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The effects of dry-off therapy on milk somatic cell count in Saanen goats

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Abstract: The aim of this study was to determine the effectiveness of dry-off antibiotic therapy and teat sealant on somatic cell count (SCC) in Saanen goats. The goats were randomly divided into 3 groups. In Groups I (n = 50) and II (n = 50), the goats were treated with intramammary antibiotics and a combination of intramammary antibiotics and internal teat sealant at dry-off, respectively. The animals in Group III (n = 50) were designated as the control group. For the SCC analysis and bacteriological examination, milk samples (n = 900) were collected separately from each udder half during routine morning milking, prior to drying off, and at months 1, 2, 3, 4, and 5 of following lactation. The pretreatment prevalence of intramammary infection at dry-off was 4.7% (7/150) for halves. Isolated pathogens were coagulase-negative staphylococci (57.1%) and *S. aureus* (42.9%) from infected halves. Dry-off antibiotic and dry-off antibiotic with teat sealant therapy reduced milk SCC levels significantly ($P < 0.01$) when compared to the control group. On the other hand, the difference in SCC between dry-off antibiotic and dry-off antibiotic with teat sealant therapy groups was not statistically significant ($P > 0.01$). In conclusion, intramammary antibiotics administered alone and a combination of intramammary antibiotics and teat sealant reduced milk SCC levels significantly.

Key words: Dairy goat, dry-off therapy, somatic cell count, teat sealant

1. Introduction

Goat milk production is a dynamic and growing industry that is fundamental to the well-being of millions of people worldwide, and is a vital part of the national economy in many countries, especially in the Mediterranean and Middle East (1). In many Mediterranean countries, such as Spain, Greece, Turkey, and Morocco, the farming of these animals is a traditional and fundamental part of the national economy (2).

Goat milk quality can tolerate different technological treatments in order to obtain a product with the ability to satisfy consumer demands in terms of health, nutritional value, safety, and satisfaction (3). Milk somatic cell count (SCC) is the basis of mastitis and milk quality control programs. SCC in small ruminants has been the focus of many recent studies concerning how to produce the best quality dairy products for human consumption and reduce losses due to mastitis (4). In dairy goats, some studies have

shown that mammary bacterial infections are a major cause of increased SCC and loss of production (5). Contreras et al. (6) stated that goat milk from infected udder halves had a much higher level of SCC than expected, suggesting that the goat udder response to infection, as measured by SCC, is greater than that of the cow.

Programs implemented on farms for dairy cows cannot be directly applied to farms for small dairy ewes and goats. Differences in herd size, marginality of some areas for small ruminants, particular shepherding systems, difficulties in keeping routine individual records, and other particularities make small ruminants very different from dairy cows and require the design of specific strategies for controlling milk quality (7). To improve the health status of the herd, different strategies such as vaccination, milking hygiene, teat dipping, dry-off antibiotic therapy, and teat sealers may be useful (7–9). It has been stated that dry-off antibiotic therapy is used in dairy goats to

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control subclinical mastitis and reduce SCC (8,10). Dry-off treatment has the advantage of antibiotics being used when the animal is not being milked, so that there is no milk loss and no antibiotic contamination of the bulk-tank milk (11). However, there have been few reports of dry-off therapy using intramammary antibiotics and especially internal teat sealants in goats. Therefore, in the present study, we aimed to determine the effectiveness of dry-off antibiotic therapy and teat sealant on SCC during lactation.

2. Materials and methods

2.1. Animals

The present study was conducted in 2013 and 2014 at a private dairy goat farm in Ankara, Turkey. A total of 900 milk samples, taken from 150 Saanen goats, were included in the study. The ages of the goats varied between 2 and 4 years, and the goats were machine-milked once a day in the morning. The animals were fed dry hay supplemented with a commercial mixture and had free access to water. All goats were clinically normal at sampling and had not received antibiotics or antiinflammatory therapy prior to the 30 days of drying off.

