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METABOLISABLE ENERGY REQUIRED BY FERAL GOATS FOR MAINTENANCE AND THE EFFECTS OF COLD CLIMATIC CONDITIONS ON THEIR HEAT PRODUCTION

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SUMMARY

The energy metabolism of 6 feral goats, aged 2 to 6 years, was measured at 15°C. They were fed lucerne hay at a level calculated to be close to maintenance.

The ratio of metabolisable energy (ME) to digestible energy in the diet was 0.82, and the ME required for maintenance was calculated to be 0.29 MJ ME/$kg^{0.75}$/d.

Heat production was increased by exposure to an air temperature of 5°C both with a wind of 7km/h and without. Values for the lower critical temperatures of these goats, with coats 57 mm deep and fed at maintenance were calculated to be 9°C and 12°C without and with wind respectively, values which are similar to those predicted for sheep with fleeces 30 mm deep.

INTRODUCTION

There appears to be little published information about the energy metabolism of goats or about the effects of cold climatic conditions on these animals. Since there is considerable interest in the productivity of goats in New Zealand, the present experiment was carried out to provide some data for the feral goat.

MATERIALS AND METHODS

Six castrated male feral goats, with an average age of 4 years (range 2 to 6 years) had been grazing on hill-country pastures until brought indoors 4 months before the experiment began.

The goats were fed lucerne hay at a level calculated to provide 0.4 MJ ME/$kg^{0.75}$/d for one month before the experiment and during the measurement periods; their average fasted liveweight was 20.5 kg (range 15.4 to 25.9) at the start of the experiment.

A complete energy balance of 7 days duration was carried out with each goat while it was in a calorimeter chamber at an air temperature of 15°C. Food intake, faecal and urinary outputs, oxygen consumption, carbon dioxide production and methane production were measured, using the methods described by Holmes and McLean (1974), and heat production was calculated from these data using the equation of Brouwer (1965).

After each 7-day balance period had been completed the goat

remained in the calorimeter for an additional 9 days during which time heat production was measured while the goat was exposed to various climatic conditions as shown below:

Days 0 to 7; 12 and 16	15 °C; 1.4 km/h wind
Days 8, 11 and 16	15 °C; 7.0 km/h wind
Days 9 and 14	5 °C; 1.4 km/h wind
Days 10 and 13	5 °C; 7.0 km/h wind

The faster wind speed was created by a fan located inside the calorimeter behind the animal. The climatic conditions were changed at 0830 each day.

RESULTS

The average liveweight of the goats during the experiments was 21.1 kg and they lost weight by an average of 0.03 kg/d over the experimental period of 1 month.

The mean values for energy metabolism are shown in Table 1; the average value for energy retention was close to zero.

TABLE 1: MEAN VALUES FOR SOME ASPECTS OF ENERGY METABOLISM FOR THE SIX GOATS MEASURED AT 15 °C (± S.E.M.)

Metabolisable energy intake (MJ/kg$^{0.75}$/d)	0.391 (± 0.01)
Heat produced (MJ/kg$^{0.75}$/d)	0.385 (± 0.01)
Digestibility of dietary energy (%)	55.7 (± 0.5)
Metabolisability of digestible energy (%)	82.2 (± 0.6)

The relation between energy retained (ER) and metabolised energy intake (MEI) was calculated and subsequently a value of 0.39 MJ ME/kg$^{0.75}$/d was calculated to be equivalent to a value of zero for ER.

The mean values for heat production measured in the various climatic conditions are shown in Table 2, together with the corresponding values calculated for the thermal conductance of the goats' bodies. Heat production was increased and thermal conductance was decreased by exposure to the lower temperature. However, both measurements were increased by exposure to the faster wind speed with the effect of wind being much greater at the lower air temperature.

Mean values for the depth and weight of the goats' coats, measured on the trunk, were 57 (± 3) mm and 395 (± 22) g/m^2.

TABLE 2: MEAN VALUES FOR HEAT PRODUCTION AND BODY THERMAL CONDUCTANCE† MEASURED IN VARIOUS CLIMATIC CONDITIONS.

	Air temperature and wind-speed				*Pooled S.E.M.*	*Significant effects*
	15 °C		*5 °C*			
	1km/h	*7km/h*	*1km/h*	*7km/h*		
heat produced ($MJ/kg^{0.75}/d$)	415	413	446	491	± 7	Temperature** Wind**
thermal conductance ($MJ/m^2/°C/d$)	252	254	189	213	± 3	Temp x Wind**

† Thermal conductance was calculated as:

$$\left(\frac{\text{Heat Produced}}{(39 - T_A) \times A} \right)$$

where 39 = measured rectal temperature (°C)
T_A = measured air temperature (°C)
A = calculated body surface area (m^2)
($0.098\ LW^{0.633}$ kg; Brody, 1945)

Because no account has been taken of evaporative heat loss in these calculations, the present values for thermal conductance should be reduced by 10 to 15% for the purposes of comparison with values for true thermal conductance.

DISCUSSION

The present estimate of ME required for maintenance (ME_M) is 0.39 $MJ/kg^{0.75}/d$ comparable values of 0.38 and 0.32 $MJ/kg^{0.75}/d$ can be calculated for a growing lamb or an adult sheep respectively, weighing 21.1 kg (M.A.F.F. 1975). This type of comparison between goats and sheep is complicated by the differences which generally exist in weight-for-age; for example the MEI required to maintain constant liveweight was 0.43 $MJ/kg^{0.75}/d$ for 28 kg 2-year old Saanen goats, and 0.30 $MJ/kg^{0.75}/d$ for 68 kg 3-year old sheep (Mohammed and Owen, 1980). Roy-Smith (1980) reported that the fasting heat production of goats and sheep were 0.33 and 0.27 $MJ/kg^{0.75}/d$ respectively; however no information was provided about the weights and ages of these animals.

Although it is difficult to make valid comparisons from the above data, they suggest that, when expressed per $kg^{0.75}$, ME_M is higher for adult goats than for heavier adult sheep, but similar to that for growing lambs of the same liveweight as the adult goats.

The present goats were compared with 8-month old castrated male lambs in an earlier experiment when fed to appetite on the

same lucerne hay; feed intake and digestibility of the feed were similar for both types of animal. (A.W.F. Davey, pers. comm.).

It can be calculated from the present data that a 21 kg goat fed at maintenance would produce 5.73 MJ of heat per day per square metre of body surface; the latter value, together with those for thermal conductance (Table 2), can be used to calculate values for the lower critical temperature (T_{CL}) for the present goats using the methods outlined by Blaxter (1977). (The lower critical temperature, in the present context, is the lowest air temperature to which the animal can be exposed without being forced to increase its rate of heat production.)

Similarly, using the data provided by Blaxter (1977), and assuming that a 21 kg sheep fed at maintenance would produce 5.73 $MJ/m^2/d$, corresponding values can be calculated for T_{CL} of a 21 kg sheep (Table 3).

TABLE 3: LOWER CRITICAL TEMPERATURE (°C) FOR GOATS AND SHEEP

	Coat Depth mm	*Wind Speed*	
		1 km/h	*7 km/h*
Goats	57	9	12
Sheep	30	9	16
	60	−4	8

These estimates indicate that the goats with a coat 57 mm deep are less resistant to cold conditions than sheep with a fleece of similar depth.

The values for T_{CL} calculated for the present goats indicate that, in New Zealand, goats will frequently be exposed to sub-critical climatic conditions, particularly if they are on a relatively low level of feeding.

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