Composition and bulk tank somatic cell counts of milk from dairy goat herds in Southeastern Brazil

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Abstract

The milk composition and somatic cell count (SCC) are requirements for assessment milk quality and mastitis in goat herds. Studies conducted with dairy goat herds indicated that the milk composition differed among them to due to factors such as genetic, feeding, system of production, stage of lactation, year and year-season. The objective of this study was to assess SCC and other milk quality indicators (fat, protein, lactose, and total solids) for goat milk bulk tank. The influence of the herd and year-season on the milk composition as well as herd, milking system and year-season on SCC was also evaluated. Thirteen Brazilian dairy goat herds with about 1,400 dairy goats were included in the study. Six herds were milked by hand and in the remaining seven machine milking was used. Herds were sampled at weekly intervals during two lactations. A total of 913 bulk milk samples were analysed using a automated equipment. The general average percent values for fat, protein, lactose and total solids were, respectively, 3.44, 2.95, 4.45 and 11.69. The effect of herd and season was significant for all milk components and bulk milk goat somatic cell count (SCC). The SCC average of all 13 herds was 779,000 cells/ml. The average SCC values of herds milked by hand and by machine were 1,121,000 and 848,000 cells/ml respectively. In both groups, the SCC was lower in the winter and higher in the autumn. Herd characteristics were responsible for higher variability on components and SCC in goat herds.

Key words:
Goat milk.
Milk composition.
Somatic cell count.

Introduction

The quality of goat milk depends on its composition as well as the somatic cell count (SCC). Composition refers to the milk´s content of major nutrients (fat, protein, lactose and total solids) and SCC is an indicator of the state of udder health that affects the quality of the milk produced.

Studies with dairy goat herds showed variation of fat and protein between goat breeds.[1,2,3] Goats of several European breeds produce milk with lower fat content in the tropics than in temperate zones.[4] The lactation number influenced the fat and protein contents.[5,6] Higher levels of milk production were associated with lower concentrations of total solids, particularly fat content in milk.[7] Differences due to season of kidding were highly significant for all components and the highest protein content was observed in the spring.[5] Protein content of milk did not vary during different periods of lactation but lactose decreased and milkfat increased with the advancement of lactation.[8,9] Studies conducted with French, Greek, Portuguese and Spanish dairy goats indicated that the milk composition differed among them due to factors such as genetic, feeding, system of production, stage of lactation, year and year-season[6,10,11]. The genetic make-up and nutrient intake of the goat breed had a direct influence on both milk yield and concentration of the milk constituents.[9]

The use of SCC as an indicator of the health status for cow milk is widely known. The values of normal cow milk is inappropriate to evaluate and interpret for goat milk due to the presence of many cytoplasmatic particles resulting from apocrine milk secretion in goat udders, while the process in cow udders is merocrine.[4] Cytoplasmatic particles, containing no DNA, but in the size-range of somatic cells in goat milk can mistakenly be counted as somatic cells when particle counting methods are used. To establish SCC parameter for goat milk is necessary to know the normal values as well as their normal variation when goat udder halves are free of inflammation or infection and free of subclinical or clinical symptoms.[12]

There has been an important increase in goat milk production in Brazil in the last ten years.[13] The Southeast of Brazil, mainly the "Região Serrana" of Rio de Janeiro State presents traditional milk goat dairy industry, but data on milk quality is scarce.

The objective of this study was to assess SCC and other milk quality indicators (fat, protein, lactose, and total solids) for goat milk bulk tank. The influence of the herd and year-season on the milk composition as well as herd, milking system and year-season on SCC was also evaluated.

Material and Method

Thirteen dairy goat herds with an estimated total population of 1,400 lactating dairy goats were included in the study. All herds had season of kidding beginning in August and ending in May. The herds were comprised by European breed animals (Saanen, Toggenburg and Alpine). Herds were sampled at weekly intervals during two lactations (August/2000 to May/2001 and August/2001 to May/2002). Volumes of 70 ml of milk were obtained from each herd after bulk milk tank had been homogenized. Samples were preserved with Bronopolâ (D&F Control Systems, Inc), and maintained under refrigeration until being processed at the laboratory. A total of 913 milk samples were analysed using a Bentley Combi 2300 equipment. The SCC and components (fat, protein, lactose and total solids) were determined by flow citometry and measurement energy absorption at specific wavelengths in the mid infra red region, respectively.[14,15] The SCC values were classified initially in three categories (1: < 750,000 cells/ml; 2: from 750,000 to 1,000,000 cells/ml; 3: > 1,000,000 cells/ml). Because the equipment was calibrated for cow milk, the SCC values were adjusted with a reduction of 25,75%[16,17]. The milking system was classified in two categories: herds milked by hand (6) and herds milked by machine (7). Statistic analyses were conducted using independent samples T Test[18], factorial (2-way) ANOVA[19]. The general linear model used to evaluate the effects of herd and year-season on milk's contents and SCC was: $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_1 X_2$, where Y is the outcome variables (fat, protein, lactose, total solids and SCC) and X_1, X_2 and X_1X_2 are the explicative variables (herd, year-season and its interaction, respectively). The same general linear model was also used to evaluate the effects of milking system and year-season on SCC where Y is the outcome variables (SCC) and X_1, X_2 and X_1X_2 are the explicative variables (milking system, year-season and its interaction, respectively).

