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Body energy changes and metabolisable energy requirements in growing and adult sheep at pasture.

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ABSTRACT

Metabolisable energy (ME) intake and body compositional and energy changes were measured in grazing lambs weaned at 4 or 12 weeks of age and in light or heavy ewes offered 3 herbage allowances during early lactation.

Body energy change (MJ/kg) from 4 to 12 weeks of age varied markedly between early weaned (7.4) and suckled lambs (13.4) because of different rates of body fat deposition but was similar for both groups (16.4) from 12 to 24 weeks of age. Average efficiency of utilisation of ME for growth was 0.38 and maintenance energy requirement 0.691 MJ ME/kg $W^{0.75}$/d. The ME intakes of lambs were considerably higher than those estimated using MAFF (1975) and ARC (1980) data, particularly between 4 and 12 weeks of age.

The energy content of body weight loss (MJ/kg) was greater in light (60) than in heavy ewes (37) because of a higher proportion of fat in weight loss in light ewes. Absolute body energy loss (MJ/d) was lower in light (6.3) than in heavy ewes (7.9), but ME intake (MJ/d) and milk energy production (MJ/d) were similar for each class of ewe.

Keywords Sheep; lambs; ewes; metabolisable energy; body energy; body composition; pasture feeding.

INTRODUCTION

Theoretical estimates of metabolisable energy (ME) requirements for sheep are normally based on body weight and assumed values, mainly from indoor studies, for maintenance energy requirement (ME_m), changes in body composition or energy content, and efficiency of utilisation of ME consumed above maintenance (MAFF, 1975; ARC, 1980). There is limited information on these parameters in grazing sheep.

In the 2 experiments described here ME intake, body composition and energy change were measured in:

— grazing lambs weaned at 4 or 12 weeks of age (Expt. A);

— light or heavy ewes offered different herbage allowances during early lactation (Expt. B).

MATERIALS AND METHODS

Experiment A

Two groups of male castrate and female lambs sired by Southdown rams and single-reared by Dorset ewes were weaned at 4 (W4) or 12 (W12) weeks of age. Herbage allowance was 3 to 4 kg DM/head/d for ewes before weaning and for lambs after weaning. Herbage intake by lambs was measured using chromic oxide dilution. Digestibility of herbage dry matter consumed by lambs was based on values for sward samples taken before grazing and adjusted using diet selection data from oesophageally fistulated sheep grazing similar pastures (Geenty *et al.*, unpublished). Digestibility declined from 0.82 initially to 0.78 during the second half of the experiment. Milk production by ewes was estimated by sample milking. Further details on methods and determination of ME intake by lambs were given by Geenty and Sykes (1981).

Body energy changes of lambs were estimated from comparative slaughter data collected at intervals of 2 to 4 weeks between 3 and 24 weeks of age. Gross chemical composition was measured (Geenty *et al.*, 1979) and body energy calculated using values of 23.6 and 39.3 MJ/kg respectively, for protein and fat (ARC, 1980).

Experiment B

Dorset ewes (n = 58) rearing twin Suffolk-cross lambs were offered herbage allowances of approximately 2 (L), 5 (M), or 8 (H) kg DM/ewe/d during the first 6 weeks of lactation. Half of the ewes had light (48 kg) and half heavy (62 kg) maternal body weight at parturition after different herbage allowances during pregnancy. ME intake of ewes during lactation was estimated from chromic oxide dilution and milk production was determined using sample milking and lamb weighing before and after suckling. Body composition of ewes at parturition and after 6 weeks of lactation was measured by comparative slaughter and energy content obtained from bomb calorimetry. Experimental details are given by Geenty (1983).

Statistical Analysis

Body compositional and energy changes and energy balance in lambs were determined by regression

TABLE 1 Logarithmic regressions of body fat (FW, kg) on empty body weight (EBW, kg) and regressions of body energy (E, MJ) on live weight (LW, kg).

