIOLOŠKOG I KEMIJSKOG SASTAVA KOZJEG MLIJEKA TIJEKOM DRUGE LAKTACIJE

Sažetak

Dva puta mjesečno, od lipnja do studenoga 1999 (tri tjedna nakon prve mužnje), su oduzimani pojedinačni uzorci večernjeg i jutarnjeg mlijeka od 10 koza srnaste pasmine. U 200 uzoraka mlijeka analiziran je ukupan broj mezofilnih, koliformnih i proteolitičkih bakterija te spora, i kemijski sastav mlijeka. Kod pojedinačne koze praćena je i proizvodnja mlijeka, odnosno mliječnost. Mlijeko je u prosjeku sadržavalo 5,65·10⁴ mezofilnih aerobnih bakterija/ml, 2,04·10³ koliformnih bakterija/ml, 3,57·10³ proteolitičkih bakterija/ml i 20 spora/ml. Proizvodnja mlijeka smanjila se je u prvom mjesecu mužnje, da bi nakon toga ostala nepromjenjena. Prosječna dnevna proizvodnja mlijeka je bila 1177 ml/kozi. Koncentracija svih analiziranih sastojaka mlijeka (mliječna mast, bjelančevine, suha tvar bez masti i suha tvar) s izuzetkom laktoze, lagano se povećavala. Mlijeko je u prosjeku sadržavalo 3,33 % masti, 2,69 % bjelančevina, 4,14 % laktoze, 7,63 % suhe tvari bez masti i 10,96 % suhe tvari.

Ključne riječi: kozje mlijeko, sastav mlijeka, ukupni broj mezofilnih bakterija, proizvodnja mlijeka.

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