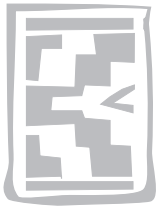

Value of tests for evaluating udder health in dairy goats: somatic cell counts, California Milk Cell Test and electrical conductivity

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ABSTRACT

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The value of electric conductivity (EC), California Milk Cell Test (CMCT) and somatic cell count (SCC) as diagnostic tools was investigated in dairy goats. Conductivity colour reading correlated with SCC. Milk samples with conductivity colour red had significantly higher SCC than those with conductivity colours green and orange ($P < 0.001$). There were moderate positive correlations between CMCT ($R^2 = 0.470$), and conductivity score and CMCT and conductivity colour readings ($R^2 = 0.597$). Conductivity scores were significantly ($P < 0.001$) higher during and after intra-mammary treatment with Cloxamast LC and conductivity colours were significantly different between treatment and control groups ($P < 0.001$). There was a weak positive correlation between conductivity colour and stage of lactation ($R^2 = 0.317$) and a moderately positive correlation between conductivity score and stage of lactation ($R^2 = 0.523$). A moderately negative correlation was shown between milk yield and conductivity score ($R^2 = –0.426$) and between milk yield and conductivity colour ($R^2 = –0.433$).

Moderate positive correlations were present between CMCT and SCC ($R^2 = 0.689$) and between CMCT and stage of lactation ($R^2 = 0.459$). CMCT ratings were significantly different ($P < 0.001$) for the intramammary treatment groups. CMCT ratings for infected and non-infected udder halves ($P = 0.008$) were significantly different; as were those for infected and non-infected udder halves and for left and right udder halves separately ($P = 0.010$). CMCT ratings for milk samples with SCC above and below 750 x 10^3 cells per mℓ were significantly different ($P < 0.001$) as well as for milk from treated and control udder halves with SCC below or above 750 x 10^3 cells per mℓ ($P < 0.001$). CMCT was found to be more accurate for indicating the absence of mastitis than for diagnosing it.

There were significant differences in log SCC between treatment and control groups, during and after treatment. Infected udder halves had significantly higher log SCC than non-infected udder halves before and after treatment, but not during treatment. There was a moderate positive correlation between stage of lactation and SCC ($R^2 = 0.438$).

Keywords: CMCT, dairy goats, electric conductivity, mastitis, SCC, tissue tolerance

INTRODUCTION

Mastitis is a serious disease of dairy goats generally resulting from invasion of the udder by an infectious agent (Smith & Sherman 1994) and deleteriously affects milk production. According to Smith & Sherman (1994) the main predisposing factors of mastitis are poor milking hygiene and inefficient use of milking machines. Somatic cell counts (SCC),

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California Milk Cell Test (CMCT), electric conductivity (EC), and microbiological investigations are used in the diagnosis of mastitis in goats (Contreras, Sierra, Corrales, Sanchez & Marco 1996; Galina, Morales, Lopez & Carmona 1996; Hart, Zeng, Escobar & Brown-Crowder 1996; Zeng, Hart, Escobar & Tesfai 1998; Morgante, Brajon, Cuteri, Perfetti, Di Maurizio & Ranucci 2000; Paape 2000). The SCC may also be used to define milk prices. There is however little agreement on criteria for diagnosing subclinical mastitis and the use and interpretation of SCC in goat milk.

The caprine mammary gland produces milk by apocrine secretion, and cellular tissue appears in milk as DNA-free particles, similar in size to leukocytes (Dulin, Paape & Wergin 1982). Also present in variable numbers in goat milk are intact epithelial cells sloughed from acini and ducts (Smith & Sherman 1994). The Fossomatic method, where only nuclei are counted, is therefore more reliable for determining SCC in goat milk than the Coulter counter, which counts all particles. Normal goat milk has a higher somatic count (700 000 to 1 000 000 cells per mℓ milk) than normal cow milk (Hinckley & Williams 1981). A diagnosis of mastitis is based on the premise that the measurement of 1.5 million or more leukocytes per mℓ milk is indicative of inflammation of mammary tissue and possibly of udder infection (Smith & Sherman 1994). According to Smith & Sherman (1994) the CMCT is more useful for ruling out mastitis, than for diagnosing it in goats. Researchers have used the conductivity of the milk as an indicator of the severity of the inflammatory process in the udder (a mastitis infection) (Linzell & Peaker 1975; Sheldrake, McGregor & Hoare 1983). Preliminary work by Smith & Sherman (1994) has shown conductivity not to be a useful measure in screening for subclinical mastitis in goats.

