BODY TEMPERATURE AND HEAT PRODUCTION IN SHEEP EXPOSED TO INTERMITTENT COLD

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Introduction

Ruminants living in middle or high latitudes experience large day-night fluctuations in their thermal environment. In these regions, a relatively cold ambient temperature during the night-time in the absence of solar radiation imposes a negative thermal load on the animal. Ruminant livestock kept outdoors may regulate the rate of heat production and the rate of heat loss to maintain internal homeothermy in the natural thermal environment. However, it is still unclear how ruminants regulate their body heat in response to a fluctuating thermal environment despite numerous studies of thermoregulatory mechanisms in a constant low temperature.

The objective of this experiment was to examine body heat content and the heat production rate of sheep exposed to intermittent cold.

Materials and Methods

Five adult castrated crossbred male sheep (33-44 kg) were used, each having a carotid artery surgically placed in a loop of skin. They were housed in metabolic cages having a head hood and kept in a controlled environment room at an air temperature of 25±2°C for at least 2 mo.. One day after the measurement in the warm environment, the animals were exposed to intermittent cold for 12 h (18:00-06:00 h) at an air temperature of 5±1°C followed by 12 h (06:00-18:00 h) at 25±2°C over a period of 7 successive days. The sheep were shorn once weekly to keep a fleece depth of about 6 mm and offered 20 g/kg body weight of lucerne hay in a single meal daily at 10:00 h. Twenty four hour measurements were made on days −1 and 7 of intermittent cold exposure.

The blood temperature of the carotid artery, representing the core temperature(Tc), and skin temperatures were measured every 2 min using thermocouples. Thermocouples were placed on 10 sites on the left side of the body surface (upper flank, 2; lower flank, 2; upper leg, 2; lower leg, 2; neck, 1 and ear, 1). Oxygen consumption was measured once an hour for 10 min and the heat production rate was calculated. Respiration rate (RR) was measured hourly by palpating the movements of the abdomen.

TABLE 1. 12 h MEAN VALUES OF CORE(Tc), MEAN SKIN(Ts), AND MEAN BODY(Tb) TEMPERATURES, HEAT PRODUCTION RATE(M) AND RESPIRATION RATES(RR) OF SHEEP IN WARM AND INTERMITTENT COLD ENVIRONMENTS

Item	Warm		Intermittent	
	25°C (18-06 h)	25°C (05-18 h)	5°C (18-06 h)	25°C (06-18 h)
Tc (°C)	38.5±0.02	38.81±0.02	38.60±0.04	39.12±0.07*
Ts (°C)	36.0±0.2	35.3±0.2	27.2±0.6***	34.5±0.4
Tb (°C)	38.2+0.0	38.3+0.0	37.0±0.1***	38.5±0.1*
M (kJ/kg$^{.75}$/h)	16.69±0.58	18.62±0.39	31.64±0.18***	20.37±0.84
RR (rate/min)	16.5±2.1	17.1±2.1	12.2±1.2*	14.3±1.2*

Values represent mean ± SE. Significant differences between warm and intermittent cold for each corresponding 12 h period were determined using student's *t*-test. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

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Mean skin temperature(Ts) and mean body temperature(Tb) were calculated using the equation of McLean et al.(1983). Results are shown as mean values for 12 h measurements for five animals. Student's paired *t*-test was employed for evaluating the significance of differences between days -1 and 7 for each corresponding 12 h period.

Results

The mean core temperature(Tc) during the period at 5°C (18-06 h) of intermittent cold was similar to that during the corresponding period (18-06 h) in the warm environment, while Tc in the 25°C period(06-18 h) of intermittent cold was significantly ($p < 0.05$) higher than that in the corresponding period (06-18 h) in the warm environment. Mean skin temperature(Ts) during the cold period markedly decreased ($p < 0.001$) by about 9°C when compared with that in the corresponding time period in the warm environment, while Ts during the 25°C period recovered to a similar level to that in the warm environment. Mean body temperature(Tb) was significantly lower ($p < 0.001$) during the cold period of intermittent cold, whereas a slight increase in Tb during the 25°C period of intermittent cold was statistically significant ($p < 0.05$) when compared with the value during the similar period in the warm environment. Heat production(M) was greatly increased ($p < 0.001$) by cold exposure, followed by an immediate decrease during the first one hour of the 12 h warm period, reaching a similar level to that in the warm environment. A significantly ($p < 0.05$) lower respiration rate was observed during both the cold and 25°C periods of intermittent cold than during the corresponding periods in the warm environment.

Discussion

The results of the present investigation clearly show that the core temperature of sheep increased during a 12 h warm period following 12 h of exposure to cold. A similar trend was also observed for mean body temperature(Tb). These results suggest that during a warm period of an intermittent cold exposure cycle, heat could be stored in the animal body. We have tried to calculate the amount of body heat storage during the 12 h warm period following a cold period, based on the difference in mean body temperatue measured between just before the beginning of the warm period (or at the end of the cold period) and at the end of the 12 h warm period. Body heat storage of about 7 kJ/kgBW/12 h was equivalent to 8% of heat production for the 12 h cold period.

It seems that sheep exposed to intermittent cold could store body heat during a period of 12 h in the warm, and dissipate body heat in the cold, suggesting an effective metabolic saving during the cold period.

(Key Words: Intermittent Cold Exposure, Body Temperature, Heat Production)

Literature Cited

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