METABOLIZABLE ENERGY REQUIREMENTS FOR MAINTENANCE AND GROWTH OF SUCKLING CALVES GIVEN MILK REPLACER

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Summary

A total of 38 energy balance trials were done for calves fed a liquid milk replacer, calf starter and second cut mixed hay. Milk replacer supplied 81% of the total dietary energy. Live weight of calves averaged 54.1 (S.D. ± 6.2) kg and daily gain 0.37 (±0.23)kg. The metabolizability of gross energy averaged 0.822. A regression was calculated relating energy retention (ER, kJ/kg$^{0.75}$) to the intake of metabolizable energy (IME, kJ/kg$^{0.75}$): ER = 0.72 (±0.12) IME − 330, r = 0.702, P < 0.01, S.E. ± 18.0. Metabolizable energy for maintenance (MEm) was calculated to be 458 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 averaged daily gain (ADG, kg): MEg = 413 (±91) ADG + 0.2, r = 0.650, P < 0.01, S.E. ± 21. The amount of ME requirement for suckling calves was estimated using values obtained above.

(Key Words: Milk Replacer Fed Calves, Metabolizable Energy, Maintenance, Growth, Metabolizability)

Introduction

Feeding of reconstituted liquid diet for preruminant calves has been established, yet little work has been done on the utilization of the energy for growth by suckling calves. Calves given whole milk have been reported to utilize metabolizable energy with the efficiency of 0.77 to 0.85 (ARC, 1965). Animals given liquid milk replacer appeared to have a little lower efficiency of utilization of metabolizable energy than those fed whole milk. Van Es (1970) found the efficiency of utilization of metabolizable energy for growth in veal calves fed liquid milk replacer to be 0.687. Calves aged at 1 to 6 weeks have utilized metabolizable energy for growth with the efficiency of 0.70 when they were given reconstituted liquid diets (Neergaard, 1980).

The present study was designed to measure the efficiency of utilization of metabolizable energy for growth and to estimate the metabolizable energy required for maintenance and growth of suckling calves given a liquid milk replacer.

Materials and Methods

Fourteen Holstein-Friesian male calves were fed a milk replacer, calf starter and second cut mixed hay. Calves were kept in individual crates and fed at different levels as previously described (Sekine et al., 1987a) without the level for 1.0 kg of daily gain. Energy balances were measured when the calves were 2, 4 and 5 weeks of age. A total of 38 balances were determined. Faces 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., 1987a). Live weights of animals were measured at the beginning and at the end of 7-day collection periods. Feed offered, feed weighbacks and faces were analyzed for proximate composition as described by Sekine et al. (1987b), and gross energy using an adiabatic bomb calorimeter (Sekine et al., 1987b) (table 1). Intakes and retention of energy were expressed on the basis of metabolic body size (kg$^{0.75}$). Statistical analysis were made by the methods of correlation, regression and covariance analyses described by Steel and Torrie (1960).

Results

The calves ingested a mean of 674 g of dry matter from milk replacer, 166 g of calf starter and 12 g of hay (table 2). The quantity of gross

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TABLE 1. PROXIMATE COMPOSITION OF FEEDS

Feed		DM	CP	EE	C. Fibre	NFE	GE
		%	% of DM				MJ/kgDM
Milk replacer	Mean	86.7	36.3	11.3	0.53	43.5	21.4
	S.D.	4.7	2.7	2.8	0.27	6.5	0.8
Calf starter	Mean	85.9	23.5	2.9	8.1	58.5	18.6
	S.D.	2.6	1.5	0.8	0.3	2.5	1.1
2nd cut mixed hay	Mean	87.7	18.6	4.0	27.5	38.6	18.5
	S.D.	1.3	5.2	1.3	4.3	4.4	0.4

TABLE 2. 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	674	166	12	852
% of total	79.1	19.5	1.4	100
Gross energy				
MJ/day	14.4	3.1	0.2	17.7
% of total	81.3	17.4	1.3	100

energy supplied by the milk replacer was 14.4 MJ/day which represented 81% of the total intake of energy. The solid feeds supplied 3.3 MJ/day or 19% of the total gross energy.