The objective of this study was to evaluate the value of EC results, CMCT and SCC as diagnostic tools for mastitis in dairy goats.

MATERIALS AND METHODS

Experimental animals

The trial was conducted at the Faculty of Veterinary Science, University of Pretoria at Onderstepoort during the summer months, using the faculty's Teaching Animal Unit's milk goat herd. The trial was conducted on 29 lactating Saanen goats of which 12 were in early lactation, two in mid lactation and 15 in late lactation. The goats were relatively low producers giving less than 1.3 ℓ per day.

A clinical udder examination, milk yield, age and stage of lactation were evaluated so that animals could be allocated in the experiment by the principle of pairing. One goat of each pair was then allocated to either the treatment groups or the control group. The last pair had no control. Goats were identified by temporary markings.

Sampling

Goats were milked at 12-hourly intervals, using a milking machine with a low milk line and set at a system vacuum of 36 kPa and a pulsation rate of 74 pulses per min. At each milking, foremilk udder half samples were taken aseptically (Giesecke, Du Preez & Petzer 1994), and then assessed for conductivity and CMCT (Karzis 2005). Udder halves were milked separately and milk yields were recorded for trial times from –24 h to +108 h during the trial.

Antibiotic treatment

Intramammary products investigated

Ten goats each were treated with two intramammary antibiotic preparations formulated for use in the treatment of mastitis in cows: Cloxamast LC (G2018)(Intervet SA) containing 200 mg cloxacillin, 75 mg ampicillin and a blue dye (T1), and Spectrazol Milking Cow (83/594) (Schering-Plough Animal Health) containing 250 mg cefuroxime (T2). Both these products were formulations for use in intramammary treatment of mastitis in cattle. With both products, goats were treated only in the left udder half (T1 and T2), leaving the right udder half as an intra-udder control (C1 and C2). Nine goats were not treated and acted as control animals (CR and CL).

Administration of antibiotics

When the udder had been milked out, the entire content of the syringe containing the respective antibiotic formulation was inserted aseptically into the left udder half of each of the 20 goats. Three treatments were administered at 12-hourly intervals.

Laboratory tests

Somatic cell counts

The Milk Laboratory at Department of Production Animal Studies, Faculty of Veterinary Science, University of Pretoria, carried out microbiological tests and SCC on all milk samples. The SCC was assessed using a Fossomatic 90 counter (The Rhine Ruhr Group). Inter- and intra-laboratory milk stand-

ard samples were used to verify the accuracy of the somatic cell counts (Van den Heever, Katz, Prinsloo, Giesecke, Rawlings & Jones 1983).

Conductivity determination

Mastitic milk has a higher electrical conductivity (EC) than normal milk due to its higher electrolyte content, especially sodium and chloride ions. Conductivity measurements were made at each milking, from half-udder milk samples, using the MAST-O-TEST™ 2.0 (Durotec, South Africa) hand-held conductivity meter.

California Milk Cell Test

The CMCT is a chemical-physical technique for the evaluation of somatic cell numbers in milk. It depends chemically on the reaction between the CMCT reagent and the DNA (from the nuclei of epithelial cells and leukocytes) in the milk. This affects the viscosity of the mixture, which is evaluated visually. The CMCT was measured in the dairy according to standard procedures (Giesecke *et al*. 1994; Karzis 2005).

Statistical analyses

The T-test (two-sample unpaired) was used to test for differences between goats with or without bacteria in their milk. The data was generally acceptably normal in distribution, except for SCC, which was transformed to log values. All tests were considered significant up to the 5 % level of significance.

Data management

All data were entered and stored in Microsoft Excel. Data were statistically analysed using the statistical programme GenStat.

