PROTEIN AND ENERGY REQUIREMENT FOR MAINTENANCE AND GROTH OF BALI CATTLE

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ABSTRACT

This experiment was conducted to determine the protein and energy requirement for maintenance and growth of bali cattle. The experiment used randomized completely block design (RCBD), which consisted of five treatments and three weight groups as block. The initial body weight of male bali cattle was 198.67-207.00 kg. The treatments were five rations which composed with different protein and energy content as follows: ration A with 15.42% protein and 4020 kcal GE/kg DM, ration B with 14.74% protein and 3750 kcal GE/kg DM; ration C with 13.11% protein and 3790 kcal GE/kg DM ; ration D with 10.33% protein and 3920 kcal GE/kg DM, and ration E with 10.58% protein and 3530 kcal GE/kg DM. The variables measured were nutrient intake and as well as the calculation of the energy and protein requirement. The results showed that dry matter and energy intake were not significant different, but the highest protein consumption was on A treatment and the lowest was on E treatment (0.77 vs 0.52 kg/d). Requirement of protein and energy for maintenance was 8.23 g/ $W^{0.75}$/d and 137.85 kcal/$W^{0.75}$/d, while requirement of protein and energy for growth was 345.25 g/kg body weight gain and 3753.31 kcal/kg body weight gain. Total protein and energy requirements of growing bali cattle could be calculated with the formula PRt = 8.23 $W^{0.75}$ + 345.25 ΔW g / d and ERt = 137.85 $W^{0.75}$ + 3753.31 ΔW kcal/d, where: PRt is total protein requirements; ERt is total energy requirements; W is body weight and ΔW is weight gain).

Key words: growing bali cattle, protein and energy requirements

INTRODUCTION

Bali cattle is one of Indonesia native germplasm with high genetic potential and economic values to be developed as meat source. It has several advantages such as: high reproduction rate including pregnancy rate (80-90%), birth rate (75 -85%), carcass value is 56% and meat quality is quite good (Soehadji, 1991).

Generally, rearing system of bali cattle in Bali was traditional and their feed mostly realy on grass available in the field without considering its nutrient content. Some farmers offer rice bran as a supplement but from its nutrient balance could not fulfill the requirement for optimizing the production. Fulfilling of sufficient and balance nutrient requirement for livestock is needed because it was one of the major environment factor which affecting growth and production of livestocks (Maryono, 2006). Although livestock have high genetic potential but if the feed offered was not meet the nutrient requirement, the expected production could not be achieved.

Protein and energy are essential nutrients and have to be considered in formulating ration for ruminants. Leng (1991) stated that balance of protein and energy ration influenced the efficiency of nutrient utilization and finally affected livestock productivity. Therefore, ration formulation with sufficient and balance nutrient could result maximum livestock productivity to support their genetic potential. Until now, there is no nutrient requirement especially energy and protein of bali cattle available, so it is needed a formula to calculate the requirement of maintenance and growth of bali cattle in growing phase.

Nutrient requirement especially protein and energy could be determined based on feeding trial and changing of body composition (Mahardika, 1996, Sukarini, 2000). The observations of metabolic aspects such as digestion process, nutrient balance measurement and conversion value, followed by the observation of the livestock performance such as growth rate and body composition changed could be used as a basic calculation on protein and energy requirement of the animal. Data of protein and energy requirement could be used as a basic information incomposing bali cattle ration to fulfill the livestock requirements.

MATERIALS AND METHODS

The initial body weight of male bali cattle use in the experiment was range from 198.67- 207.00 kg. Acompletely randomized block design (RCBD) was used in this experiment, consisted of five treatments and three weight groups as block. The treatments were five rations which composed with different protein and energy content as follows: ration A with 15.42% protein and 4020 kcal GE / kg DM of, ration B with 14.74% protein and 3750 kcal GE / kg DM; ration C with 13.11% protein and 3790 kcal GE / kg DM; ration D with 10.33% protein and 3920 kcal GE /kg DM, and ration E with 10.58% protein and 3530 kcal GE / kg DM. The complete rations in mash form were given *ad libitum*. Feed composition and its nutrient content are shown in Table 1.

