ISSN 0370-2731/2002 Proceedings of the New Zealand Society of Animal Production 62: 16-18

BRIEF COMMUNICATION

Effect of transport stress on somatic cell counts in dairy goats

S. MCDOUGALL[1], F.M. ANNISS AND A.A. CULLUM

Animal Health Centre, PO Box 21, Morrinsville, New Zealand.

Somatic Cell Counts (SCC) are commonly used as an indirect measure of prevalence of bacterial infection and of milk quality in dairy cattle. However, interpretation of SCC in dairy goats is more complex due to a higher basal SCC and the fact that SCC appear to be influenced by a number of factors other than bacterial infection. Increased SCC is associated with bacterial infection of the udder in goats (Dulin *et al.,* 1983; Ryan *et al.,* 1993; Poutrel *et al.,* 1997). However, SCC in goats also increases with age (Dulin *et al.,* 1983), increases as lactation progresses (Dulin *et al.,* 1983; Kalogridou-Vassiliadou *et al.,* 1992; Wilson *et al.,* 1995), varies among breeds (Sung *et al.,* 1999) and increases as milk production declines (Zeng & Escobar, 1994; Pizzillo *et al.,* 1994). Stressors such as change in nutrition, kidding, oestrus and vaccination have also been suggested as causes of increased SCC in goats (Lerondelle *et al.,* 1992; Aleandri *et al.,* 1994; Pizzillo *et al.,* 1994; Zeng *et al.,* 1997).

The stress response includes both corticosteroid release from the adrenal cortex in response to adrenocorticotrophic hormone (ACTH) and adrenal medulla release of the catecholamines adrenaline and noradrenaline (Tyrrell *et al.,* 1991). Injection of dairy cattle with exogenous ACTH results in an elevation in circulating leukocyte counts but no change in the SCC (Paape *et al.,* 1973, 1975). However, transportation is likely to release both corticosteroids and catecholamines and has been used to examine various physiological responses in goats (Sanhouri *et al.,* 1989; Greenwood & Shutt, 1992).

It was hypothesised that stress, as a result of transportation, would result in elevated peripheral white-cell count, increased serum cortisol concentrations, elevated SCC and depression of milk production in lactating dairy goats.

Eighteen, mixed-age (1 to 8 years), Saanen or Saanen-cross dairy goats from a commercial herd in the sixth month of lactation (February, 2001) were used for the trial. The milk volume of each goat was determined twice daily (at approximately 05:30 h and 16:30 h) for 7 days (day 0 = first day) by placing a calibrated milk meter in the long milk line. The milk samples were weighed to estimate volume and a sub-sample of milk was taken for analysis of SCC, milk fat, protein and lactose content (LIC, Riverlea, Hamilton). On Day 3, a randomly selected half of the goats (n=9) were loaded onto an mesh-sided but open-topped 4 x 6 m trailer at approximately 15:45 h and driven continuously at approximately 60 km/h for 45 minutes on shingle and sealed public roads. The remaining goats were held in a large set of cattle yards adjacent to the milking shed and provided with water. Following transportation the goats were milked. On Day 5 the same procedure was repeated, but the other group of nine goats were transported. Both days on which transport occurred were fine with a light wind and the ambient temperature was between 20 and 25 ^{o}C. Six goats from each of the transported and non-transported groups had blood samples drawn into evacuated blood tubes containing EDTA or no anticoagulant (Vacutainer, Becton-Dickson, Auckland, New Zealand) on Days 3 and 5. Samples were collected before transportation, between 15:15 h and 15:45 h, and again following transportation, between 16:30 h and 17:00 h. Serum was recovered following centrifugation at 3000 rpm and frozen at –20 ^{o}C before analysis for serum cortisol concentrations. Samples were analysed in duplicate using a double-antibody assay. The cross reactivities with 11-deoxycortisol were 8.0%, 6b hydroxycortisone 2.6%, corticosterone 5.2%, 21-deoxycortisol 2.2% and progesterone <0.1%. Dilutions of goat serum containing a high concentration of cortisol in charcoal stripped serum were parallel to the standard curve. The within assay coefficient of variation was 13.8%, 5.5% and 8.5% for 4 to 6 replicates of pooled serums with concentrations of 5.7±0.8, 32.3±1.8 and 59.0±5.0 ng/ml of cortisol, respectively.