RESULTS AND DISCUSSION

Conductivity in goat milk

Park (1990) found strong negative correlations between conductivity and protein and milk fat in French-Alpine and Anglo-Nubian goats. These results however, were not in agreement with those of Okigbo, Sheliah, Richardson, Ernstrom, Brown & Tippets 1984. Results from the study of Park (1990) suggested that SCC and conductivity may not be good indicators of the presence of bacteria in goat milk. In the present study, weak positive correlations were found between SCC and conductivity scores (R^2 = 0.242) and conductivity colours (R^2 = 0.256). Goat milk samples with a conductivity colour red also had a significantly ($P < 0.001$) higher log SCC than those with conductivity colours green and orange. The present study found a moderate positive correlation between CMCT and conductivity scores (R^2 = 0.470) and conductivity colours (R^2 = 0.597), respectively. These findings are in agreement with those reported by Park (1990) and Park & Nuti (1985) who found low positive correlations between SCC, conductivity and certain bacterial counts in goat milk. In the present investigation, a moderate positive correlation was also shown between the stage of lactation and conductivity scores (R^2 = 0.523) and colours (R^2 = 0.317) and a moderate negative correlation between milk yield and conductivity score (R^2 = –0.426) and colour (R^2 = –0.433).

The effect of intra-mammary treatment on conductivity results

Conductivity scores for left and right udder halves were determined for each goat in this research. There was a significant difference ($P < 0.001$) in conductivity score, prior to, during and post intramammary treatment with Cloxamast LC (T1). However, no significant difference was shown between udder halves treated with Spectrazol (T2) and inter-half controls (C2) or between the left (CL) and right (CR) udder halves of the control animals (Table 1) for the same periods. This could possibly indicate an increased permeability of the udder barrier to sodium chloride following Cloxamast LC treatment, and suggesting tissue irritation following treatment with Cloxamast LC but not with Spectrazol.

Conductivity colours for the milk of goats in the treatment groups comparing left and right udder halves were significantly different (Table 2). This implies that the number of conductivity colour counts per category did depend on treatment. The milk of goats in control group C1 had the highest percentage of green and orange (87.6 %) conductivity readings and the lowest percentage of red (12.4 %), while for the half-udder groups, the CL and CR udder halves had the highest percentage of red (42.9 %) and the lowest percentage of green and orange (57.1 %) readings. The high percentage of red colour conductivity readings in the control animals' udder halves is hard to explain (Table 2). The frequencies between the samples from the control group C1 differed significantly from those of combined samples from udder halves used as controls (CL group); and from those of the goats in group T1 and T2; but not from the goats in group C2. The frequency of occurrence of conductivity colours between goats in

TABLE 1 Conductivity scores for treated and untreated udder halves of milk goats, before, during and after treatment with Cloxamast (T1) and Spectrazol (T2) compared to those of the control animals (both halves not treated)

Treatment time (Rx)	T1 Mean + SD	T2 Mean + SD	CR and CL (control animals) Mean + SD
Before treatment (–36 h to Rx1)	1.75 ± 4.95[b]	–1.10 ± 2.89[a]	–1.56 ± 4.11[a]
During treatment (Rx2)	–8.33 ± 3.68[b]	–2.40 ± 4.14[a]	–1.67 ± 2.92[a]
During treatment (Rx3)	–3.17 ± 11.20[a]	–2.80 ± 2.97[a]	–2.22 ± 2.39[a]
During treatment (12 h)	–14.17 ± 7.22[a]	–3.20 ± 2.15[a]	–1.33 ± 2.40[a]
After treatment (24–156 h)	–2.05 ± 3.98[a]	–1.09 ± 2.15[a]	–2.32 ± 5.80[a]
CV %	–199.30 %	–178.47 %	–246.11
F probability	$P < 0.001$	$P = 0.019$	$P = 0.964$

[ab] Means were separated using Fisher's protected Least Significant Difference at the 5 % level. Means per column followed by the same letter, did not differ significantly at the 5 % level

P is significant at the 1 % level ($P < 0.001$)

TABLE 2 Conductivity readings (colour code) for milk samples from milk goats for the treatment groups compared to those for the control groups

Treatment (Rx)	Conductivity green and orange	Conductivity red	Total sample numbers per treatment
T1 (Cloxamast LC)	145 (71.8 %)	57 (28.2 %)	202
C1 (Inter-udder control for T1)	177 (87.6 %)	25 (12.4 %)	202
T2 (Spectrazol)	128 (75.3 %)	42 (24.7 %)	170
C2 (Inter-udder control for T2)	146 (85.9 %)	24 (14.1 %)	170
CL (Control left udder half)	84 (57.1 %)	63 (42.9 %)	147
CR (Control right udder half)	99 (67.8 %)	47 (32.2 %)	146
Total	**779**	**258**	**1 037**

The Chi-squared test performed on the data above was significant ($\chi 2 = 58.236$; $P < 0.001$; degrees of freedom = 5)