Table 1. Composition and Nutrient Content of Treatment Feed

Feed Ingredients (%)	Treatments					Kearl Standard (1982)
	A	B	C	D	E	
Feed Components:						
Elephant grass	10	15	27	40	55	-
Gliricidia	25	20	8	5	0	-
Pollard	5.5	10	14.5	10.5	5.5	-
Coconut meal	17	11.5	10	5	2	-
Cassava meal	35	38	36	35	33	-
Molasses	4	4	3	3	3	-
Coconut oil	2	0	0	0	0	-
Urea	1	1	1	1	1	-
Salt	0.4	0.4	0.4	0.4	0.4	-
Pignox	0.1	0.1	0.1	0.1	0.1	-
Total	100	100	100	100	100	-
Nutrient Content (% DM)[1)]:						
Dry Matter	89.49	90.00	90.63	89.73	90.58	-
Ether Extract	4.09	3.67	1.76	2.52	2.33	-
Crude Fiber	17.81	17.58	19.36	20.29	21.23	-
Crude Protein	15.42	14.74	13.11	10.33	10.58	-
GE(kcal/kg)[2)]	4020	3747	3790	3920	3535	-
Ca	0.92	0.99	0.92	1.03	0.70	0.48
P	0.10	0.12	0.07	0.11	0.06	0.30

Notes: [1)]. Laboratory analysis (Nutrition, Beef Cattle Research Working Group Grati, East Java, 2011)
[2)]. Nutrition Laboratory analysis (IPB, Bogor, 2011)

Parameters measured were dry matter (DM), protein, and energy intake, protein and energy requirement on growing phase of bali cattle were calculated.

This measurement was conducted at the end of the experimentation. Briefly measurement procedure as followed: 10 ml blood samples were obtained through jugular vein, and then injected with 0.43 cc per $kgW^{0.75}$ urea (30% concentration) to the blood circulation through the jugular vein. After 12 minutes of the injection, blood samples were taken from the jugular vein and then thirty blood samples were send to Prodia for centrifuged to obtain plasma liquid. The plasma liquid was analyzed to determine the level of blood urea before and after urea injection. Body composition could be determined through calculation of the urea space using the following formula:

Nutrient requirement especially protein and energy could be calculated based on the feeding trial and changing of body composition. Body composition of the animal was measured by urea space technique (Rule *et al*., 1986).

$$\textbf{Urea Space (\%)} = \frac{\textbf{Injection of urea (mg)}}{\textbf{10 x body weight x change of blood urea (mg)}}$$

The empty body water (EBW), body fat and body protein were calcuated using the following formula:

Body Water (%) = 59.1 + 0.22 RU - 0.04 BW

Body Fat (%) = 19.5 to 1.31 RU - 0.05 BW

Body Protein (%) = 16.5 + 0.07 RU + 0.001 BW

Note:
RU = Urea Sapce (%)
BW= Body Weight (kg)

All data collected were calculated and analyzed using analysis of variance. When the results found were significantly different (P <0.05), analysis will be continued using Duncan's multiple range test at the 5% level (Steel and Torrie, 1986).

RESULTS AND DISCUSSION

Average intake of dry matter (DM), crude protein and energy are shown in Table 2. The differences of nutrient contents in the treatment rations did not affect dry matter and energy intake. These results reflected that the provision of rations with different protein and energy did not affect the ration intake. Basically, ration intake was intended to meet the energy requirements of cattle, so the animals stop eating when energy needs are met. The capacity of digestive tract especially the rumen was the other factor affects the level of feed intake. If the content of crude fiber in the ration is high, the animal will consume less feed.

The average DM intakes on all treatments were 4.90-5.40 kg/d or equivalent with 2.04-2.19% of body weight. According to Kearl (1982), cattle with 200 kg body weight and 0.5 kg weight gain needed 5.2 kg dry matter intake or 2.6% from body weight. Putri *et al*., (2010) found that male bali cattle with 220.00 to 228.33 kg body weight consumed 2.14-2.47 kg/d of dry matter or equivalent with 0.97-1.08% of body weight, while male bali cattle with 279.00-300.32 kg body weight fed with different types and composition of forage and supplemented with carbohydrate consumed 6.32-7.00 kg/d of dry matter or equivalent with 2.27-2.33% of body weight (Suryani, 2012). The differences of the above results due to the different of body weight, and types of ration. According to Parakkasi (1999), the amount of dry matter intake by cattle depended on body weight, rate of production, environmental condition, body condition, and feed quality.

Rations with different protein and energy contents affected the intake of crude protein of bali cattle significantly (P <0.05). Crude protein intake on treatment A was 0.77 kg/d (Table 2). Treatments B was only 3.9% higher than treatment A while treatment C was only 15.58% lower compared to treatment A, and then differences were not significantly different (P>0.05). Crude protein intakes on treatment D and E were 28.51% and 32.47% lower (P <0.05) than treatment A respectively, but there were not.differences (P>0.05) were found between treatment C, D and E.

The differences in protein contents of the above rations (A, B, C, D and E) might caused the result of this study since the activity of rumen microbe in feed fermentations was affected by protein content in the ration (Tamminga, 1992). However, according to Sutardi (1991) bali cattle need higher protein and other nutrient in their feed compared to other cattle breed.