The EDTA samples were inverted 5 times before one drop of the blood was removed and smeared onto a clean 75 mm x 25 mm glass microscope slide and air dried. The slides and the EDTA blood tubes were forwarded within 24 hours to the laboratory (Alpha Scientific, Hamilton, New Zealand) where white-cell count and differential counts were performed by experienced technicians.

The data were analysed by examining the change between 'pre-transport' and''post-transport' values for each animal within each transport day. For the cortisol and haematological parameters the post-transport value was subtracted from the pre-transport value (i.e., 16:30 h value – 15:45 h value). For milk production (both volume and milksolids) the morning result was subtracted from the afternoon result. The differences were then analysed using a general linear model with replicate (i.e., Day 3 or Day 5) and treatment (i.e., transport or no-transport) as the main effects. The first-order interaction of replicate by treatment was tested in each model and removed from the final model if P>0.1. One doe, on the day of non-transport, had an increase in SCC from 717 to 8459 from morning to afternoon milking and this goat was removed from further analysis. Non-parametric tests were used to analyse SCC as log transformation failed to normalise the data. The change from pre- to post-transport (i.e., a.m. to p.m.) was examined using Wilcoxin signed-rank test and the effects of transport stress and replicate (Day)

[1]Corresponding Author. Tel +64 (7) 889 5159; Fax: +64 (7) 889 3681; smcdoug@ahc.co.nz

on the difference in SCC (i.e., p.m.-a.m.) were analysed using Mann-Whitney U tests. Data are presented as mean ± standard error of the difference unless otherwise stated.

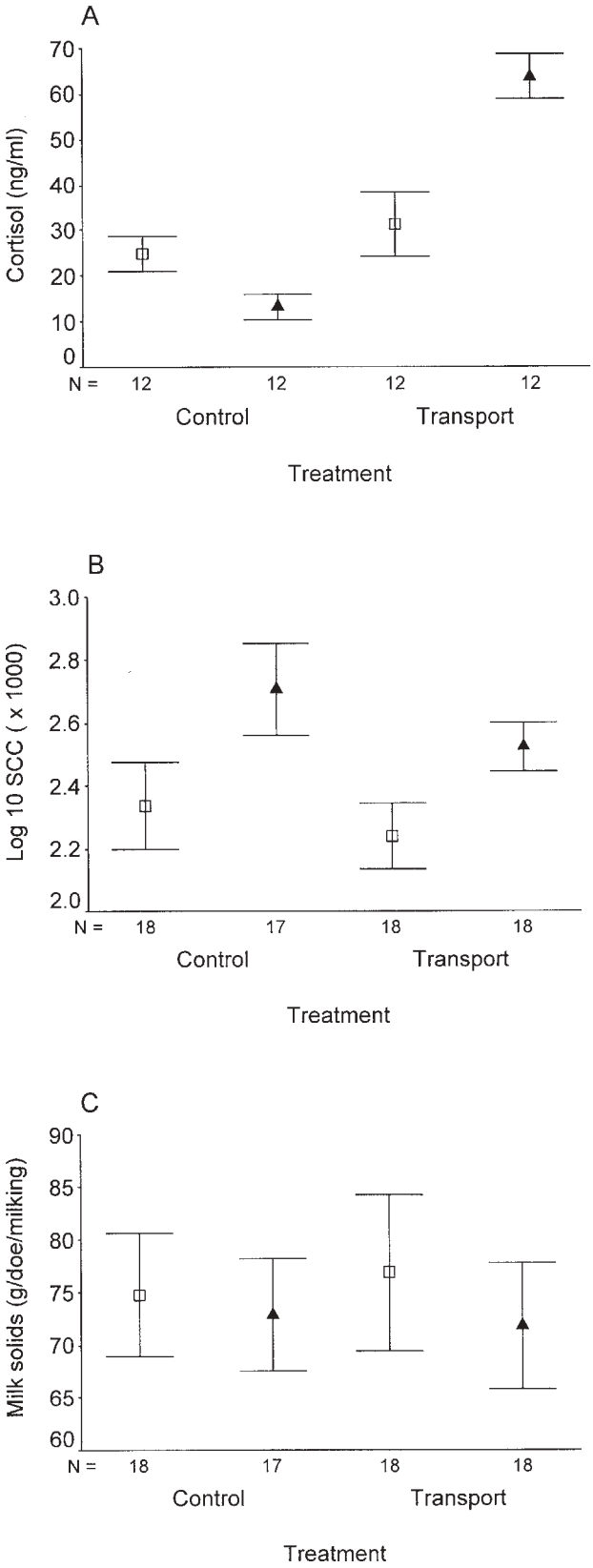
Transport resulted in open-mouth breathing in all goats. Some goats chose to sit in sternal recumbency, but most of goats remained on their feet for a majority of transport period. Transport significantly increased the concentration of lymphocytes compared to no transport ($0.6 \pm 0.4 \times 10^9$/l vs. $-0.5 \pm 0.4 \times 10^9$/l, P=0.05) and the percentage of lymphocytes tended to fall more in un-transported than in transported animals (-6.2% ± 2.3% vs. -0.9% ± 2.3%, P=0.12). There was no effect of replicate nor was there a replicate-by-transport interaction for any other of the haematological variables (P>0.1). The mean pre-transport cortisol concentration was 28.1 ± 19.6 ng/ml and did not differ between does to be transported or not transported on either replicate (P>0.2; Figure 1a). Transport increased the serum cortisol compared to no transport (16.6 ± 9.4 ng/ml vs. -10.6 ± 9.4 ng/ml, pre-post difference in cortisol concentration, P=0.05; Figure 1a). There was no affect of replicate nor was there a replicate by transport interaction in the change in serum cortisol (P>0.2). There was no affect of transport treatment (Z=-0.50, P=0.62; Figure 1b) or replicate (Z=-0.878; P=0.38) on SCC. The does were producing 1.18 ± 0.36 L/day and 0.15 ± 0.05 kg milk solids/doe per day. Transport did not affect volume (P>0.2) or milk solids production (P>0.2; Figure 1c).

