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THE UTILIZATION OF THE ENERGY OF FRESH MILK BY YOUNG JERSEY AND FRIESIAN CALVES

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INTRODUCTION

The energy requirements of the pre-ruminant calf have been reviewed by Davey (1974) who drew attention to the considerable variation between the results of several workers. In the work of Blaxter (1952), using calorimetric techniques and one calf, values for the net efficiency of utilization of metabolized energy (ME) above maintenance (k_g) and the requirement for metabolized energy for maintenance (ME_m) were 0.85 and 0.54 $MJ/kg^{0.75}$ per day, respectively. Johnson (1972) using a slaughter technique derived values of 0.63 for k_g and 0.39 to 4.43 $MJ/kg^{0.75}$ per day for ME_m depending on environmental conditions.

There have been few other reported studies on the energy metabolism of calves fed fresh milk, and it appears that there have been no comparisons between Jersey and Friesian calves in this respect; the present experiment was carried out in an attempt to provide information on these two aspects.

EXPERIMENTAL

Eight male calves of each of the two breeds, Jersey and Friesian, were used, having been removed from their dams at 2 to 3 days of age; all calves were subsequently fed fresh Friesian milk at two levels of feeding. Each calf was fed on either the higher or lower level of feeding during days 3 to 14 (approx.) and subsequently on the other level of feeding during days 16 to 35 (approx.). Four calves of each breed were fed on the higher level first and then the lower level, and the sequence was reversed for the other four calves of each breed. The levels of feeding were calculated to produce daily liveweight gains of 0.25 kg and 0.50 or 0.70 kg. Calves were fed their daily ration in two equal feeds at 35 to 40°C. Measurements of nitrogen and energy metabolism were made on each calf during the last week of the period on a particular level of feeding; faeces and urine were collected during 7 days and heat production was measured during the last 5 days. In addition, heat production was measured for each calf during the period 40-64 h after the last feed, at the end of each balance period. The energy and nitrogen contents of milk, faeces and urine were determined, and heat production was calculated from measurements of oxygen consumption, carbon dioxide production, and urinary nitrogen exretion (Holmes, 1973). All measurements with fed calves were made at 20°C, whereas those with fasted calves were made at 25°C ambient temperature.

RESULTS AND DISCUSSION

Fasting Heat Production

The relations were calculated for each breed, on a logarithmic basis, between fasting heat production and liveweight and the equations were:

Jersey: $FHP = 0.358\ W^{0.80}$ SE estimate $\pm$ 8%

Friesian: $FHP = 0.396\ W^{0.76}$ SE estimate $\pm$ 9%

FHP: Fasting heat production; MJ per day.
W: Liveweight during fasting; kg.

Both equations were significant ($P < 0.01$) but the difference between the regression coefficients was not significant. Both coefficients were close to 0.75, which has therefore been used as a base in this paper. Using this base, the difference in FHP between the breeds was not significant (Table 1). However for both breeds, the FHP of calves which had previously been fed on the

TABLE 1: MEAN VALUES FOR ENERGY METABOLISM, LIVEWEIGHT AND LIVEWEIGHT GAIN OF JERSEY AND FRIESIAN CALVES RECEIVING WHOLE MILK

	Level of Feeding and Breed				*SE of Means*
	High		*Low*		
	Friesian	*Jersey*	*Friesian*	*Jersey*	
Liveweight (kg)	48.4	29.8	44.7	28.7	
Liveweight gain (kg/day)	0.61	0.41	0.30	0.29	
Metabolizable energy intake (MJ/kg$^{0.75}$ per day)	0.908	0.899	0.578	0.686	±0.013
Energy retained (MJ/kg$^{0.75}$ per day)	0.334	0.349	0.129	0.194	±0.012
Fasting heat production (MJ/kg$^{0.75}$ per day)	0.448	0.441	0.385	0.401	±0.005

higher level of energy intake was higher than that of the calves previously fed on the lower level ($P < 0.01$) (Table 1).

The present values are similar to the corresponding value, 0.47 $MJ/kg^{0.75}$ per day, cited by Blaxter (1962) but are considerably lower than that of Ritzman and Colovos (1943) of 0.58 $MJ/kg^{0.75}$ per day; the latter was cited by and used as the preferred value by A.R.C. (1965).

