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Effects of two methods of fibre removal on the cold resistance of cashmere goats

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ABSTRACT

The cold resistance of cashmere wethers in which cashmere had been harvested by shearing the whole fleece, or by removal of down only through repeated hand combings, was studied at two ambient temperatures (10°C and 30°C) and two wind speeds (0 and 6 km/hr). Heat production was calculated from oxygen consumption measured over 24 hours, in 8 pairs of goats fed at 1.25 times maintenance level. In shorn goats, heat production increased by 50% during exposure to 10°C (compared with 30°C) while the corresponding increase for combed goats was only 9%. The interaction between the effects of the low temperature and the method of fibre removal was significant ($P<0.001$). Similarly at 10°C, exposure to a wind of 6 km/hr caused a larger increase in heat production in shorn goats than in combed goats; the interaction was significant ($P<0.05$). The data show clearly that the combed goats were considerably more resistant to cold conditions than the shorn goats.

Keywords Cashmere, cold resistance, critical temperature, fibre harvesting, goats, hand combing, heat production, oxygen consumption.

INTRODUCTION

Cashmere fibre grows from December through to July and is then shed from August onwards (Mitchell *et al.*, 1989). Optimum cashmere harvesting is achieved with a shearing time of late July (McDonald, 1985; Betteridge, *et al.*, 1987). The lowest temperature to which goats can be exposed to without increasing oxygen consumption is termed 'lower critical temperature' (LCT). Dry shorn goats have a LCT of between 23-25°C while wet shorn goats have a LCT of are 28-30°C (Holmes and Clarke, 1989). The low mean temperatures of 9 and 10°C during July and August respectively in the Manawatu region (Ohakea Metetrology Office, 1990) make shorn goats highly susceptible to cold stress. Newly shorn sheep have similar LCT to goats however sheep rapidly grow fibre following shearing and produce protective grease and increase the thickness of their skin (Wodzicka-Tomaszewska, 1960). Goats regrow fibre very slowly and have low levels of grease and remain susceptible to cold stress for up to 3 months after shearing (Mitchell *et al.*, 1989). Goats in good condition can withstand a reasonable degree of cold stress (Rizzoli and McGregor, 1988). However the long sustained period in which the goat is below it's LCT results in a mobilization of body reserves and a high risk of death due to cold stress. Losses of up to 50% of flocks have been reported in Australia (Rizzoli and McGregor, 1988) and 10-15% have been documented in New Zealand (Buddle, *et al.*, 1987) and considerably higher mortality rates are rumoured.

Cold resistance depends on the rate at which heat is lost from the animal (Young, 1981). Rate of heat loss is determined by coat insulation properties which are largely explained by the depth and structure of the coat (Bennett, 1964). Shearing removes this insulating coat leaving the shorn animal without protection against adverse environmental conditions.

When cashmere goats are shorn, both guard hair and cashmere are removed. The guard hair is a waste fibre which is removed during processing. However if the guard hair could be retained on the goat it is likely to provide some insulation against cold. In China cashmere is harvested using hand combing which leaves the guard hair on the goat. The objective of this study was to quantify the cold resistance of goats retaining a coat of guard hair in comparison with conventionally shorn goats.

MATERIALS AND METHODS

Sixteen mature cashmere wethers were used in this

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experiment and assigned into pairs in a fixed nested design. Statistical analysis was undertaken using General Linear Models (SAS, 1985). The goats were obtained from the MAFTechnology flock at the Wanganui Hill Country Research Area. The goats were fed at 1.25 times maintenance (0.55 MJME/kg$^{0.75}$/day) on lucerne chaff containing 20% crude protein and 9.5 MJME/kg DM (Holmes and Moore, 1981). Water was freely available. The goats were grouped into pairs of similar liveweight and remained in these pairings throughout the experiment. Individual liveweights ranged from 17 to 36 kg.

TABLE 1 Treatment schedule for each pair of goats.

Days in Calorimeter	Temperature (•C)
0*-6	30
7	10
8	10+wind
9	10
10	10+wind
11-12	30

* Animals were shorn or combed on Day 0.

Four pairs of goats were allocated at random to two treatments. One treatment was shorn conventionally immediately prior to entry to calorimeter. The other group was hand combed on five occasions at weekly intervals prior to the first pair entering the calorimeter and then again immediately prior to entry to the calorimeter. Combing was carried out manually using a comb with 16 teeth spaced at 0.8 cm.

Oxygen consumption was measured at 10°C and 30°C and in wind at 0 and 6 km/hr over 24 hours (Table 1) for each pair of goats (Holmes and McClean, 1974). Different pairs were placed in two calorimeters consecutively for 12 days beginning on 26 October and finishing on 20 December. Heat production was calculated as described by Holmes (1968). LCT was estimated as shown by Holmes and McLean (1974).