Results

The number of milk samples per herd during the period changed from 53 to 78. The average (%) values obtained for all bulk tank milk samples examined and the range (minimum-maximum) were: fat (3.44; 3.15-3.87); protein (2.95; 2.85-3.00); lactose (4.45; 4.31-4.56) and total solids (11.69; 11.21-12.12). The effect of herd and year-season was significant for all milk components (P<0.05) (Table 1). The interaction between herd and year-season was significant (P<0,05) for fat, lactose, total solids and SCC. The year-season was responsible for higher variability of protein (16%), lactose (27%) and total solids (39%). The herd was responsible for higher variability of fat (27%) and SCC (36%). In adition, the interaction between herd x season and milking system x season was responsible for lower variability of fat, protein, lactose, total solids and SCC. The higher and lower values percent of fat, lactose and total solids were observed at winter and summer respectively. The higher and lower values percent of protein were observed in autumn and spring respectively (Table 2). Lactose presented different values (P<0,05) according to SCC (Table 3).

The SCC geometric mean of all 13 herds was 779,000 cells/ml. The geometric mean per herd ranged from 331,000 to 1,138,000 cells/ml. Eight herds (61,5%) presented geometric mean of BTGSCC under 1,000,000 cells/ml and five herds

Table 1 – Significance level and variance predicted on linear model for herd and season (outcome variables: fat, protein, lactose, total solids and BMGSCC)

Variation source	Fat		Protein		Lactose		Total solids		BTGSCC	
	P	VP	P	VP	P	VP	P	VP	P	VP
HERD	*	0,27	*	0,12	*	0,08	*	0,22	*	0,36
SEASON	*	0,22	*	0,16	*	0,27	*	0,39	*	0,20
HERD x SEASON	*	0,13	0,06	0,06	*	0,16	*	0,13	*	0,09
Adjusted R^2	0,435		0,266		0,375		0,514		0,462	

P – significance level; * - P < 0,05; VP – variance in dependent variable predicted on linear model.

Table 2 – Average and standard deviation of milk components (fat, protein, lactose, total solids) according to seasons and milking system

Season of the year	Milk contents (%)				
	n	Fat	Protein	Lactose	Total solids
Summer	288	3,20a ± 0,42	2,94b ± 0,15	4,19a ± 0,22	11,24a ± 0,53
Autumn	161	3,52c ± 0,45	3,07c ± 0,15	4,51c ± 0,39	11,83c ± 0,62
Winter	167	3,80d ± 0,64	2,96b ± 0,09	4,67d ± 0,38	12,37d ± 0,70
Spring	305	3,41b ± 0,44	2,89a ± 0,14	4,54b ± 0,34	11,64b ± 0,52
Average	993	3,44 ± 0,52	2,95 ± 0,15	4,45 ± 0,38	11,69 ± 0,70

Values within column with the different letters are significantly different (P<0,05)

Table 3 - Means and standard deviation of fat, protein, lactose and total solids according to BTGSCC categories

BTGSCC[1]	n	Fat	Protein	Lactose	Total solids
<750	294	3,43 ± 0.59	2,95 ± 0.16	$4,51^b$ ± 0.42	11,75 ± 0.79
751-1.000	190	3,42 ± 0.48	2,94 ± 0.17	$4,49^b$ ± 0.38	11,66 ± 0.66
>=1.000	429	3,45 ± 0.49	2,95 ± 0.14	$4,40^a$ ± 0.34	11,66 ± 0.65

[1] x 1.000 cells/ml; Values within column with the different letters are significantly different (P<0,05)

(38,5%) above 1,000,000 cells/ml. The average of BMGSCC was higher in the seven hand-milked herds (1,121,000 cells/ml; ranged from 639,000 to 1,138,000 cells/ml) than in the six machine-milked ones (848,000 cells/ml; ranged from 332,000 to 1,094,000 cells/ml) throughout lactation (Table 4). The effect of herd, milking system and season was significant for BMGSCC (P<0.05). The herd was responsible for higher variability (36%) of BMGSCC considering herd and season as explicative variables in general linear model. The other general linear model used, the milking system and season were the explicative variables. The milking system and season were responsible for 8 and 13% of variability on BMSCC respectively (Table 5). The interaction between herd X season was significant (P<0,05) but milking system X season was not significant (P>0,05) for BMGSCC. In the machine milked herds the BMGSCC (cells/ml) values for all seasons were lower than herds milked handly .

