

Study on energy metabolism of dairy buffalo heifers in Guangxi, China*

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ABSTRACT

Twelve dairy buffalo heifers aged 12-15 months with a body weight of 220 kg, were used in a randomized complete block design to study energy metabolism. The whole experiment consisted of 2 feeding trials with 20 d in-between interval, each including a digestion-metabolism trial. Animals were assigned to three levels of dietary net energy. Digestibility and metabolizability of energy were 67.1-71.4% and 55.1-59.2%. Methane loss was 9.9-10.0% of gross energy intake, heat production and heat increment were 0.534 and 0.203 MJ/kgW^{0.75}/d, respectively. Net energy for growth was between 23.2-29.1% of gross energy.

KEY WORDS: energy metabolism, dairy buffalo heifer

INTRODUCTION

There are numerous papers on diet energy requirement for animals, such as pig, poultry, goat, sheep and cattle. To our knowledge, there is little available information from experimental studies on the energy metabolism of dairy buffalo heifers. Recently, the maintenance energy requirement of buffalo is referred to the same as for cattle (Yang et al., 2005). Actually, there are lots of difference between the physical parameters of buffalo and cattle. Thus, it is necessary to do some

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experiments on buffalo energy metabolism. The aim of the present experiment was to study energy metabolism of dairy buffalo heifers through feeding, digestion and respiratory gas metabolism trials.

MATERIAL AND METHODS

Animals, diets, and experimental design

Twelve dairy buffalo heifers aged 12-15 months (BW 220 ± 12 kg) were used in a randomized complete block design. Animals were divided into 3 groups based on body weight and breed, each group including 1 Chinese Nili-Ravi, 1 Chinese Murrah and 2 crossbred (Nili-Ravi \times Murrah \times local) buffaloes.

Experimental buffaloes were fed individually (twice daily, 08.00 and 14.00) and all animals had free access to the drinking water. Three isonitrogenous diets (I, II and III) were formulated to contain 3 levels of energy in NE for lactation (8.00, 7.50 and 7.00 MJ/kg). The elephant grass and pineapple were the main ingredients as forage. The ingredients and composition of the experimental diets are presented in Table 1. Each animal was offered 3 kg concentrate per day.

The whole experiment consisted of 2 feeding trials with 20 days in-between interval, each including a digestion-metabolism trial. Each feeding trial lasted for 30 days, following 15 days for adaptation to the diet. And a 7-day digestion and 3-d respiratory gas metabolism trials were conducted on the 24 and 28th day of feeding trial, respectively. The oxygen and carbon dioxide content were determined for 4 times per day per head (06.00, 12.00, 18.00, 24.00, respectively) during the gas metabolism trial, and the temperature and pressure of atmosphere in experimental fields were also recorded at the beginning and end of gas determination (Guo, 1983).

Samplings, measurements and analysis

Live body weights were recorded for two consecutive days before morning feeding at the beginning and end of feeding/digestion-metabolism trial, respectively. Feeds offered (08.00, 14.00) and refused (13.00, 17.00) by individual buffaloes were weighed after each feeding and removed. Forage and concentrates were sampled weekly. All samples were immediately dried in an air-forced oven at 65°C for 48 h and stored in sealed plastic containers at room temperature until analysed. Dried forages and concentrates were ground firstly through a 2 mm screen, then through a 1 mm screen in a cycloter mill and analysed for dry matter (DM), crude protein (CP) and gross energy (GE) (PARR 6200).

During digestion-metabolism trial, the total faeces and urine were collected and recorded at 08.00 before morning feeding and urine/faeces samples were

Table 1. Ingredient and composition of the experimental diets

Item	Diet		
	I	II	III
<i>Ingredient, kg/d, as is basis</i>			
concentrate mixture	3.0	3.0	3.0
fresh elephant grass	12	12	12
fresh pineapple	8	8	8
<i>Ingredients of concentrate, % of DM</i>			
ground maize grain	55	48	40
wheat bran	6	14	18
rapeseed meal	22.5	18	17
soyabean meal	10	12	12.8
limestone	0.5	1	1
dicalcium phosphate	2	2	2
salt	1	2	2
premix	3	3	3
medical stone	0	0	4.2
<i>Nutritional value of concentrate</i>			
crude protein, %DM	17.5	17.5	17.5
NE _l , MJ/kg	8.00	7.50	7.00

NE_l - Net energy for lactation

acidified immediately after collection by diluting 1 volume of urine/faeces with 10% volumes of 10% H₂SO₄ and stored at -20°C. Samples were thawed at room temperature and analysed for urinary (UE) and faecal energy (FE). Oxygen, carbon dioxide concentration and total exchange gas amount were recorded during gas metabolism trial. Heat production (HP) was calculated from oxygen consumption (O₂), carbon dioxide production (CO₂) and urinary nitrogen loss (Un) using the following formula (Brouwer, 1965):

$$HP \text{ (KJ)} = 16.1753O_2 + 5.0208CO_2 - 5.9873 \text{ Un.}$$

Estimation of methane was based on Brouwer (1965).

Statistical analyses

Statistical analyses of the obtained data in the experiment were performed using Excel 2003 and the data are presented as means.