2.2. Experimental design

For the detection of the effectiveness of dry-off antibiotic therapy and teat sealants, the goats were randomly divided into 3 groups. In Group I (n = 50), the goats were treated with an intramammary infusion of a single dose of 200 mg of cephalexin monohydrate and 250 mg of neomycin sulfate (Rilexine 500 DC, Virbac, France). In Group II (n = 50), the goats were treated with intramammary infusion that combined a single dose of 200 mg of cephalexin monohydrate and 250 mg of neomycin sulfate (Rilexine 500 DC) and internal teat sealant (Orbeseal, Pfizer Animal Health, Dublin, Ireland). In Group III (n = 50), the animals were designated as the control group and did not receive any drug treatments. Prior to infusion, the teats were cleaned and treatments were administered aseptically, with one tube of each product being infused into halves on the day of drying off for each goat.

2.3. Milk sampling

The milk samples were collected separately from each udder half during routine morning milking, prior to drying off, and at months 1, 2, 3, 4, and 5 of following lactation. Before sampling, teat ends were carefully cleaned with 70% ethanol. The first stream of foremilk was discarded and nearly 10 mL of milk was collected aseptically into the sterile tubes. Samples were immediately transported to the

laboratory in the cold chain for bacteriological analysis and SCC determination.

2.4. Microbiological procedure

Milk samples were homogenized at room temperature and bacteriological tests were performed according to National Mastitis Council procedures (12). The samples (100 µL) were spread on 6% sheep blood and MacConkey agar by using disposable plastic loops. Plates were incubated at a constant temperature (37 °C) for 24 and 48 h. In addition, milk samples (100 µL) were spread on Sabouraud dextrose agar and incubated at a constant temperature (25 °C) for 72 h for yeast examination. Gram staining was performed and gram-positive colonies were examined by catalase tests. Catalase-positive and -negative colonies were accepted to be staphylococci and streptococci, respectively. Coagulase tests were used for the differentiation of *Staphylococcus aureus* and coagulase-negative staphylococci (CoNS) colonies. *Staphylococcus aureus* colonies had coagulase-positive reactions. *Streptococcus* spp. were classified according to colony morphology, hemolytic properties, Christie–Atkins–Munch–Petersen (CAMP) test, Lancefield group, and hydrolysis of esculin and hippurate. *Streptococcus agalactiae* was positive for Lancefield group B and hippurate test. *Streptococcus uberis* hydrolyzed the esculin.

2.5. Milk somatic cell counts

Milk SCC was determined by an automated fluorescent microscopic somatic cell counter, IBC-M Bactoscan (Bentley IBC-M; Bentley Instruments Inc., Chaska, MN, USA), which only counts those cells containing DNA stained by ethidium bromide.

2.6. Statistical analysis

In the present study, nonparametric receiver operating characteristic (ROC) curve analysis was used to determine the optimal cut-off points with the highest sensitivity and specificity for the determination of subclinical mastitis at drying off in Saanen goats. The Shapiro–Wilks test was performed for the normality of logarithmic and original values. Logarithmic values were used for statistical analyses. Because the distribution of the values was not normal, the Kruskal–Wallis H test was conducted to evaluate differences among the SCC and months of lactation period. In comparison of groups, ANOVA and the Kruskal–Wallis H test were used for values distributed normally and not normally, respectively. Tukey HSD and Conover–Inman multiple comparison tests were used for the identification of different groups. The Friedman test was used to compare SCC values by month, and the chi-

square test was used for comparison between the groups in accordance with microbiological examination. Continuous variables expressed as mean \pm standard deviation. All statistical analyses were performed with MedCalc 13.2.0.0. $P < 0.05$ was considered statistically significant.

3. Results

A total of 900 milk samples were analyzed for intramammary infection (IMI) and milk SCC to determine the effectiveness of dry-off therapy at drying off and at 1, 2, 3, 4, and 5 months of following lactation in Saanen goats. Pretreatment prevalence of IMI at dry-off was 4.7% (7/150) for halves. Isolated pathogens were CoNS (57.1% of all IMI) and *S. aureus* (42.9% of all IMI) from infected halves (Table 1).

All the udder halves with IMI at drying off were determined to be free of IMI in the first month following lactation in both treatment groups. For all udder halves included in the study, there was no significant difference between the treatment groups in the prevention of new subclinical infections ($P > 0.05$). CoNS, *S. aureus*, *Streptococcus uberis*, *Streptococcus agalactiae*, and yeast were isolated pathogens during the subsequent lactation (Table 2). No significant differences were found between the right and left udder halves ($P > 0.05$).