Discussion

Except for lactose, the average percentages for protein, fat and total solids during the entire two periods (August/2000-May/2001 and August/2001-May/2002) were lower than expected[20]. The lower fat values obtained could be due to the fact that herds were formed by European breeds (Saanen, Toggenburg and Alpine) raised in a tropical environment.[4] In addition, fat and protein may vary between herds mainly due to goat breeds, genetic inheritance, feeding, system of production and localisation of herds.[1,2,3,11]

The major variability of milk composition was due to herd effect. The protein content was higher during autumm, in herds milked by machine and the end of lacatation. The higher values for lactose were observed in herds milked handily and during winter.

The higher values of fat, protein, lactose and total solids observed during the

Table 4 – Average and standard deviation of bulk milk goat somatic cell count according to seasons and milking system

Season of the year	SCC (x1.000 cells/ml)			
	n	Milking hand	n	Milking machine
Summer	163	$1176^{Ab} \pm 396$	117	$906^{Bb} \pm 449$
Autumn	78	$1423^{Ac} \pm 511$	83	$1012^{Bbc} \pm 542$
Winter	86	$736^{Aa} \pm 523$	81	$548^{Ba} \pm 492$
Spring	165	$1123^{Ab} \pm 381$	140	$875^{Bb} \pm 447$
Average	492	$1121^{A} \pm 479$	421	$848^{B} \pm 499$

Values within column (lower case) and row (upper case) with the different letters are significantly different (P<0,05)

Table 5 – Significance level and variance predicted on linear model for milking system and season (outcome variables: SCC)

Statistics	Variation source		
	MILKING	SEASON	MILKING X SEASON
P	*	*	0,05
VP	0,08	0,13	0,01
Adjusted R^2		0,195	

MILKING – milking system; SEASON – season of the year; P – significance level; * - P < 0,05; VP – variance in dependent variable predicted on linear model.

winter and the lower values during summer and spring may be due to amount of dry matter intake due to climate conditions. The variation of protein according to lactation may be due to environmental conditions according to years, affecting feeding characteristics. These results are differents of results found in Murciano-Granadina goat herds located in Spain[5], where lower protein values were found in winter. These results suggest that the level of milk production in the beginning (winter) and the end (autumn) of lactation and season kidding may be associated with concentration of total solids and particularly fat content in milk[5,7]. The herd was responsible by higher variance in milk components following by season. Milk system had the lower variance in milk components. Probably, the variation of goat milk contents among herds was due mainly to differences between breeds and nutritional management.

The results from this study indicated that the milk produced in most of these herds could be considered of high quality in relation to BMGSCC, reaching the parameters established in countries such as the United States and Norway of 1,000,000 cells/ml.[1,12,21] The number of milk samples with SCC above one milion per milliliter and the average BTSCC were lower in machine milked herds. In this study the BTGSCC values were lower during early lactation (winter) and increased subsequently as the lactation advanced reaching the highest values by the end of lactation (summer). This may be due to the fact that as the goat's milk yield decreases with the advance of lactation and consequently SCC increases. The herd was responsible by higher variability in BMGSCC. Considering milking system as herd characteristic, in both general linear models the milking system was important source of variation on BGMSCC.

Conclusions

The herds, seasons, milking system and its interaction presented influence on milk composition and BMGSCC. The herd and season effects were responsible on higher variability of milk components and BMGSCC. The lower values of lactose were associated to higher values of BTGSCC. Milkfat, protein and total solids contents presented in this study were lower than those of countries with temperate climate.

Composição e contagem de células somáticas no leite de rebanhos caprinos do Sudeste do Brasil

Resumo

A composição do leite bem como a contagem de células somáticas (CCS) são requisitos para avaliar a qualidade do leite e mastite em rebanhos caprinos. Estudos conduzidos indicaram que a composição do leite varia entre os rebanhos devido a fatores genéticos, alimentação, sistema de produção, estágio de lactação, ano e estação do ano. O objetivo do estudo foi avaliar a CCS e outros indicadores de qualidade (gordura, proteína, lactose e sólidos totais) no leite de rebanhos caprinos. A influência do rebanho e estação do ano sobre a composição bem como a influência de rebanho, tipo de ordenha e estação do ano sobre a CCS também foi avaliado.Treze rebanhos caprinos localizados no Brasil, com aproximadamente 1.400 matrizes foram incluídos no estudo, Sendo ordenhados manualmente e os outros sete com equipamento de ordenha. As amostras de leite dos rebanhos foram coletadas semanalmente durante duas lactações. O total de 913 amostras foi analisado no equipamento automatizado. A média dos

Palavras-chave:
Leite de cabra.
Composição do leite.
Contagem de células somáticas.

valores percentuais para gordura, proteína, lactose e sólidos totais foram, respectivamente; 3,44; 2,95; 4,45 e 11,69. O efeito de rebanho e estação do ano foi significante para todos os componentes do leite e CCS. A média para CCS de todos 13 rebanhos foi 779.000 células/ml. As médias para CCS dos rebanhos ordenhados manualmente e mecanicamente foram, respectivamente, 1.121.000 e 848.000 células/ml. Em ambos grupos, a CCS foi menor no inverno e maior no outono. As características de rebanho foram responsáveis pela maior variação dos componentes e CCS no leite de rebanhos caprinos.

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