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ENERGY AND PROTEIN REQUIREMENT OF POST-WEANING BALI CATTLE IN EAST TIMOR

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ABSTRACT

Post-weaning cattle require a certain amount of energy and protein in order to grow optimally. Offered a mixture of several feed ingredients aims to maximize effect of the association of nutrient content. Randomized Block Design consisted of four ration treatments with four blocks of liveweight as replicate was used in this study. This study used 16 bulls Bali cattle post-weaning offered rations based on dry matter were: A (100% field grass); B (80% field grass + 20% *Corypha elata robx*); C (field grass 80% + 20% *Leucaena L*) and D (grass field 80% + 10% *Corypha elata robx* + 10% *Leucaena L*). Variable measured were body composition, energy and protein requirement. Calculation of energy and protein requirements is based on measurements of body composition using the urea space technique. Blood samples were taken through the jugular vein as much as 10 ml, then injected urea physiologically with a concentration of 30% about 0.43 per kg $W^{0.75}$. After 12 minutes of injection, blood is taken to analyze the levels of urea. Protein requirements for Bali cattle are calculated by summing protein requirement for maintenance and growth. Energy requirement for growth can be calculated by dividing energy retention with corrected weight gain with partial efficiency. Results showed that the treatments caused not significantly different in consumption, weight gain, energy and protein retention. Energy and protein requirement for maintenance of post-weaning cattle in East Timor are: 0.64 $W^{0.75}$ MJ / d and 8.18 g/$W^{0.75}$ g/d, while the energy and protein requirement for growth are 14.98 ΔW MJ/d and 226.14 ΔW /d.

KEYWORDS: Local feed, energy and protein requirement, post-weaning bulls.

INTRODUCTION

Feed is serves as a source of cellular fuel and nutrients required to synthesize the molecules necessary to grow, therefore an animal must get organic precursors (carbon skeletons) and organic nitrogen sources (such as amino acids from protein breakdown) from their food intake, in order to make various variety of organic molecules (Dryden, 2008). The performance limitations of the Bali cattle post- weaning in East Timor are slow growth (Copland et al., 2003), due to: the long dry season so the grass becomes less easily digested and loses nitrogen (N) and phosphorus (P) content; feed offered not according to livestock needs, resulting in animals lacking energy and protein. The limited supply of feed has resulted in farmers using more easily available local feed such as field grass, *Corypha elata robx* and *Leucaena L.*

Field grass is a low quality feed ingredient because of its high content of crude fiber (29.96%) and low protein (10.5%), *Corypha elata robx* is an alternative feed ingredient that has potential as an energy source (3880 K.cal /Kg) while *Leucaena L* is a good source of protein (22.79%) and is preferred by livestock. The combination of the three feed ingredients is expected to complement each other so that a positive association effect can be achieved towards meeting the energy and protein requirement of bulls Bali cattle in East Timor.

Livestock have basal energy requirement that must be met to maintain metabolic functions to maintain and sustain their lives. When an animal takes more calories than the number of calories required, the body tends to accumulate excess calories in the form of glycogen or fat (Anggorodi, 1990), therefore, the determination of energy and protein requirement of post-weaning Bali cattle is very necessary. The calculation of energy and protein requirements can be done by approaching body composition measurement and changes in animal body weight to determine the amount of nutrient deposits in the body of livestock. The approach to calculating energy and protein requirements based on changes in body composition allows for simpler but more accurate calculations, compared to other calculations.

This study aims to calculate the energy and protein requirements of male Bali cattle in East Timor. This research is expected to be useful as a recommendation for the development of Bali cattle in East Timor, especially the provision of feed in the dry season.

MATERIALS AND METHODS

This study used 16 post-weaning Bali cattle. Bulls were kept in metabolic cages where each cage is equipped with a place to feed and drink. Complete Randomized Block Design (CRBD) consisting of 4 treatments with 4 groups of body weight as replications. The study has done in August 2018 - January 2019.

