ENERGY REQUIREMENTS OF GROWING SAHIWAL × FRIESIAN HEIFERS IN MALAYSIA

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Summary

Fourteen Sahiwal × Friesian crossbred heifers were used in a 10-wk feeding trial to determine maintenance energy requirements and efficiency of gain. The heifers were individually fed with a diet consisting of 30% dry grass and 70% concentrates at either 110, 140 or 180% of the anticipated maintenance requirement (494 kJ ME/kg$^{0.75}$/day). Liveweight of individual heifers was measured weekly to calculate diet requirements and average daily gain (ADG). Diet digestibility was determined for all heifers to determine ME intake. Retained energy (RE) of individual heifers was determined from changes in total body fat and protein using a TOH isotope dilution procedure and, assuming calorific values of 39.3 and 23.6 kJ/g for fat and protein respectively. The estimated ME for maintenance was 433 and 470 kJ/kg$^{0.75}$/day by liveweight (ADG) equilibrium and energy (RE) equilibrium analysis respectively. ME requirement for one g of liveight gain was 28 kJ.

(**Key Words**: Energy Requirements, Sahiwal × Friesian Heifer, Maintenance, Growth)

Introduction

It has been established that nutrient requirement of cattle vary with breed (Garrett, 1971; Solis, et al., 1988) and environment (Frisch & Vercoe, 1982; Birkelo, et al., 1988). It is, therefore, necessary to determine the requirements of different breeds of cattle under the environment where they are kept.

A series of experiments were carried out in the Malaysian Agricultural Research and Development Institute (MARDI) to determine the nutrient requirements of the local cattle and buffaloes. The results of the studies on energy requirements of beef cattle (Devendra, 1981; Liang, et al., 1988) and buffalo (Devendra & Wan Zahari, 1981; Liang & Samiyah, 1989) have been reported previously. The present studies were undertaken to estimate the energy requirements of the local dairy cattle.

Materials and Methods

Animals and their management. Fourteen Sahiwal × Friesian crossbred heifers with an initial weight of 139.4 (SE = 17.21) kg and about 10-12 mth old were used in a 10-wk feeding trial. The heifers were assigned into 3 groups of similar weights and allocated at random to either 110% (n=4), 140% (n=5) or 180% (n=5) of the established maintenance (M) requirement of 494 kJ ME/kg$^{0.75}$/day (the value reported for Brahman × Kedah-Kelantan crossbred heifers in the same laboratory by Liang, et al., 1988).

The heifers were individually fed with a diet consisting of 30% dry grass (*Setaria sphacelata*) cut at about 6-7 wk intervals and 70% concentrates (40% maize, 30% soymeal and 30% tapioca chip). Mineral licks and clean drinking water were available at all times to the heifers. The heifers were weighed weekly throughout the experimental period and the liveweight (LW) of individual heifers was used as the basis to calcultate the daily diet requirements for the following 7 days. The weekly LW data was also used to calculate the average daily gain (ADG) of the individual heifer.

Diet digestibility was determined for each heifer at week 10 by the conventional 7-day total faecal collection procedure. Gross energy (GE) of the diet and the faecal samples was determined using bomb calorimetry. Digestible energy (DE) intake was calculated by multiplying GE intake and digestibility of the energy content of the diet. Metabolisable energy (ME) intake was calculate

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as 0.82 DE intake.

Determination of body composition and retained energy. The initial and final body composition of the heifers was determined using tritiated water (TOH) dilution technique following the procedure of Little & McLean (1981). Briefly, prior to the administration of the TOH, the heifers were deprived of food and water overnight. The TOH (0.01 μCi/kg LW) was administered intramusculary at 15:00 h to each heifer. A blood sample was obtained from each heifer at 09:00 h the next morning after equilibrium had occured. The activity of tritium in the plasma of the blood samples was determined following the procedure described by Dollah (1984). TOH space, calculated as the volume into which the injected TOH apparently had diluted was used to estimate the total body water (TBW). Total body fat (TBF), total body protein (TBP) and ash of individual heifers were estimated using equations of Little and McLean (1981). Retained energy (RE) of individual heifers was determined from changes in the initial and final total body fat and protein, assuming calorific values of 39.3 kJ/g and 23.6 kJ/g for fat and protein respectively (Garrett & Hinman 1969) for the experimental period.