Transportation increased serum cortisol concentrations and induced changes in haematological parameters. However, despite these physiological changes indicative of stress having occurred, no change in SCC was observed.

The cortisol levels were significantly increased by transportation. This indicates that physiological responses did occur during the 45 minutes of transport stress imposed within the present experiment. Increases in cortisol concentration following periods of transportation have been previously reported in goats (Sanhouri *et al.*, 1989; Greenwood & Shutt, 1992). The absolute levels of cortisol increase in the present study were less than those reported by Greenwood & Shutt (1992), but were similar to those reported by Sanhouri *et al.*, (1989).

Physiological leukocytosis due to release of endogenous corticosteroids results in lymphopenia and neutrophilia, while adrenaline release results in both neutrophilia and lymphocytosis (Morris & Large, 1990). In the present experiment, there was no overall change in total leucocyte count or neutrophil count or percentage. However, the lymphocyte count increased in transported goats while it declined in non-transported goats. This suggests that the transport stress resulted in more catecholamine than corticosteroid release.

As has been reported from dairy cattle, stress does not alter SCC (Paape *et al.*, 1973, 1975). The present experiment extends the previous studies by investigating a new species (goats) and by using a broader stressor (i.e. transportation stress rather than injection of ACTH as has been previously used). Transport elevated cortisol and likely also would have increased adrenaline and noradrenaline concentrations. However, even the broader stressor used in the present study did not affect SCC, again



FIGURES 1a, b, c. The mean (± s.e.m.) cortisol (a), log 10 somatic cell count (b) and milk production (c) before (□) and after transport (▲).

demonstrating that stress is unlikely to increase SCC, at least in the short term. Affects of chronic stressors such as poor weather, undernutrition or poor animal husbandry on SCC have yet to be determined. However, injection of ACTH for four days also failed to increase in SCC in

dairy cows (Paape *et al.*, 1973), suggesting that stress would need to be of at least four days duration to have an effect.