TABLE 3 The association between somatic cell counts (SCC) and California Milk Cell Test (CMCT) ratings (%) for milk goats

SCC groups	CMCT = 0	CMCT = 1	CMCT = 2 and 3	Total sample numbers per treatment
All SCC < 750 x 10^3	241 (56.3 %)	153 (35.7 %)	34 (7.9 %)	428
All SCC ≥ 750 x 10^3	60 (8.4 %)	276 (38.5 %)	381 (53.1 %)	717
SCC *right < 750 x 10^3	126 (55.8 %)	78 (34.5 %)	22 (9.7 %)	226
SCC **left < 750 x 10^3	115 (56.9 %)	75 (37.1 %)	12 (5.9 %)	202
SCC *right ≥ 750 x 10^3	33 (9.6 %)	134 (39.0 %)	177 (51.5 %)	344
SCC **left ≥ 750 x 10^3	27 (7.2 %)	142 (38.1 %)	204 (54.7 %)	373
CMCT numbers	301	429	415	1 145

The Chi-square test performed on the data in the table above was significant ($\chi 2 = 387.5$; $P < 0.001$; degrees of freedom = 6)

* Right udder half

** Left udder half

group C2 differed significantly from that of the goats in the group CR and CL, as well as from the goats in group T1 but not for those in group T2 suggesting little change in conductivity following treatment with Spectrazol.

No significant difference in frequencies was present between samples from goats in groups CR and CL, T1 and T2. Further studies are necessary to find optimal unit measures of conductivity of caprine milk (Park 1991).

California Milk Cell Test

SCC has been chosen as the best indicator in milk for the inflammatory response of mastitis in dairy

TABLE 4 California Milk Cell Test (CMCT) ratings (%) for infected and uninfected udder halves of milk goats

Udder halves	CMCT = 0	CMCT = 1	CMCT = 2 and 3	Total sample numbers per treatment
Infected	49 (22.5 %)	70 (32.1 %)	99 (45.4 %)	218
Non-infected	252 (27.2 %)	359 (38.7 %)	316 (34.1 %)	927
Infected *right	37 (22.6 %)	58 (35.4 %)	69 (42.1 %)	164
Infected **left	12 (22.2 %)	12 (22.2 %)	30 (55.5 %)	54
Non-infected *right	122 (30.0 %)	154 (37.9 %)	130 (32.0 %)	406
Non-infected **left	130 (25.0 %)	205 (39.3 %)	186 (35.7 %)	521
CMCT total	**301**	**429**	**415**	**1 145**

The Chi-square test performed on the data in the table above was significant ($\chi 2 = 16.938$; $P = 0.0100$; degrees of freedom = 6)
* Right udder half
** Left udder half

TABLE 5 California Milk Cell Test (CMCT) ratings for milk goats in different treatment groups (T1 and T2)

Treatment (Rx)	CMCT = 0	CMCT = 1	CMCT = 2 and 3	Total sample numbers per treatment
T1 (Cloxamast LC)	43 (19.2 %)	81 (36.2 %)	100 (44.6 %)	224
C1 (control)	54 (24.3 %)	94 (42.3 %)	74 (33.3 %)	222
T2 (Spectrazol)	41 (21.7 %)	83 (43.9 %)	65 (34.4 %)	189
C2 (control)	45 (24.1 %)	73 (39.0 %)	69 (36.9 %)	187
C (control animals)	118 (36.5 %)	98 (30.3 %)	107 (33.1 %)	323
CMCT total	**301**	**429**	**415**	**1 145**

The Chi-square test performed on the data in the table above was highly significant ($\chi 2 = 33.43$; $P < 0.001$; degrees of freedom = 8)

TABLE 6 California Milk Cell Test (CMCT) ratings (%), for right and left udder halves for treatment and control groups of milk goats

Treatment (Rx)	CMCT = 0	CMCT = 1	CMCT = 2 and 3	Total sample numbers per treatment
T1 (Cloxamast LC) **left	43 (19.2 %)	81(36.2 %)	100 (44.6 %)	224
C1 (control) *right	54 (24.3 %)	94 (42.3 %)	74 (33.3 %)	222
T2 (Spectrazol) **left	41 (21.7 %)	83 (43.9 %)	65 (34.4 %)	189
C2 (control) *right	45 (24.1 %)	73 (39.0 %)	69 (36.9 %)	187
CR (control *right)	60 (37.3 %)	45 (28.0 %)	56 (34.8 %)	161
CL (control **left)	58 (35.8 %)	53 (32.7 %)	51 (31.5 %)	162
CMCT total	**301**	**429**	**415**	**1 145**