Determination of requirements. ME Maintenance requirements (ME_m) were calculated for LW equilibrium and energy equilibrium. The ME intakes (MEI) of the individual heifer were regressed against the respective ADG values using simple linear regression ($MEI/kg^{0.75}$ = a+b ADG/kg) to determine ME_m for LW equilibrium and efficiency of LW change. ME_m for LW equilibrium was taken at the point at which ADG equaled zero while the slope of the regression was taken as the quantity of ME required for each unit of ADG. In energy equilibrium analysis, RE values were used instead of ADG values. The coefficients a and b thus represent ME_m for energy equilibrium and the quantity of ME required for each unit of RE.

Results and Discussion

Intake and average liveweight change. The chemical composition and energy value of the experimental diet are shown in table 1 while DMI, ADG and RE values of the different treatments are shown in table 2. Although there are slight variations within treatments, the ADG and RE values increased consistently as DMI increased from 110 to 140 and 180% M feeding levels. The mean DMI value recorded for the 180% M treatment level (87.27 $g/kg^{0.75}$/day) is believed to be or near to the potential *ad lib.* intake of the local cattle. This is because earlier studies in the same laboratory indicated that the *ad lib.* intake level of stall-fed cattle ranged between 64.7 to 97.9 $g/kg^{0.75}$/day depending on the quality of diet (Liang & Samiyah, 1988; Liang et al., 1988). If the above assumption was true, the overall mean ADG values of 782 g (with individual value ranged between 697-894 g) recorder for the 180% M treatment level represented the growth potential of the local Sahiwal × Friesian heifers.

Body composition and retained energy, although the equations of Little & McLean (1981) adopted for this experiment, were not calibrated for cattle under local conditions, the results of body composition of the heifers estimated at the different times were consistent. The mean values for the initial body composition based on 10

TABLE 1. CHEMICAL COMPOSITION, GROSS ENERGY (GE) AND METABOLISABLE ENERGY (ME) OF THE EXPERIMENTAL DIET

	Diet Composition	Chemical composition* (% DM)				GE	ME
	(%)	CP	ADF	EE	Ash	(KJ/g DM)	
Grass	30	7.89	28.79	1.13	3.12	18.00	
Conc.	70	18.54	8.08	2.34	4.78	16.72	
Diet	100	15.35	14.29	1.98	4.28	17.10	9.96

* CP – crude protein ADF – acid detergent fibre
EE = ether extract

TABLE 2. MEAN LIVEWEIGHT (LW)*, ME INTAKE (MEI), AVERAGE DAILY GAIN (ADG) AND RETAINED ENERGY (RE) OF THE INDIVIDUAL HEIFERS

Treatments	Animal No.	LW (kg)	MEI ($kJ/kg^{0.75}/d$)	ADG (g)	RE (MJ/d)
110%M	1	127.1	594.2	375	5.026
	2	137.7	554.9	188	3.690
	7	140.0	559.9	296	4.365
	9	150.8	571.9	192	4.158
	sub-mean		570.2	263	4.310
140%M	4	160.0	711.0	542	13.683
	12	128.4	742.1	506	11.110
	13	159.3	663.2	470	12.239
	14	171.8	697.5	699	14.846
	15	182.4	654.9	687	15.182
	sub-mean		693.7	581	13.412
180%M	5	179.5	932.5	858	19.977
	11	132.5	898.7	697	14.590
	16	190.3	901.1	894	20.497
	17	185.4	896.6	706	17.991
	18	174.3	925.9	756	18.702
	sub-mean		911.0	782	18.351

* LW at week 5.

heifers were 65.30% TBW, 12.48% TBF, 16.44% TBP and 5.89% ash (table 3). The TBW values decreased at different rates over time according to treatments, being the greatest for 180% M treatment level. Decreases in TBW were accompanied by corresponding increases in TBF but very little changes in TBP (ranged between 16.44 to 17.02%) and ash (ranged between 5.33-5.89%) over time. The mean energy contents and RE values of the different treatments are shown in table 4. Partitioning of the RE values between energy in fat and energy in protein suggested the overall average of 80.1% of each increase in RE, was being retained as tissue fat. This value was close to the 87.1% reported by Tyrrell and Reynolds (1988) for beef heifers.