Growth phase	Group	n	coeff.	SE_b	Regression intercept	r^2	RSD
Regression of log FW on log EBW							
1	W4	21	1.47	0.457	− 1.52	0.32	0.148
1	W12	11	2.41	0.308	− 2.61	0.86	0.090
2	W4	11	2.07	0.124	− 2.31	0.97	0.036
2	W12	11	2.04	0.553	− 2.25	0.56	0.085
Regression of E on LW							
1	W4	21	7.35	1.300	11.7	0.61	17.8
1	W12	11	13.35	1.640	− 74.7	0.87	26.4
2	W4	11	16.28	0.693	− 229	0.98	13.8
2	W12	11	16.64	4.190	− 233	0.60	53.5

TABLE 2 Metabolisable energy intake by lambs (MJ/lamb/d) compared with theoretical estimates.

Group	Lamb live weight 20 kg Expt. A	20 kg Comparison with- MAFF	20 kg Comparison with- ARC	30 kg Expt. A	30 kg Comparison with- MAFF	30 kg Comparison with- ARC
W4	11.4	+ 54%	+ 104%	14.7	+ 20%	+ 35%
W12	14.7	+ 15%	+ 88%	12.3	0%	+ 13%

analysis; maintenance requirement was estimated by minimising total sums of squares (Fennessy *et al.*, 1972). These changes in the lactating ewes were obtained from differences between means for comparative slaughter groups.

RESULTS

Experiment A

Growth of lambs between 4 and 12 (phase 1) and 12 and 24 weeks of age (phase 2) is shown in Fig. 1. Average growth rates (g/d) for W4 lambs during phases 1 and 2 were 96 and 214 respectively, and for W12 lambs, 245 and 182.

Allometric growth coefficients (Table 1) indicate during phase 1 a greater percentage increase in body fat weight for W12 lambs (2.41) than W4 (1.47) for each unit percentage increase in EBW.

The energy content of body weight change was examined by regressing body energy on live weight before slaughter (Table 1).

These equations show that during phase 1 the energy content of body weight change was considerably greater for W12 (13.35 MJ/kg) than W4 (7.35 MJ/kg) lambs but was similar for both groups during phase 2.

An estimate of energy balance for all lambs was made by regressing body energy change (ECH, MJ/kg $W^{0.75}$/d) on ME intake (MEI, MJ/kg $W^{0.75}$/d). The regression equation was —

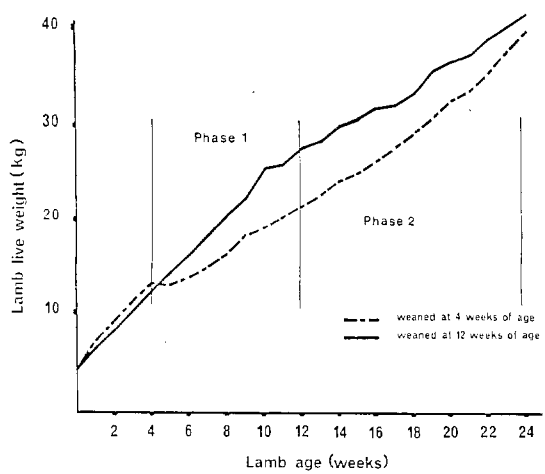

FIG. 1 Mean live weights each week of lambs weaned at 4 or 12 weeks of age.

$$ECH = 0.38\ MEI - 0.21\ (r^2 = 0.61;\ RSD = 0.097;\ SE_b = 0.048)$$

This relationship gives an average efficiency of utilisation of ME for growth (K_g) of 0.38. Calculated maintenace ME requirement (ME_m) was 0.691 MJ/kg $W^{0.75}$/d.

Values for MEI, predicted by regressing MEI/kg $W^{0.75}$/d on $LW^{0.75}$, for lambs weighing 20 kg (phase

TABLE 3 Changes in ewe weight and body energy, ME intake and milk energy production during early lactation.

Weight at parturition	Group	Weight change (kg) live weight	gut fill	fat	protein	water	Body energy change (MJ/kg)	MJ/d	ME intake (MJ/d)	Milk energy production (MJ/d)
Light	L	− 7.0	+ 2.4	− 7.6	− 1.0	− 0.6	46	7.7	17.4	8.8
(48.3 kg)	M	− 4.1	+ 1.6	− 6.0	− 0.4	+ 0.8	60	5.8	23.5	12.1
	H	− 3.3	+ 1.5	− 5.9	− 0.1	+ 1.2	73	5.7	27.6	12.0
Heavy	L	− 12.0	+ 2.3	− 9.2	− 1.2	− 3.7	33	9.4	17.2	10.0
(62.6 kg)	M	− 9.6	+ 2.6	− 8.7	− 0.9	− 2.5	39	8.9	23.3	11.9
	H	− 6.9	+ 2.1	− 6.2	− 0.7	− 2.0	39	6.4	27.9	11.8

1) and 30 kg (phase 2), are compared with theoretical estimates using MAFF (1975) and ARC (1980) data for lambs of similar live weight and growth rate (Table 2).