The Chi-square test performed on the data in the table above was significant ($\chi 2 = 34.228$; $P < 0.001$; degrees of freedom = 10)
* Right udder half
** Left udder half

cattle (Griffin, Morant & Dodd 1987). The CMCT is an indirect measurement of SCC and a cow-side test that enables bovine practitioners to detect inflamed udder quarters promptly for immediate therapeutic or management-related action. According to Lewter, Mullowney, Baldwin & Walker (1984) a negative CMCT result is a good indicator of the absence of infection, but a positive test does not always indicate infection. The value of CMCT for dairy goats has been further investigated in this study.

CMCT and SCC

The legal limit of SCC for goats in South Africa is currently set at 750 x 10^3 cells per mℓ (Act No. 54 of 1972, R.1555, 21 November 1997). In this study, a moderate positive correlation was found between CMCT and SCC ($R^2 = 0.689$) and between CMCT and stage of lactation ($R^2 = 0.459$). The Chi-square test performed on the CMCT ratings versus SCC < 750 x 10^3 cells per mℓ and SCC $\geq$ 750 x 10^3 cells

TABLE 7 Differences in Log SCC for milk goats between treatments and control groups for different treatment times. (Analysis of unbalanced design)

Treatment (Rx)	No. of samples (*n*)	Log SCC at Rx2 Mean + SD	Log SCC at Rx3 Mean + SD	Log SCC at 12 h Mean + SD	Log SCC at 24 h Mean + SD	Log SCC at 36 h Mean + SD	Log SCC at 60 h Mean + SD
T1	12	3.59 ± 0.31^{a}	3.65 ± 0.55^{a}	4.01 ± 0.29^{a}	3.67 ± 0.45^{a}	$3.71 + 0.35^{a}$	3.42 ± 0.28^{a}
C1	12	3.17 ± 0.38^{b}	2.71 ± 0.55^{b}	3.07 ± 0.30^{b}	2.80 ± 0.43^{b}	$2.92 + 0.38^{ab}$	3.08 ± 0.28^{ab}
T2	10	3.06 ± 0.46^{b}	3.10 ± 0.48^{ab}	3.34 ± 0.37^{b}	3.12 ± 0.44^{ab}	$3.19 + 0.27^{b}$	3.30 ± 0.37^{a}
C2	10	3.01 ± 0.46^{b}	2.68 ± 0.64^{b}	2.88 ± 0.45^{b}	2.74 ± 0.58^{b}	$2.95 + 0.64^{b}$	2.66 ± 1.02^{b}
C	18	3.29 ± 0.55^{ab}	2.85 ± 0.61^{b}	3.11 ± 0.51^{b}	2.86 ± 0.70^{b}	$2.97 + 0.71^{b}$	3.22 ± 0.68^{a}
F probability		0.025*	< 0.001***	< 0.001***	< 0.001***	0.002**	0.045*
CV %		13.95	19.08	12.4	18.23	16.91	18.8

[ab] Means were separated using Fisher's protected Least Significant Difference at the 5 % level. Means per column followed by the same letter, did not differ significantly at the 5 % level

* $P < 0.05$

** $P < 0.01$

*** $P < 0.001$

per mℓ was significant (Table 3). Udder halves with SCC < 750 x 10^3 cells per mℓ, had the highest percentage of CMCT scores of zero (56.3%) and the lowest percentage of CMCT scores of 2 and 3 (7.9%), while for udder halves with SCC ≥ 750 x 10^3 cells per mℓ the opposite was true, with a high proportion of CMCT scores of 2 and 3 (53.1 %) and a low proportion of CMCT scores of zero (8.4 %). There was no significant difference for SCC < 750 x 10^3 cells per mℓ and ≥ 750 x 10^3 cells per mℓ for udder halves with CMCT score of 1.