Since the equations of Little & McLean (1981) were used directly without calibration for local conditions, the TBW values obtained for this study could have been underestimated resulting in higher TBF values. Although these TBF values were comparable to those reported for older cattle (Berg & Butterfield, 1976; Solis et al., 1988), they are believed to be high for the young heifers used in this experiment. Nevertheless, it is believed that the data for the body composition obtained in this experiment served the purpose for relative comparison between

TABLE 3. PREDICTED INITIAL AND FINAL BODY COMPOSITION OF THE HEIFERS IN THE DIFFERENT TREATMENTS (VALUES ARE IN % OF FASTED WEIGHT)

Treatments	Water	Fat	Protein	Ash
Initial (n=10)	65.30(2.33)	12.48(2.35)	16.44(.26)	5.89(.26)
Final:				
110%M (n=4)	65.72(2.93)	14.93(2.93)	17.02(.56)	5.33(.59)
140%M (n=5)	55.92(5.27)	21.54(5.15)	16.59(.53)	5.74(.54)
180%M (n=5)	53.81(2.80)	23.71(2.82)	16.63(.60)	5.84(.19)

( ) = Standard Error

TABLE 4. MEAN ENERGY CONTENT (MJ / ANIMAL) AND RETAINED ENERGY (MJ / ANIMAL) OF THE HEIFERS IN THE DIFFERENT TREATMENTS

Treatments	As fat	As protein	Total
110% :			
Initial	615.74(51.91)	486.81(41.46)	1102.55(93.39)
final	833.65(44.87)	570.59(30.70)	1404.24(75.57)
retained	217.91	83.78	301.69
140% :			
Initial	658.35(82.20)	520.81(65.11)	1179.16(147.3)
final	1448.20(178.1)	669.82(82.31)	2118.01(26.45)
retained	789.85	149.01	938.85
180% :			
Initial	665.98(95.59)	526.85(75.68)	1192.82(171.3)
final	1743.19(226.5)	734.24(95.45)	2477.44(321.9)
retained	1077.21	207.39	1284.62

( ) = standard error.

treatments but less so in absolute terms.

Maintenance requirements. Results of the regression analysis were;

(i) $MEI/kg^{0.75}$ = 432.599 + 534.772 ADG (SE_m = 42.45, SE_b = 71.81 and r = 0.86) and,

(ii) $MEI/kg^{0.75}$ = 470.167 + 0.021 RE (SE_m = 41.98, SE_b = 0.003 and r = 0.88).

These equations suggested that the ME_m for LW equilibrium was 433 $kJ/kg^{0.75}$/day while that for energy equilibrium was 470 $kJ/kg^{0.75}$/day. The 8% difference in the two values was comparable to the 6% difference reported by Solis et al. (1988). These authors reported a mean ME_m of 448 $kJ/kg^{0.75}$/day for LW equilibrium and 423 $kJ/kg^{0.75}$/day for energy equilibrium analysis. The values estimated in this study, therefore, fall within the accepted range.

The ME_m values obtained in this study were 12% (LW equilibrium) and 5% (energy equilibrium) respectively lower than the 494 $kJ/kg^{0.75}$/day value obtained earlier for the Brahman × Kedah-Kelantan crossbred heifers (Liang, et al., 1988). Although the differences could be due to breed effects, it is believed that the better quality diet (because of the higher concentrate to roughage ratio) used in this experiment has contributed to the present lower values. Effect of diet quality on ME_m of beef heifers was also reported by Tyrrell and Reynolds (1988).

The ME requirement for LW gain as recorded in this study was 0.535 $kJ/kg^{0.75}$ for each g of LW gain. Taking an average LW of 200 kg, the estimated ME requirement for each g of LW gain was 28 kJ.

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