Table 1: Chemical composition of field grass, *Corypha elata robx* and *Leucaena L.*

Feed/Nutrient content (% DM)	Field grass	*Leucaena L.*	*Corypha elata robx*
Dry Matter	91.47	91.26	91.26
Organic Matter	87.97	92.23	95.98
Crude Protein	10.5	22.79	3.73
Crude Fiber	29.96	18.92	26.75
Crude Fat	12.22	13.97	11.55
Ingridients extract without nitrogen	26.77	27.95	65.21
TDN	24.59	50.82	74.88
NDF	64.27	56.17	57.83
ADF	35.90	30.62	32.60
ADL	28.37	25.56	25.23
Gross Energy (K.cal/Kg)	3560	3880	3460

Analysed at Nutrition and Animal Nutrition Laboratorium of Udayana University 2018

* Analysed by Meat Technology and Feed Technology Laboratorium IPB Bogor 2018

The feed given was field grass, *Corypha elata robx* and *Leucaena L* which adopting a dose of feed use by farmers in East Timor, the composition of the research ration consisted of four tratments were: A (100% field grass); B (field grass 80% + *Corypha elata robx* 20%); C (80% field grass + 20% *Leucaena L*) and D (80% field grass treatment + 10% *Leucaena L* + 10% *Corypha elata robx*). Nutrient content of feed ingredients is as presented in Table 2.

Table 2: Nutrient Content of Ration.

Nutrient (% DM)	Treatment			
	A	B	C	D
DM	91.47	91.43	91.43	91.43
OM	87.97	89.57	88.82	89.20
CP	10.5	9.15	12.96	11.05
CF	29.96	25.32	27.75	26.54
CF	12.22	12.09	12.57	12.33
Ingridients extract without nitrogen	26.77	34.46	27.01	30.73
TDN	24.59	34.65	29.84	32.24
NDF	64.27	56.17	57.83	57.00
ADF	35.90	30.62	32.60	31.61
Hemicellulosa	28.37	25.56	25.23	25.39
GE (K.cal)	3560	3540	3624	3582
Body Composition				

Animal body composition was measured using the Urea Technique (Urea Space) according to Bartle et al. (1983). This measurement was done once, at the end of the experiment. The measurement procedure was as follows: blood samples taken through the jugular vein as much as 10 ml, then injected physiologically urea with a concentration of 30% as much as 0.43 cc per kg $W^{0.75}$ into the bloodstream through the jugular vein. After 12 minutes of injection, blood was drawn from the jugular vein. The blood sample was centrifuged to get plasma fluid. Plasma fluid was analyzed to determine blood urea levels before and after the injection of the urea. Body composition can be determined by calculating the urea space using the formula

$$\text{Urea Room (\%)} \; \frac{\text{Urea injected (mg)}}{10 \times \text{body weight} \times \text{urea change (mg)}}$$

Body water, body fat and body protein are determined by the following formula: Body water (%) = 59.1 + 0.22 RU - 0.04 BH (Rule et al., 1986)

Body fat (%) = 19.5 - 1.31 RU - 0.05 BH

Body protein (%) = 16.5 + 0.07 RU + 0.001 BH

Information:

RU = Urea room (%) BH = Body Weight (Kg)

Energy Dan Protein Requirment Calculation

Nutrient deposition can be calculated by converting daily body weight gain based on body composition, while deposition of fat and protein can be calculated using the following formula:

Protein deposition (g/h) = % body protein x daily body weight gain Fat deposition (g/h) = % body fat x daily weight gain

The fat and protein deposition can be converted to energy retention, with the provision of deposition of 1 g of body protein containing 5.5 K.cal and deposition of 1 g of body fat containing 9.32 K.cal (Ørskov and Ryle, 1990). Energy retention can be determined by the following formula:

RE = (DP 5.5) + (DL 9,32)

Information:

RE = Energy retention (K.cal/day) DP = protein deposition (g/day) DL = Fat Deposition (g/day).

Protein retention can be calculated by formula:

Protein retention (g/day) = % body protein x daily weight gain. Basic life protein needs = protein consumption - total body protein.

Protein requirements for growth = (protein retention - body weight gain) / biological value of protein.

Energy requirements for growing Bali cattle are calculated by the formula: Energy requirements = (thermetabolism energy - energy retention) x 70%. Energy for growth, it is calculated using the formula: (energy retention / weight gain) x 70%.

Data Analysis

Data were analyzed using ANOVA. If there were differences among the treatments, the futher analysed using the Duncan test at 5% level according to Steel et al. (2006).