The Chi-square test performed on the CMCT ratings versus SCC < 750 x 10^3 cells per mℓ and SCC ≥ 750 x 10^3cells per mℓ for left and right udder halves respectively was significant (Table 3). Right udder halves with SCC < 750 x 10^3 cells per mℓ, had the highest percentage of CMCT score of zero (55.8 %) and the lowest percentage of CMCT scores of 2 and 3 (9.7%), while left udder halves with SCC ≥ 750 x 10^3 cells per mℓ, had the highest percentage of CMCT scores of 2 and 3 (54.7%) and the lowest percentage of CMCT scores of zero (7.2%) indicating that intra-mammary treatment increases the CMCT score.

CMCT and infected and non-infected udder halves

According to Contreras *et al*. (1996) both the SCC and CMCT could be used to detect a high percentage of truly uninfected glands, but the percentage of false positives was high.

The Chi-square test performed on the CMCT ratings versus infected and non-infected udder halves in this investigation was significant (Table 4). Infected udder halves had a higher percentage of CMCT scores of 2 and 3 (45.4%) than CMCT scores of zero (22.5%); while this difference was not as pronounced for non-infected udder halves (34.1% and 27.2%). The Chi-square test performed on the CMCT ratings for infected and non-infected udder halves considering left and right udder halves separately was significant (Table 4). Non-infected right udder halves, had the highest percentage of CMCT score of zero (30.0%) and the lowest percentage of CMCT scores of 2 and 3 (32.0%) while the opposite was true for infected left udder halves, with CMCT scores of 2 and 3 at 55.5% and CMCT scores of zero at 22.2%.

The frequencies between non-infected right and left udder halves were not significantly different, nor were the frequencies between infected and non-infected left udder halves. The frequencies between infected right udder halves and non-infected right and left udder halves and infected left udder halves were not significantly different. The frequencies of CMCT scores between non-infected right udder halves and infected left udder halves were, however, significantly different (Table 4).

Effect of intra-mammary treatment on the CMCT scores

The Chi-square test performed on the CMCT ratings versus treatment groups was highly significant (Table 5), indicating that the number of CMCT counts per category was influenced by the treatment.

The Chi-square test performed on the CMCT ratings versus treatment and control groups for left and right udder halves separately was significant, also indicating that the number of CMCT counts per category was influenced by the intra-mammary treatment (Table 6). Milk samples from Control right (CR) and CL udder halves, had the highest percentage of CMCT scores of zero (37.3%) and (35.8%), while udder halves treated with Cloxamast LC (T1) had the highest percentage of CMCT scores of 2 and 3 (44.6%) indicating tissue irritation due to treatment with the product.

The frequencies of CMCT scores between milk samples from goats in groups C1 and C2, CR, CL, T1, and T2 did not differ significantly, nor did the frequencies for those from goats in groups C2 and CR, CL, T1 and T2 (Table 6). The frequencies between groups CR and CL were not significantly different nor were the frequencies between T1 and T2. However, the frequencies between CR and T1 and T2; and between CL and T1 and T2 differed significantly.

Somatic cell count

There was a significant difference in log SCC for milk samples from goats in treatment and control groups during treatment (sample times: Rx2, Rx3 and 12 h) and after treatment (sample times: 24 h, 36 h and 60 h) (Table 7). The log SCC of milk from goats in the group T1 increased notably more, between sample times Rx2 and 60h than that for goats in the group T2 (Fig. 1 and 2). The small increase in SCC during and after intra-mammary treatment with Spectrazol (T2) in dairy goats is in agreement with findings of Karzis, Donkin & Petzer (in press).

The differences in log SCC between milk from udder halves of treatment groups Cloxamast LC (T1-C1), Spectrazol (T2-C2) and the control animals group (C left to C right) were only significant ($P < 0.001$) during sample times Rx2 and 12 h, (Table 7).

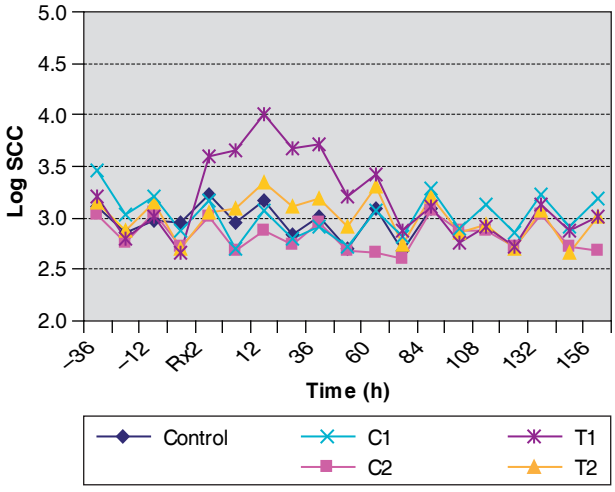

FIG.1 Mean log SCC of milk goat treatment groups (C, T1, C1, T2, C2) over time (h)