Table 2. Nutrient Intake and Nutrient Retention in Bali Cattle

Variable	Treatments					SEM
	A	B	C	D	E	
DM intake (kg/d)	5.01[a]	5.40[a]	4.97[a]	5.29[a]	4.90[a]	0.33
GE intake (kcal/d)	20119.10[a]	20222.52[a]	18710.74[a]	20726.74[a]	17302.39[a]	1310.12
Protein intake (kg/d)	0.77[a]	0.80[a]	0.65[ab]	0.55[b]	0.52[b]	0.05
Retained fat (kg/d)	0.11[a]	0.11[ab]	0.10[ab]	0.08[bc]	0.06[c]	0.01
Retained protein (kg/d)	0.09[a]	0.09[a]	0.08[a]	0.07[ab]	0.05[b]	0.01
Retained Energy (kcal/d)	1467.81[a]	1440.78[ab]	1316.98[ab]	1110.56[bc]	831.47[c]	103.17

Description:

A: ration with 15.42% protein and 4.02 Mcal GE / kg DM
B: ration with 14.74% protein and 3.75 Mcal GE / kg DM
C: ration with 13.11% protein and 3.79 Mcal GE / kg DM
D: ration with 10.33% protein and 3.92 Mcal GE / kg DM
E: ration with 10.58% protein and 3.53 Mcal GE / kg DM
DM = daily dry matter intake
GE = gross energy daily intake
SEM = Standard Error of the Treatment Means
Values in the same row followed by different superscript are significantly different (P<0.05)

Fat, protein and energy retention could be determined by converted the daily gain of the cattle based on body composition with urea space distribution technique (Rule *et al*., 1986). Energy retention of bali cattle on treatment A was 1467.81 kcal/d (Table 2), while energy retention on treatment B and C were 1.84% and 10.28% lower than treatment A. Energy retention on treatment D and E were 24.34% and 43.35% lower ($P < 0.05$) compared to treatment A.

The high energy retained (RE) by cattle on treatment A, B and C caused by the increase of protein and fat retention. Fat and protein were body components that could be converted into energy. According to Ørskov and Ryle (1990) energy content of one gram of fat and protein were 9.32 and 5.5 kcal/g respectively. The high energy retention had a positive impact on body weight gain and showed by the increase of weight gain of the cattle given treatments A, B and C.

Protein and energy requirement of bali cattle with 200-350 kg weight are shown in Table 3.. Protein requirement was determined by feeding trial and changing of body composition. The calculation based on data of feed protein digestibility and protein biological value (Blaxter, 1969). Protein retention could be calculated by multiplying body protein content with body weight gain, and protein requirement for maintenance could be calculated by substraction of protein intake with protein for growing. Based on the calculations, protein requirement for maintenance on bali cattle was 8.23 g/$W^{0.75}$/d.

Protein requirement for growth on bali cattle was calculated based on body weight gain, body composition, protein biological value and protein los through urine which corrected by endogenous nitrogen (N). Results of the experiment showed that the average retention of protein for 1 kg of body weight gain was 222.77 g. If that corrected by its biological and digestibility value, then protein requirement for growth was 345.25 g. Total protein requirement of bali cattle could be calculated by the protein requirement for maintenance and protein for growth as follows: **PRt = 8.23W$^{0.75}$ + 345.25 ΔW g/h** (where: PRt is total protein requirements (g/d), W is body weight (kg) and ΔW is body weight gain (kg)

Based on the above formula, bali cattle with 250 kg body weight and 0.75 kg weight gain required protein for maintenance was 517.43 g/d and for growth 258.94 g / h, so total protein requirement was 776.37 g / d. If the weight gain was 0.5 kg / d protein requirement for growth was 172.62 g / d, and total protein requirement was 690.06 g / d. Gentsch *et al.* cited by Kearl (1982) reported that digestible protein for maintenance was 2.86 g/$W^{0.75}$ / d. According to Partama (2000) protein requirement for maintenance of goats was 4.40 g/$W^{0.75}$ / d and protein requirement for growth as much as 315.0 g / d for each 1 kg of weight gain, while on buffalo needed 2.51 g/$W^{0.75}$ / d digestible protein for maintenance (Mahardika, 1996).

The same calculation based on body weight and growth found that protein requirement for maintenance on male bali cattle was higher than reported by Kearl (1982). The different reported in this experiment probably was due to the different animal use in the experiment.