RESULTS AND DISCUSSION ANIMAL APPEARANCE

The average body weight gain of post-weaning male Bali cattle showed not significantly different (P> 0.05). The treatment A tends to give the highest weight gain (0.59 kg/day). The more *Corypha elata robx* is added in the ration (by 20% - treatment B) the smaller body weight gained (0.47 kg/day), due to the nutrient content (Table 2) in the *Corypha elata robx* is lower, in addition the mixture of field grass and *Corypha elata robx* causes consumption decreased resulting available energy was insufficient and protein precursor (N). The low of body weight gain also due to *Corypha elata robx* has a low protein content, therefore, to use *Corypha elata robx* as feed should mixed with the higher nutrient quality feed. Yuliaty (2013) used 100% *Leucaena L* on Bali cattle found weight gain of Bali cattle an the fattening phase was 0.26 kg/day (± 0.24). Magno (2018) by giving 100% *Leucaena L* on Bali cattle found an increase body weight gain of 0.50 kg/day, but if *Leucaena L* was mixed with corn straw, each 50% and 75% found body weight gain at 0.46 and 0.39 kg/day, this indicates that *Leucaena L* can be used as a supplementary material with field grass in East Timor especially when the feed is rare.

Table 3 Appearance, body composition, energy and protein retention in post-weaning Bali cattle in East Timor.

Variable	**Treatment**				
Appereance (kg/da):	**A**	**B**	**C**	**D**	**SEM**
DM Consumption	3.70^a	3.20^a	3.08^a	3.58^a	0.40
Inition Body weight	102.13	97.25	89.59	87.25	3.87
Body weight gain	0.59^a	0.47^a	0.50^a	0.57^a	0.05
In vivo Digestibility (%)					
Digestibility DM	61.59^a	60.88^a	56.79^a	67.03^a	1.61
Digestibility OM	63.49^a	71.10^a	62.67^a	71.16^a	1.52
Digestibility CP	64.58^a	65.63^a	68.22^a	72.19^a	1.32
Digestibility CF	67.69^a	64.31^a	61.16^a	69.94^a	1.94
Body Composition (%):					
EBW	59.08^a	59.11^a	59.11^a	59.10^a	15.55
Body Fat	22.33^a	21.75^a	21.47^a	21.38^a	0.37
Body Protein	16.63^a	16.62^a	16.63^a	16.63^a	0.01
Energi and protein Retention					
Energy Consumption (MJ/kg)	60.09^a	51.89^a	50.96^a	58.66^a	2.78
Energy Retention (MJ/kg)	7.34^a	5.76^a	6.11^a	7.05^a	0.45
Protein Consumption (g/d)	424.20^a	320.57^b	436.36^a	432.96^a	21.55
Retention protein (g/d)	96.80^a	77.47^a	82.63^a	96.80^a	5.07

Information:

A: ration with 100% field grass

B: rations with 80% field grass and 20% Corypha elata robx

C: ration with 80% field grass and 20% Leucaena L

D: ration with 80% field grass and 10% Corypha elata robx and 10% Leucaena L Different superscripts on the same line were significantly different ($P < 0.05$) SEM: "Standard Error of The Treatment Means"

The body weight gain was not significant due to the consumption of the fourth treatments were not different ($P > 0.05$) (Table 3), resulted all cattle had the same opportunity to consump of the available feed ingredients. Field grass is low in protein but has high palatability; Corypha elata robx has a low protein content but contains high energy so that it can function as a source of energy and *Leucaena L* can be used as a source of protein, therefore, there has been a maximum association effect of the feed ingredients provided. If the forage source has a variety of species between grasses and legumes, especially good quality plant species will improve the quality of its natural grass (Anonimous, 1978) Moreover, that the association of legumes can lead to mutually beneficial interference and symbiosis (Suarna, 2015).