Graham *et al.* (1974) reported an equation for young milk-fed lambs which related FHP to $liveweight^{0.75}$, previous level of feeding and previous liveweight gain. Values for fasting heat production were calculated using that equation, and using present data for liveweight, liveweight gain and energy intake; these calculated values were in close agreement with the measured values, allowing for the longer period of fasting in the present experiment than in the work of Graham *et al.* (1974).

ENERGY METABOLISM

The mean values for some measurements have been presented in Table 1. The mean value for the gross energy content of milk was 2.98 MJ/kg, and an average of 94.9% of this gross energy was available as ME.

The relations between ME intake and energy retained were calculated and are presented below:

Jersey: $ER = 0.708\ (\pm 0.051)\ ME - 0.290\ (Sy._x\!: 0.028)$ --- 1

Friesian: $ER = 0.633\ (\pm 0.039)\ ME - 0.238\ (Sy._x\!: 0.027)$ --- 2

ER = Energy retained, $MJ/kg^{0.75}$ per day.
ME = Metabolizable energy intake, $MJ/kg^{0.75}$ per day.

Both equations were significant ($P < 0.01$) but the difference between the regression coefficients was not significant. The regression coefficient for the pooled data was 0.665 (± 0.031).

These regression coefficients, which provide an estimate of k_g are similar to that of 0.69 (Van Es *et al.*, 1969), and to that of 0.63 quoted by Johnson (1972). However, these are much lower efficiencies than that of 0.85 of Blaxter (1952). In addition, equations 1 and 2 are very similar to those derived from slaughter data for young milk-fed lambs by Walker and Norton (1971).

Using the above equations, values of 0.409 and 0.393 $MJ/kg^{0.75}$ per day for ME_m can be estimated for the two breeds. These are similar to the values of Van Es *et al.* (1969), and Johnson (1972) of 0.45 and 0.39, respectively, but much lower than values of other workers which range from 0.51 to 0.59 MJ $ME/kg^{0.75}$ per day (see Davey, 1974).

The present estimates for ME_m and for fasting heat production are very similar, suggesting a value of about 1.00 for the *apparent* efficiency of utilization of ME below maintenance. Values of 0.95 and higher have been recorded for other simple-stomached animals (Mitchell, 1964); however, since there is a clear effect of the previous level of feeding on fasting heat production in the present work, uncertainty must exist about the choice of a value for fasting heat production in the above comparison.

Liveweight Gain

Mean values of 8.8 and 7.6 MJ retained per kg liveweight gain were calculated from the present data for the higher and lower levels of feeding, respectively. These compare with values of 9.5 and 8.9 MJ/kg obtained with calves and lambs, respectively (A.R.C., 1965; Walker and Norton, 1971). Using the present pooled value of 0.67 for the net availability of ME, the present values become 13.1 MJ and 11.4 MJ ME required per kg liveweight gain.

The overall requirements for ME have been sumarized in Table 2 for calves of several liveweights and gaining at different rates. When these ME requirements were recalculated in terms of whole milk (3.0 MJ of ME per kg with 4.5% milk fat) the values were generally lower than those recommended by Davey (1974). However, the present experiments were carried out in the close confines of calorimeters under strictly thermoneutral conditions. Other work, from which requirements for liveweight gain have been derived, were carried out under less controlled conditions.

TABLE 2: ESTIMATED METABOLIZABLE ENERGY REQUIREMENTS* (MJ/DAY) OF JERSEY AND FRIESIAN MALE CALVES RECEIVING WHOLE MILK

Liveweight (kg)	*Liveweight Gain (kg/day)*		
	0.0	*0.25*	*0.5*
30	5.1	8.0	11.7
40	6.4	9.3	13.0
50	7.5	10.4	14.1
60	8.6	11.5	15.2

* Maitenance: 0.401 MJ/kg$^{0.75}$ per day.
Liveweight Gain: 11.4 MJ/kg and 13.4 MJ/kg for liveweight gains of 0.25 kg and 0.50 kg per day, respectively.

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