Experiment B

Changes during early lactation in ewe body weight, body components and energy are given in Table 3 with estimates of ME intake and milk energy production.

Average live body weight loss was greater for heavy (15%) than light ewes (8%). Loss of fat weight as a proportion of live body weight loss was 144% for light and 86% for heavy ewes; this was associated with body hydration of light ewes and dehydration of heavy ewes. Average increase in gut fill was slightly greater for heavy (2.3 kg) than light (1.8 kg) ewes. The energy content of live body weight loss (MJ/kg) was on average 62% greater, and absolute body energy loss (MJ/d) 20% less, for light than heavy ewes. Average MEI (MJ/d) and milk energy production (MJ/d) were similar for light and heavy ewes.

DISCUSSION

Patterns of growth for lambs weaned at 4 or 12 weeks of age were similar to those reported by Geenty (1979). The marked reduction in body fat deposition by early- compared with later-weaned lambs during growth phase 1 is due to body fat mobilisation immediately following weaning and reduced feed intake during the transition to complete ruminant. Associated with this was a 45% reduction in the energy content of body weight gain in early weaned compared with suckled lambs. Despite this, ME intake by early weaned lambs was 54% and 104% greater, respectively, than theoretical estimates based on MAFF (1975) and ARC (1980) during phase 1, and 15% and 88% greater, respectively, for suckling lambs. Increases of observed compared with theoretical ME intake during phase 2 were smaller, ranging from 20 to 35% for W4 and 0 to 12% for W12 lambs. An estimate of ME requirement from the data of Ulyatt *et al.* (1980) was 25% greater than that observed in the present study. It appears that ME_m values used by MAFF and ARC are lower than the value of 0.691 MJ ME/kg $W^{0.75}$/d here and K_g values used are higher than the present value of 0.38. Fennessy *et al.* (1972) reported values of 0.29 for K_g and 0.70 for ME_m in growing lambs offered fresh cut pasture and Rattray and Joyce (1976) calculated ME_m values of 0.473 and 0.786 MJ ME/kg $W^{0.75}$/d, respectively, for spring and autumn pasture. The relatively higher feed requirement of early weaned lambs during phase 1 is probably due to the high proportion of protein in body weight gain which has a higher energy cost than does fat deposition (Rattray and Joyce, 1976; Graham, 1980).

During early lactation there was a large difference in the average energy content of body weight loss in light (60 MJ/kg) compared with heavy ewes (37 MJ/kg) as a result of a higher proportion of fat in weight loss for light ewes. Similar large variation in the energy content of body weight change has been shown in lactating ewes by Cowan *et al.* (1980) and in lactating cows by Moe *et al.* (1971). Despite this difference in body energy change, ME intake and milk energy production were similar for light and heavy ewes offered similar herbage allowances. Average maintenance ME requirement (0.635 MJ ME/kg $W^{0.75}$/d) and efficiency of utilisation of total energy (ME above maintenance and mobilised body energy) for milk production (0.60), estimated in the study by Geenty (1983) were similar for light and heavy ewes.

Total ME intake was similar to theoretical estimates using data from ARC (1980) and Ulyatt *et al.* (1980) though both sources indicate about a 6% increase in ME requirement for each 10 kg increased increment in ewe live weight. It appears that the relatively greater body energy loss (MJ/d) by heavy ewes in the present study, though the difference was less than suggested by that in live-weight loss, had a sufficient sparing effect on ME requirement to compensate for their higher maintenance ME cost (MJ/d) compared with light ewes.

These 2 experiments show that the composition and energy content of body weight change can vary markedly in growing lambs according to weaning age, and in lactating ewes, according to body weight at parturition. These factors, in addition to energetic efficiency and maintenance parameters, need to be considered in addition to body weight for accurate estimation of ME requirement.

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