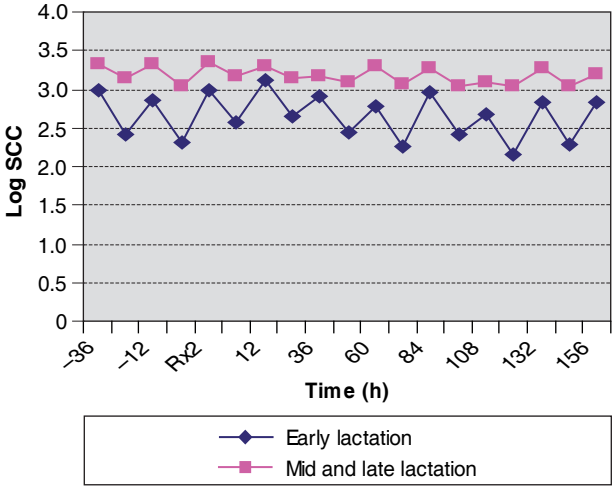

FIG.2 Mean log SCC of milk goats in early lactation versus goats in mid and late lactation

The difference of log SCC between left and right udder halves was significant for treatment and control groups prior to (–36 h and –24 h), during (Rx2, Rx3 and 12 h) and after (24 h and 36 h) treatments (Table 7). This indicates that intramammary treatment with Cloxamast LC and Spectrazol was not necessarily the cause of a difference in log SCC between left treated and right untreated udder halves, as this difference was also evident for the baseline values prior to treatment (Table 7).

Infected udder halves had significantly higher log SCC than non-infected udder halves before (–12 h and Rx1) and after treatment (84 h, 96 h, 108 h, 120 h, 132 h and 144 h), but not during treatment.

The log SCC of milk from infected udder halves was higher than that from non-infected ones. This finding differed from findings of Radostits, Gay, Blood & Hinchcliffe (2000) which showed that much of the variation in SCC was not due to intramammary infection. Non-infected goats had SCC > 1 million per mℓ making SCC controversial as a guide to diagnosis in goats (Radostits *et al*. 2000). A physiological threshold of 500 x 10^3 has been suggested (Contreras *et al*. 1996), but a count of > 1 million cells per mℓ has been said to be positive for mastitis (Kalogridou-Vassiliadou, Manolkidis & Tsigoida 1992). Other observations indicate that the most discriminating threshold for diagnosis of infection is 0.8 x 10^6 cells per mℓ (Lerondelle, Richard & Issartial 1992). Some of the factors that affect SCC in goat milk are: breed, stage of lactation, parity, season, management or farming systems, infective microorganisms and infusion products or intramammary treatment (Smith & Sherman 1994).

This study found a moderate positive correlation between lactation stage and SCC (R^2 = 0.438) and in Fig. 2 a higher log SCC of udder halves in mid and late lactation compared to those in early lactation for the trial period is indicated.

CONCLUSIONS

Goat milk samples, with a conductivity colour red had significantly higher log SCC than those with a conductivity colours green and orange while there was a moderate positive correlation between CMCT and both conductivity scores and colours. Conductivity colour reading and the SCC increased also as a result of intramammary antibiotic treatment.

A moderate positive correlation was present between SCC and CMCT, as has been found in cow milk. Both tests, SCC and CMCT, had moderate positive correlations with lactation stage. CMCT seems to be a measurement that is more accurate for ruling out mastitis than for diagnosing mastitis.

There was a significant difference in SCC between treatment and control groups during and up to 60 h after treatments, indicating tissue irritation due to intramammary treatment. The level of SCC differed between products, with higher SCC shown when Cloxamast LC was used compared to Spectrazol. Contrary to common belief, infected udder halves had significantly higher log SCC than non-infected udder halves before and after treatment. This study also found higher log SCC of udder halves in mid and late lactation compared to those in early lactation. When SCC is used as a measure of udder health in goats, their breed, stage of lactation, milk

yield and type of bacterial infection should be taken into account as these factors may affect it.

Tests such as conductivity, CMCT and SCC were not reliable for mastitis diagnosis on their own and should be accompanied by microbiological tests for a more accurate diagnosis.

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