Total energy requirement for growing bali cattle can be calculated by adding energy for maintenance and energy requirement for growth. Energy for maintenance of bali cattle was calculated by substracting the metabolizable energy during the research with energy retention which has been corrected by the partial efficiency ($\Delta RE / \Delta ME$). Mount (1979) found that $\Delta RE/\Delta ME = 0.70$ and it means 70% of the increased in metabolizable energy above maintenance will be retained, and 30% as heat loss. Based on formula ME = HP + RE/0.70, heat production (HP) for maintenance can be calculated. Heat production (HP) on bali cattle was found 137.85 kcal/$W^{0.75}$

Energy requirement for growth calculated by dividing energy retention with body weight gain which corrected by partial efficiency. The average energy retained for each 1 kg body weight gain was found 2627.32 kcal. Energy requirement for growth of bali cattle was found 3753.31 kcal/kg or equivalent to 15.69 MJ/ kg body weight gain. Total energy requirement could be calculated using the following formula: **ERt = 137.85 $W^{0.75}$ + 3753.31 ΔW kcal/d** (where : ERt is total energy requirements (kcal/d), W is Body weight (kg) and ΔW is Body weight gain (kg)

Based on the calculation using above formula, bali cattle with 250 kg weight and 0.75 kg weight gain required 8666.86 kcal/d of energy for maintenance and 2814.98 kcal/d energy for growth, so total energy requirement become 11481.84 kcal /d. If body weight gain was 0.5 kg/d, the energy requirement for maintenance 8666.86 kcal/d and energy for growth was 1876.66 kcal/d, so total energy requirement was 10543.51 kcal/d (Table 3).

Patle and Mudgal (1975) stated that the metabolizable energy requirement of cross-breed cattle for maintenance was 107 kcal/ $W^{0.75}$/d. Sukarini (2000) found that maintenance energy requirement on lactating bali cattle was 126.79 kcal/$W^{0.75}$/d and energy maintenance requirement on pregnant bali cattle was 174.64 kcal/ $W^{0.75}$/d (Putra, 1999). On the other hand Mahardika (1996), found that energy requirement for maintenance of buffalo was 100.48 kcal/ $W^{0.75}$/d. These differences were related to physiological status and species of the animals and also the environment factors.

Table 3. Calculated Protein and Energy Requirements for Maintenance and Growth in Male Bali Cattle

W (kg)	ΔW (kg/d)	Protein for Maintenance (g/d)	ME.for Maintenance (kcal/d)	Protein for Growth (g/d)	ME.for Growth (kcal/d)	Total Protein (g/d)	Total ME (kcal/d)
	0	437.70	7331.27	0	0	437.70	7331.27
	0.25	437.70	7331.27	86.31	938.33	524.01	8269.60
200	0.50	437.70	7331.27	172.62	1876.66	610.32	9207.93
	0.75	437.70	7331.27	258.94	2814.98	696.63	10146.25
	1.00	437.70	7331.27	345.25	3753.31	782.94	11084.58
	0	517.43	8666.86	0	0	517.43	8666.86
	0.25	517.43	8666.86	86.31	938.33	603.75	9605.19
250	0.50	517.43	8666.86	172.62	1876.66	690.06	10543.51
	0.75	517.43	8666.86	258.94	2814.98	776.37	11481.84
	1.00	517.43	8666.86	345.25	3753.31	862.68	12420.17
	0	593.25	9936.83	0	0	593.25	9936.83
	0.25	593.25	9936.83	86.31	938.33	679.57	10875.15
300	0.50	593.25	9936.83	172.62	1876.66	765.88	11813.48
	0.75	593.25	9936.83	258.94	2814.98	852.19	12751.81
	1.00	593.25	9936.83	345.25	3753.31	938.50	13690.14
	0	665.96	11154.70	0	0	665.96	11154.70
	0.25	665.96	11154.70	86.31	938.33	752.28	12093.02
350	0.50	665.96	11154.70	172.62	1876.66	838.59	13031.35
	0.75	665.96	11154.70	258.94	2814.98	924.90	13969.68
	1.00	665.96	11154.70	345.25	3753.31	1011.21	14908.01

Notes:

W : Body weight
ΔW : Body Weight gain
ME : Metabolizable Energy

CONCLUSION

It might be concluded that protein and energy requirement for maintenance on male bali cattle were 8.23 g / $W^{0.75}$/d and 137.85 kcal/ $W^{0.75}$/d respectively, while protein and energy requirement for growth were 345.25 g / kg body weight gain and 3753.31 kcal/ kg body weight gain. Total protein and energy requirements for male bali cattle during growing were PRt = 8.23 $W^{0.75}$ + 345.25 ΔW g / d and ERt = 137.85 $W^{0.75}$ + 3753.31 ΔW kcal/d respectively, the formulas that might be used for estimation where (PRt is total protein requirements; ER tis total energy requirements; W is body weight and ΔW is body weight gain).

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