The calves weighed 54.1 (S.D. ± 6.2) kg at the start of the experiment, gained on average 0.37 (±0.23) kg/day. The average digestibility of the energy was 0.860 (±0.005) and metabolizability of gross energy (q) averaged 0.822 (±0.060). The regression of q on energy digestibility (ED) is shown by the following equation:

$q = 0.989\ (\pm 0.088)\ ED - 0.028$,

$r = 0.880$, $P < 0.01$, S.E. ± 0.004.

The regression analyses of energy retention (ER, kJ/kg$^{0.75}$) on intake of metabolizable energy (IME, kJ/kg$^{0.75}$) revealed that the coefficients of regression resulted in 0.64 ± 0.12, 0.68 ± 0.14 and 0.73 ± 0.16 for 2, 4 and 5 weeks of age, respectively, which showed no significant difference among the age groups. The analysis of covariance also showed no significant difference among the ages. Thus, the results were pooled and resulted in the following equation:

$ER = 0.72\ (\pm 0.12)\ IME - 330$,

$r = 0.702$, $P < 0.01$, S.E. ± 18.0.

This equation shows that for suckling calves the efficiency of utilization of ME for growth (kg) was 0.72 and metabolizable energy required for maintenance (MEm) was 458 kJ/kg$^{0.75}$.

The quantity of IME for growth of an individual animal was calculated by subtracted MEm. The residual of 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.

$MEg = 413\ (\pm 91)\ ADG + 0.2$,

$r = 0.650$, $P < 0.01$, S.E. ± 21.

Thus, a kilogram of ADG required 413 kJ/kg$^{0.75}$ of ME over that required for maintenance.

Discussion

The efficiency of utilization of ME for calves fed whole milk has been reported to be 0.85 (ARC, 1965) and 0.77 to 0.82 (Gonzalez-Jimenez and Blaxter, 1962). These figures were higher than those found in the present study. The difference may be partly caused by the inclusion of the efficiency of utilization of ME for maintenance (km). Neergaard (1980) has reported that km was 0.86 for calves fed liquid diets between the ages of 1 to 6 weeks. The efficiency of utilization of ME for growth (kg) has been reported to be 0.70 for calves fed liquid diets (Neergaard, 1980) and 0.687 for veal calves fed liquid milk replacer (van Es, 1970). The kg found in the present study agreed well with these reported values. Vermorel et al. (1980) found the Friesian calves fed a milk substitute diet utilized ME for growth with the efficiency of 0.638 ± 0.100 which was a little

lower than that obtained in the present study. Their calves at 5 weeks of age were fed 82 to 91% of their total energy as milk and q ranged from 0.856 to 0.886. Energy supply of liquid milk replacer composed 81% of the total and q was 0.822 in the present study. The kg at 2 weeks of age was 0.64 ± 0.12 in the present study, which agreed well with the result obtained by Vermorel et al. (1980). The results of the present study showed no significant difference among ages. Therefore, there may be no significant difference between the kg found by Vermorel et al. (1980) and the present study. Thus, for calves fed a liquid diet the kg value is around 0.7.

The quantity of ME required for maintenance was calculated to be 458 kJ/kg$^{0.75}$ in the present study. This value is agreement with those reported from other studies (van Es, 1970, Kirchgessner et al., 1976, Neergaard, 1980 and Vermorel et al., 1980).

The requirement of ME for suckling calves was estimated using the figures obtained in the present study and compared with values calculated by the ARC system (1980) (table 3). The amount of ME required for maintenance and growth of scukling calves agreed well.

It was concluded that milk-replacer-fed calves gaining less than 0.5 kg/day require 458 kJ/kg$^{0.75}$ of ME for maintenance and 413 ± 91 kJ/kg$^{0.75}$ for each kg of daily gain.

TABLE 3. ESTIMATION FOR ME REQUIREMENT OF SUCKLING CALVES USING VALUES OBTAINED IN THE PRESENT STUDY

	Daily gain kg/day		
	0	0.25	0.5
Present study[1], MJ/d.	9.1	11.2	13.2
A.R.C (1980)[2], MJ/d.	9.5	11.7	14.3
Difference, MJ/d.	−0.4	0.5	−1.1

[1] Live weight, 54.1 kg; MEm, 458 kJ/kg$^{0.75}$; MEg, 413 kJ/kg$^{0.75}$.
[2] Live weight, 54.1 kg; q, 0.822.

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