It is concluded that stress induced by 45 minutes of transportation increased serum cortisol concentration, altered lymphocyte count but did not affect SCC.

ACKNOWLEDGEMENTS

The assistance of Margreet Voermans and Ruben Tolboom in handling and transporting the goats and the herdowner for allowing the goats to be used is gratefully acknowledged. The study was funded by a Foundation for Research, Science and technology grant (AHC 801).

REFERENCES

Aleandri, M.; Fagiolo, A.; Calderini, P.; Colafrancesco, R.; Giangiolini, G.; Rosati, R.; de Michelis, F. 1994: *International symposium: somatic cells and milk of small ruminants,* Bella Italy. pp 55-60

Dulin, A.M.; Paape, M.J.; Schultze, W.D.; Weinland, B.T. 1983: Effect of parity, stage of lactation and intramammary infection on concentrations of somatic cells and cytoplasmic particles in goat milk. *Journal of dairy science 66*: 2426-2433

Greenwood, P.L.; Shutt, D.A. 1992: Salivary and plasma cortisol as an index of stress in goats. *Australian veterinary journal 69:* 161-163

Kalogridou-Vassiliadou, D.; Manolkidis, K.; Tsigoida, A. 1992: Somatic cell counts in relation to infection status of the goat udder. *Journal of dairy research 59*: 21-28

Lerondelle, C.; Richard, Y.; Issartial, J. 1992. Factors affecting somatic cell counts in goat milk. *Small ruminant research 8:* 129-139.

Morris, D.D.; Large, S.M. 1990: *In:* Smith, B. P. *ed.* Large Animal Internal Medicine, The C.V. Mosby Company, St Louis. pp 425-433

Paape, M.J.; Schultze, W.D.; Miller, R.H.; Smith, J.W. 1973: Thermal stress and circulating erythrocytes, leucocytes, and milk somatic cells. *Journal of dairy science 56*: 84-91

Paape, M.J.; Schultze, W.D.; Miller, R.H.; Smith, J.W. 1975: Influence of exercise and stage of lactation on the milk somatic cell response of normal quarters to adrenocorticotrophin. *Journal of food protection 42*: 719-723

Pizzillo, M.; Cogliandro, E.; Rubino, R.; Fedele, V. 1994: *International symposium: somatic cells and milk of small ruminants,* Bella Italy. pp 31-35

Poutrel, B.; Decremoux, R.; Ducelliez, M.; Verneau, D. 1997: Control of intramammary infections in goats - impact on somatic-cell counts. *Journal of animal science 75:* 566-570

Ryan, D.P.; Greenwood, P.L.; Nicholls, P.J. 1993: Effect of caprine arthritis-encephalitis virus-infection on milk cell count and N-acetyl-Beta-glucosaminidase activity in dairy goats. *Journal of dairy research 60*: 299-306

Sanhouri, A.A.; Jones, R.S.; Dobson, H. 1989: The effect of different types of transportation on plasma cortisol and testosterone concentrations in male goats *British veterinary journal 145*: 446-450

Sung, Y.Y.; Wu, T.I.; Wang, P.H. 1999: Evaluation of milk quality of Alpine, Nubian, Saanen and Toggenburg breeds in Taiwan. *Small ruminant research 33*: 17-23

Tyrrell, J.B.; Aron, D.C.; Forsham, P.H. 1991: Glucocorticoids and adrenal androgens *In:* Greenspan, F. S. *ed.* Basic and Clinical Endocrinology, Prentice-Hall International Inc, Connecticut, USA. pp 323-362

Wilson, D.J.; Stewart, K.N.; Sears, P.M. 1995: Effects of stage of lactation, production, parity and season on somatic-cell counts in infected and uninfected dairy goats. *Small ruminant research 16:* 165-169

Zeng, S.S.; Escobar, E.N. 1994: Factors affecting somatic cell counts of goat milk throughout lactation: parity and milk production. *International symposium: somatic cells and milk of small ruminants,* Bella Italy. pp 16-19

Zeng, S.S.; Escobar, E.N.; Popham, T. 1997: Daily variation in somatic cell count, composition and production of Alpine dairy goats. *Small ruminant research 26:* 253-260