Dry-off antibiotic and dry-off antibiotic with teat sealant therapy reduced milk SCC levels significantly ($P < 0.01$) when compared to the control group. On the other hand, SCC differences between dry-off antibiotic and dry-off antibiotic with teat sealant therapy groups were not statistically significant ($P > 0.01$; Table 3).

4. Discussion

The prevalence of subclinical mastitis has been estimated at 5%–30% or even higher (13,14); however, there are only limited data about the incidence of IMI of goats in the literature. In this study, it was found that the pretreatment prevalence of IMI at dry-off was 4.7% (7/150) for halves. In the present study, isolated pathogens were CoNS

(57.1% of all IMIs) and *S. aureus* (42.9% of all IMIs) from infected udder halves at drying off. The prevalence of postpartum first bacterial isolation was 6%. The isolated microorganisms after parturition were CoNS, *S. aureus*, *S. uberis*, and yeast. During the subsequent samplings, the isolated microorganisms were CoNS, *S. aureus*, *S. uberis*, *S. agalactiae*, and yeast. The variability in the prevalence of caprine mastitis between reports can be attributed to the differences in farm management and farm hygiene, milking management practices, the breed considered, or the technical knowledge of the investigators (8). In this study, the prevalence of mastitis is lower than in the literature data; this is thought to be related to the fact that the study was conducted on a farm with proper milking hygiene and environmental management. Several pathogens such as *Streptococcus* spp., Enterobacteriaceae, *Pseudomonas aeruginosa*, *Mannheimia haemolytica*, *Corynebacterium*, and fungi can cause mastitis, although *Staphylococcus* spp. are the most frequently diagnosed causal microorganisms of IMIs in goats, which is consistent with the current study.

Mastitis mainly causes an increase in SCC, which is the indicator of milk quality (15). It can also be considered as a sensitive tool for analyzing the effects of IMI on milk yield, milk composition, and efficiency of curd, cheese, and yogurt production, preventing food toxicity from IMIs (1,16,17). However, it is worth noting that there are 3 characteristics that distinguish goat milk from sheep or cow milk: higher values of SCC, cytoplasmic particles, and polymorphonuclear neutrophils. Therefore, the cell concentration in goat milk is higher than in cow and sheep milk (6,18). Thus, in the absence of mastitis, SCC in goat milk can vary between 270×10^3 and 2000×10^3 SC mL⁻¹, whereas in cow and sheep milk it would vary between 10×10^3 and 200×10^3 SC mL⁻¹ (19). Intramammary infection caused by bacteria is the main cause of increased SCC in goat's milk (16). The arithmetic mean SCC from all halves was 1,463,073 cells mL⁻¹ at drying off. The arithmetic mean SCC levels at months 1, 2, 3, 4, and 5 of following lactation were 948,426, 799,820, 1,131,700, 824,180, and

Table 1. The prevalence of mastitis pathogens (n; % in parentheses) at drying off.

	Group 1	Group 2	Group 3	Total
Bacterial growth (+)	3 (6%)	1 (2%)	3 (6%)	7 (4.7%)
Bacterial growth (-)	47 (94%)	49 (98%)	47 (94%)	143 (95.3%)
<i>S. aureus</i>	2 (4%)	-	1 (2%)	3 (2%)
CoNS	1 (2%)	1 (2%)	2 (4%)	4 (2.7%)

Table 2. The results of bacteria isolated on subsequent lactations (n; % in parentheses).