RESULTS

At 30°C there was little difference (9%) in the heat production between the shorn and combed goats, whereas at 10°C the shorn goats produced 48% more heat (Table 2). Exposure to 10°C caused increased heat production to goats in both groups ($P<0.001$). However the increase was much larger for the shorn goats (50%) than for the combed goats (9%), and the interaction between the effects of fibre removal method (FRM) and temperature was singificant ($P<0.001$).

At 10°C exposure to wind (6 km/hr) caused increased heat production by goats in both groups ($P<0.001$). However the increase was larger for the shorn goats (25%) than for the combed goats (20%) and the interaction between the effect of FRM and temperature (Table 3) was significant ($P<0.05$).

The estimated values for lower critical temperatures in no wind (Table 3) for combed goats are 4°C lower than those for shorn animals. Exposure to wind increased this to a difference of 6°C.

TABLE 2 Effects of fibre removal method (FRM) and ambient temperature (30° and 10°C) on the mean daily heat production (MJ/kg$^{0.75}$) of cashmere goats.

	Temperature (°C) 10		30		±SEM
Fibre Removal Method	Shorn	Combed	Shorn	Combed	
Heat Production (MJ/kg$^{0.75}$)	692	399	398	365	±29

Significance of effects: FRM***, Temperature***, FRMxTemperature***

TABLE 3 Effects of fibre removal method (FRM) and two different wind speeds (0 and 6 km/hr) on the mean daily heat production (MJ/kg$^{0.75}$) at an ambient temperature of 10^{o}C and the lower critical temperatures (^{o}C) of cashmere goats.

	Wind (km/hr) 0		6		± SEM
Fibre Removal Method	Shorn	Combed	Shorn	Combed	
Heat Production (MJ/kg$^{0.75}$)	592	399	743	481	±36
Lower Critical Temperature (°C)	20	16	24	18	

Significance of effects: FRM ***, Wind ***, FRMxWind *

DISCUSSION

Little difference in heat production between the shorn and combed goats was expected at 30^{o}C because this temperature should have been within the thermoneutral zone for both types of goats. Under cold conditions (10^{o}C with or without wind), the combed goats produced about 0.66 times the heat produced by the shorn goats. These differences show the beneficial insulative effects of retaining a coat of guard hair under cold conditions.

The results of this experiment are consistent with the results of Holmes and Clark (1989) in which goats increased heat production by 50% (cf 48%) following a change in temperature from 5 to 27^{o}C and exposure to a 6 km/hr wind further increased heat production by 20% (cf 25%) at 10^{o}C. In the present study LCT were 20^{o}C in calm and 24^{o}C in windy conditions for shorn goats which were similar to those calculated by Holmes and Clark (1989). The effect wind on LCTs in goats is similar to that recorded in sheep (Alexander, 1974). However the absolute value for LCT of 20^{o}C for shorn goats is slightly lower than the 24^{o}C calculated for shorn sheep at a similar level of feeding (McGraham *et al.*, 1959). The lower values for LCT of goats in the present study compared with sheep, may be due to the present experimental procedure which maintained goats in pairs in the calorimeter whereas McGraham's sheep were maintained individually.

Comparisons with corresponding data for sheep (Baxter, 1977) suggests that the hair coat which remained in place after combing conferred additional insulation equivalent to about 19 mm and 24 mm of sheep fleece at 0 and 6 km/hr respectively when compared with shorn goats. Following exposure to this very mild winter wind, shorn goats increased their daily heat production by 3 MJ (for a 20 kg goat) while combed goats increased by only 1 MJ. Shorn goats would need to consume an additional 380 grams DM of hay to meet the higher energy requirements associated with wind an increase which may exceed their voluntary intake capacity. Whereas the combed goats would have to sustain an increased intake of only 125 grams DM of hay. These differences represent considerable savings in daily metabolizable energy requirements which potentially should be translated into a reduction in loss of liveweight, increased liveweight gain or reduced feed intake and improved goat survival in combed goats. Field studies have to date failed to identify differences in liveweight or survival of shorn and combed goats (Litherland *et al.*, 1991).

Despite the additional cold resistance conferred by combing on cashmere goats the practicality of combing goats on New Zealand farms remains in doubt. The time taken to hand comb goats is excessive and the quantity of down harvested by combing is lower than that harvested by shearing. In addition there is some evidence that the higher yielding combed fleeces have higher levels of cashmere wastage during processing than shorn fleeces (Litherland *et al.*, 1991). Farmers will have to weigh carefully the advantages of an increase in cold resistance and thus potential goat survival against lower down weights and high costs of combing. Strategies such as mechanised combing and synchronisation of shedding will need to be developed before combing could be used practically by New Zealand farmers.

CONCLUSIONS

The cold resistance of cashmere wethers was increased by the retention of the guard hair coat compared with conventional shearing. Under "mild early spring" conditions shorn goats produced 2.4 MJ heat per day more than combed goats.

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