THE EFFICIENCY OF UTILIZATION OF METABOLIZABLE ENERGY OF MILK-REPLACER-FED CALVES AT WEANING PERIOD

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Summary

A total of 22 energy balance trials were done for calves fed a liquid milk replacer, calf starter and second cut mixed hay during weaning period. Milk replacer supplied 50% of the total dietary energy, calf starter 42% and hay 8%. Live weight of calves averaged 64.6 (S.D. ± 7.8) kg and daily gain 0.54 (±0.22) kg. The metabolizability of gross energy averaged 0.751. A regression was calculated relating energy retention (ER, $kJ/kg^{0.75}$) to the intake of metabolizable energy (IME, $kJ/kg^{0.75}$):

$ER = 0.69(\pm 0.09)\ IME - 395,\ r = 0.888,\ P < 0.01,\ S.E. \pm 7.1.$

Metabolizable energy for maintenance (MEm) was calculated to be 572 $kJ/kg^{0.75}$ when ER = 0. The amount of IME over MEm for an individual animal (MEg, $kJ/kg^{0.75}$) was regressed on average daily gain (ADG, kg) by the method of regression through the origin:

$MEg = 364\ (\pm 55)\ ADG,\ r = 0.634,\ P < 0.01,\ S.E. \pm 12.$

The amount of ME required for maintenance and growth was estimated to be 936 $kJ/kg^{0.75}$.
(Key Words: Weaning Calves, Metabolizable Energy, Metabolizability, Maintenance)

Introduction

Young calves begin to consume solid diet gradually as they grow and the rumen develops gradually in size and function toward the end of the suckling period. Thus, milk makes up less and less of their ration. When a calf is eating 0.5 to 0.7 kg calf starter daily, it is ready to wean from the liquid ration regardless of age and it can be weaned successfully to dry feed at as early as 3 weeks of age (Church, 1986; Church and Pond, 1982). There are some studies on the utilization of the energy for growth by suckling calves (ARC, 1965; Neergaard, 1980; Sekine et al., 1988). There is, however, no study on the efficiency of utilization of metabolizable energy (ME) by calves at weaning period when they are transferring their subsistence from the liquid diet to the solid feed.

The present study purposed to measure the efficiency of utilization of ME for growth and to estimate the ME required for maintenance and growth of calves at weaning period.

Materials and Methods

Twenty two Holstein-Friesian castrated male calves were fed a milk replacer, calf starter and second cut mixed hay. Calves were kept in individual crates and fed at 2 different levels of ME required to gain at daily rates of 0.5 and 0.8 kg as previously described (Sekine et al., 1988). Energy balances were measured when the calves were weaning at 6 to 7 weeks of age. A total of 22 balances were determined for 2 treatments with 11 replications. Faeces and urine were measured by total collection over 7 day periods. The respiratory measurement and the calculation of heat production were determined as described previously (Sekine et al., 1988). Live weights of animals were measured at the beginning and at the end of 7-day collection periods.

Feed offered, feed weighbacks and faeces were analyzed for proximate composition and gross energy using an adiabatic bomb calorimeter (Sekine et al., 1987). Proximate composition of feeds was presented elsewhere (Sekine et al., 1988). Intakes and retention of energy were expressed on the basis of metabolic body size ($kg^{0.75}$). Statistical analysis were made by the

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methods of correlation and regression analyses described by Steel and Torrie (1960).

Results

The calves ingested a mean of 585 g of dry matter from milk replacer, 568 g of calf starter and 118 g of hay (table 1). The quantity of gross energy supplied by the milk replacer was 12.5 MJ/day which represented 49.6% of the total intake of energy. The starter supplied 10.6 MJ/day or 41.8% of the total gross energy and hay 2.2 MJ/day or 8.6%.