RESULTS AND DISCUSSION

Ingredient and composition of the experimental diets are showed in Table 1. Contents of DM, CP and GE were 23 and 11.43%, 6.42 and 6.78% of DM and 16.4 and 15.6 MJ/kgDM for elephant grass and pineapple, respectively.

Results of energy metabolism of experimental buffaloes are summarized in Tables 2 and 3. Although the designed energy values of three diets were different, the actual dietary GE intakes were similar. Maybe the experimental diet affects the diet intake. More energy was lost from faeces than from urine. The ratio of digestible energy (DE) to GE varying from 70.3 to 73.0% in early stage (12-13 months) was higher than that from 66.6 to 67.4% in late stage (14-15 months).

Table 2. Intake dry matter (DMI), gross (GE), digestible (DE) and metabolizable energy (ME), losses of energy in urine (UE) and methane (CH₄), and digestibility and metabolizability of energy in buffaloes

Item	First trial			Mean	Second trial			Mean
	I	II	III		I	II	III	
BW, kg	219	220	223	223	260	261	264	262
DMI, kg	5.21	5.49	5.38	5.38	5.81	6.03	5.84	5.89
Energy metabolism, MJ								
GE intake	83.76	87.41	83.91	85.03	94.22	96.82	93.94	94.99
DE intake	61.13	61.45	59.43	60.67	63.47	65.21	62.27	63.75
UE	1.56	1.94	1.863	1.79	1.87	2.23	2.07	2.05
CH ₄	8.30	8.74	8.57	8.54	9.25	9.60	9.30	9.39
	-----%-----				-----%-----			
DE/GE	73.0	70.3	70.8	71.4	67.4	67.4	66.60	67.1
ME/GE	61.2	58.1	58.4	59.2	55.6	55.1	54.5	55.1
ME/DE	83.6	82.6	82.5	83.0	82.5	81.9	81.8	82.1
UE/GEI	1.9	2.2	2.2	2.1	2.0	2.3	2.2	2.1
CH ₄ /GE	9.9	10.0	10.2	10.0	9.8	9.9	9.9	9.9

The ratio of metabolizable energy (ME) to DM in the two periods were not different, i.e. 82.1-83.0%, similar to that for dairy cattle (82%) (China Ministry of Agriculture, 2004), but higher than the results of lactating buffaloes (80.2%) (Wen et al., 2003). It is suggested that efficiency with which the DE is converted to ME is higher in buffalo heifers than in lactating buffaloes.

Loss as methane was estimated based on DM intake (Brouwer, 1965), i.e. intake of 1 kg DM produces 40 l methane, 1 l methane is 0.714 gram, and 1 gram of methane's calorie is 64.032 KJ. From the data in Table 2, it was found that methane loss was about 10 % of total energy intake in dairy buffalo heifers.

In ruminants, 76-86% of the DE is converted to ME, and only 30-65% of the ME is converted to net energy (China Ministry of Agriculture, 2004). However, the ratio of ME to DE was 82.1-83.0%, and ratio of net energy to ME was 74.0-

Table 3. Energy lost as heat production (HP), heat increment (HI), intake of net energy (NE) and NE used for maintenance (NEm) and growth (NEg) in buffaloes

Item	First feeding trial			Mean	Second feeding trial			Mean
	I	II	III		I	II	III	
Energy metabolism, MJ								
ME	51.27	50.77	49.00	50.35	52.35	53.38	51.20	52.31
NE	39.34	38.21	37.28	38.61	39.91	40.18	37.91	39.10
NEm ^a	24.35	23.60	23.91	23.95	26.82	26.93	27.12	26.95
NEg	14.99	15.61	13.38	14.66	12.39	13.26	10.80	12.15
HI	11.93	11.56	11.71	11.73	13.14	13.19	13.29	13.21
	-----MJ/kgW ^{0.75} /d-----				-----MJ/kgW ^{0.75} /d-----			
HP	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
HI	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203
	-----%-----				-----%-----			
NEg/GE	17.9	17.9	15.9	17.2	13.2	13.7	11.5	12.8
NEm/GE	29.1	27.0	28.5	28.2	28.5	27.8	28.9	28.4
HI/GE	14.2	13.2	14.0	13.8	13.9	13.6	14.1	13.9
NE/ME	77.1	75.3	76.1	76.2	76.2	75.3	74.0	75.2
NEg/ME	29.2	30.8	27.3	29.1	23.7	24.8	21.1	23.2

^a the NEm value was based on the fasting heat production (FHP) value in our lab experiment, i.e. for 15-month buffalo, FHP=0.331 MJ/kgW^{0.75}/d, NEm=FHP*125% (Yang et al., 2005)

77.1% with dairy buffalo heifers (Table 3), suggesting that buffalo heifers may utilize the ME at higher efficacy.

CONCLUSIONS

Digestibility and metabolizability of energy were 67.1-71.4% and 55.1-59.2%, methane loss was 9.9-10.0% of gross energy in dairy buffalo heifers. Heat production and heat increment were 0.534 and 0.203 MJ/kgW^{0.75}/d, respectively.

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