	Group 1 (n = 50)				Group 2 (n = 50)				Group 3 (n = 50)				Total (n = 150)			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Bacterial growth (+)	3 (6%)	-	1 (2%)	6 (12%)	4 (8%)	5 (10%)	2 (4%)	5 (10%)	2 (2%)	4 (8%)	1 (2%)	3 (6%)	9 (6%)	9 (6%)	4 (2.7)	14 (9.3%)
Coagulase-negative <i>Staphylococcus</i>	1 (2%)	-	1 (2%)	4 (8%)	2 (4%)	3 (6%)	-	3 (6%)	-	1 (2%)	-	2 (4%)	3 (2%)	4 (2.7%)	1 (0.7)	9 (6%)
<i>S. aureus</i>	1 (2%)	-	-	2 (4%)	2 (4%)	2 (4%)	1 (2%)	-	1 (2%)	1 (2%)	1 (2%)	1 (2%)	4 (2.7%)	3 (2%)	2 (1.3)	3 (2%)
<i>S. uberis</i>	-	-	1 (2%)	2 (4%)	-	-	1 (2%)	-	1 (2%)	-	-	-	1 (0.7%)	-	2 (1.3%)	2 (1.3%)
<i>S. agalactiae</i>	-	-	-	1 (2%)	-	-	-	2 (4%)	-	-	-	-	-	-	-	3 (2%)
Yeast	1 (2%)	-	-	6 (12%)	-	-	-	5 (10%)	-	2 (4%)	-	2 (4%)	1 (0.7%)	2 (1.3%)	-	13 (8.7%)

1st: Sampling 1; 2nd: sampling 2; 3rd: sampling 3; 4th: sampling 4.

Group 1: Intramammary antibiotics alone.

Group 2: Intramammary antibiotics and teat sealant.

Group 3: Control.

Table 3. The results of somatic cell counts according to groups.

	At dry off	Sampling 1	Sampling 2	Sampling 3	Sampling 4	Sampling 5
Group 1	1,099,440 ^a	269,100 ^a	298,620 ^a	1.161.500 ^a	582,440 ^a	604,440 ^a
Group 2	1,332,140 ^a	386,720 ^a	600,720 ^a	703.960 ^a	824,360 ^a	610,620 ^a
Group 3	1,957,640 ^a	2,189,460 ^b	1,500,120 ^b	1.529.640 ^b	1,065,740 ^b	1,563,300 ^b

^{a,b}: Columns with different superscripts differ ($P < 0.01$).

Group 1: Intramammary antibiotics alone.

Group 2: Intramammary antibiotics and teat sealant.

Group 3: Control.

926,120 cells mL⁻¹, respectively. Dry-off antibiotic and dry-off antibiotic with teat sealant therapy reduced milk SCC levels. In our study, decreased SCC may have cured the existing infection before dry-off and prevented new infections during the dry period.

The nonlactating udder is highly susceptible to certain infections, with the new infection rates being the highest in the early and late dry periods. There is evidence that suggests that more than 50% of the new infections may persist into the next lactation if not eradicated by appropriate treatment (20), and infections acquired during the dry period can cause clinical mastitis during the following lactation (21). The dry period is well-acknowledged as being the optimal time to cure existing IMIs (22) as well as being a period of high risk for the acquisition of new IMIs (23,24). Thus, several authors (10,25) concluded that systematic and/or intramammary antibiotic treatment of goats at drying off is an efficient method for the reduction of subclinical mastitis. Poutrel et al. (10) recommend systematic treatment when SCC in bulk milk is high ($>1.000 \times 10^3$ cells mL⁻¹) and when CoNS are involved in IMI.

Intramammary infusion of a teat sealant containing bismuth subnitrate in dairy cows with SCC at or below 200,000 cells/mL at drying off has been shown to be effective in the prevention of new IMIs (26). Bradley et al.

(27) reported that the clinical efficacy of a combination of teat sealant and intramammary antibiotics was superior to intramammary antibiotics alone in the prevention of clinical mastitis during the dry period and early lactation. In this study, intramammary antibiotics alone and a combination of intramammary antibiotics and teat sealant were used, and all the infected udder halves were cured successfully at drying off. However, neither of these treatments could prevent new IMIs at subsequent lactation, as stated by previous studies (27–29). Poutrel et al. (10) suggested that drying off therapy was an efficient method for the cure of subclinical mastitis and control of SCC in early lactation in goats. In addition to this report, an ample number of studies carried out on cows indicated that precalving antibiotic treatment reduced the milk SCC in early lactation (27,29,30).

Rabiee and Lean (31) reported that the use of internal teat sealants alone at dry-off significantly reduced the incidence of IMI and clinical mastitis in low-SCC uninfected dairy cows. However, it was not possible to evaluate the impact of using internal teat sealants alone due to the limited number of animals in our study.

In conclusion, intramammary antibiotics alone and a combination of intramammary antibiotics and teat sealant reduced milk SCC levels significantly.

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