TALBE 1. MEAN DRY-MATTER AND ENERGY SUPPLIED BY DIETS AND THEIR RELATIVE SUPPLY TO THE TOTAL

	Milk replacer	Calf starter	2nd cut mixed hay	Total
Dry-matter				
g/day	585	568	118	1271
% of total	46.0	44.7	9.3	100
Gross energy				
MJ/day	12.5	10.6	2.2	25.3
% of total	49.6	41.8	8.6	100

The calves weighed 64.6 (S.D. ± 7.8) kg at the start of the experiment and gained on average 0.54 (±0.22) kg/day. The average digestibility of the gross energy was 0.802 (±0.064) and metabolizability (q) averaged 0.751 (±0.072). The regression of q on energy digestibility (ED) is shown by the following equation:

$$q = 0.93(\pm 0.10)\ ED + 0.0003,\quad r = 0.909,$$
$$P < 0.01,\quad S.E. \pm 0.007.$$

The regression analysis of energy retention (ER, kJ/kg$^{0.75}$) on intake of ME (IME, kJ/kg$^{0.75}$) resulted in the following equation:

$$ER = 0.69\ (\pm 0.09)\ IME - 395,\quad r = 0.888,$$
$$P < 0.01,\quad S.E. \pm 7.1.$$

This equation shows that for weaning calves the efficiency of utilization of ME for growth (kg) was 0.69 and ME required for maintenance (MEm) was 572 kJ/kg$^{0.75}$.

The quantity of IME for growth of an individual animal was calculated by subtracted MEm. The residual IME was considered to be ME for growth (MEg). Then, MEg (kJ/kg$^{0.75}$) was regressed on average daily gain (ADG, kg) at the period when IME was measured, using the method of the regression through the origin:

$$MEg = 364(\pm 55)\ ADG,\quad r = 0.634,\quad P < 0.01,$$
$$S.E. \pm 12.$$

Thus, a kilogram of ADG required 364 (±55) kJ/kg$^{0.75}$ of ME over that required for maintenance.

Discussion

No report has been published on the efficiency of utilization of ME for growth of calves at weaning period so far. The value of kg observed in the present study, however, was a little lower than that found in suckling calves (Sekine et al., 1988). This discrepancy might have been caused by the difference in the proportion of energy supply by the liquid feed. Vermorel et al.(1980) found that the Friesian calves fed a milk substitute diet utilized ME for growth with the efficiency of 0.507 ± 0.033 which was lower than that observed in the present study. Their calves at 10 weeks of age were fed 22% of their total energy as milk substitute and q averaged 0.697. Energy supply of liquid milk replacer composed 50% of the total and q was 0.751 in the present study. Therefore, the difference in the proportion of energy supply by milk substitute may be responsible for the difference between the kg observed by Vermorel *et al.*(1980) and the present study. It was concluded that for calves in weaning period the kg value is 0.69 when they are given about 50% of their total energy as a liquid milk replacer.

TABLE 2. ESTIMATION FOR ME REQUIREMENT OF WEANING CALVES USING VALUES OBTAINED IN THE PRESENT STUDY

	Daily gain (kg/day)			
	0	0.25	0.5	0.75
Present study[1] (MJ/d)	13.0	15.1	17.1	19.2
ARC(1980)[2] (MJ/d)	11.1	13.6	16.4	19.7
Difference (MJ/d)	1.9	1.5	0.7	−0.5

1 Live weight, 64.6 kg; MEm, 572kJ/kg$^{0.75}$; MEg, 364 kJ/kg$^{0.75}$.

2 Live weight, 64.6 kg; q, 0.751.

The quantity of ME required for maintenance was calculated to be 572 kJ/kg$^{0.75}$ and for growth 364 kJ/kg$^{0.75}$ in the present study. The requirement of ME for weaning calves was estimated using those figures and compared with values calculated by the ARC system (1980) (table 2). The quantity of ME required for maintenance and growth of weaning calves agreed fairly well with a tendency to be higher at maintenance and growth with a small ADG (0.25 kg/day).

It was concluded that milk-replacer-fed calves gaining about 0.5 kg/day at weaning period require 572 kJ/kg$^{0.75}$ of ME for maintenance and 364±55 kJ/kg$^{0.75}$ for each kg of daily gain.

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