Body Composition

The average of empty body water (EBW) not significantly different (Table 3). The data was higher than the results of a study by Widiadnyana et al. (2013) in Bali cattle by replacing king grass with rice straw as an energy source supplemented with *Gliricidia sepium* leaves as a degradable source of protein against body composition reported body water content in the range of 47.79 - 48.50%. The differences due to the cattle in this study was in a period of very dynamic growth so the nutrient needs are more focused on the growth process of their body tissues. Body composition varies depending on various factors including body weight, age, breed, gender and animal feed (Soeparno, 1990). Based on body water content, livestock in this study can be categorized as fat cattle. Anggorodi (1990) argues that the performance of lean cattle if their body's water levels is 43% and fat cattle if the body's water content is 64%. Cows generally have a normal water content of around 39.8 - 77.6% (Berg and Butterfield, 1976).

The EWB data indicated that the body's protein is relatively the same for all treatments, which is around 16% caused by protein in young animals was more stored as a component of muscle and bone tissue. Tillman et al. (1998) reported that the body protein percentage was not affected by food and age when maturity was achieved. However, protein levels of the body are more influenced by offspring, because many protein substances are contained in the bone muscles that make up most of the body of the animal. Widiadnyana (2013) reported that the body's protein levels of Bali cattle ranged from 16.84 - 16.90% and Putri (2011) found 16.75 – 16.77%. In this present study the cattle can be categorized as fat cattle, according to Anggorodi standard (1990) that fat animals have a 13% protein content, while according to Berg and Butterfield (1976) the normal range of cow body protein is generally 12.4 - 20.6 %.

The average proportion of body fat in cattle (Table 3) showed not significantly different (P> 0.05). The body fat was in the normal range as published by Berg and Butterfield (1976) at 1.8 - 44.6%. The body fat o the cattle in this study were below than the standard size of beef cattle (41%) by Anggordi (1990), caused by the age of the cattle is around 4-6 months, which cattle still using the energy consumed for the growth process and not for accumulating body fat. Sampurna (2013) when measured the growth of Bali cattle of various ages of growth (0 - 26 months) revealed that the fastest growth rate in ages 1- 6 months while fat accumulation occurred at the end of the growth (2 years). Kurnianto et al. (2008) stated that the inflection point in livestock is divided into three phases, firstly growth phase of body organs, brain and nervous system, then the growth phase of bone and muscle in the last phase is the growth of fat deposits.

Energy Retention

The average energy consumption, metabolic energy, energy retention, showed not significantly different (P> 0.05). Metabolic energy is used for maintaining body tissue, production, body heat and heat lost during the metabolic process (Tillman et al., 1998; Dryden, 2008). While energy retention is energy stored as a new network for the benefit of growth in the form of fat and protein (Tilman et al., 1998). If the stored energy is high, then the possibility of body weight gain will increase, so that body weight gain in this study is in line with this theory, the highest body gain in treatment A, followed by treatment D, C and lowest in treatment B. Data in Table 3 figured that the ration containing 20% Corypha elata robx in the ration (treatment B) produced the lowest energy retention followed by adding 20% *Leucaena L* (treatment C), but if the three feed ingredients are combined (treatment D) produced energy retention was higher than treatment B and treatment C and almost the same as treatment A, caused by the energy in the ration (Table 2) was almost the same, moreover, the energy formed is still used for the body's metabolic processes. During the growth of livestock, energy is mainly intended for tissue biosynthesis in the form of muscles (Irianto, 2017). Therefore, the cattle have not stored energy because the available energy is still intended for the synthesis of body tissues.

The average energy expenditure for maintenance in Bali cattle in this study was 0.64 MJ/$W^{0.75}$/day. Data in Table 3, showed that the use of Corypha elata robx in rations of post-weaning Bali cattle in East Timor caused by lower energy retention compared to when cattle fed Corypha elata robx mixed with *Leucaena L* and field grass and also lower when compared to just using field grass as single feed. Therefore, using Corypha elata robx at the farmer level in East Timor can be done when feed scarce but it is highly recommended to combine with higher quality feed ingredients. An efficient and good ration will provide enough energy for growth (Pond et al., 2005).

Protein Retention

The average consumption of crude protein post-weaning Bali cattle fed field grass, Corypha elata robx and *Leucaena L* showed not significantly different (P> 0.05) (Table 3). The lower consumption of protein in ration without Corypha elata robx is caused by Corypha elata robx being bulky so that cattle stop consuming feed when the rumen capacity is fully filled.

(Partama, 2013) stated that livestock consuming bulky feed would be limited by their gastric capacity. The protein retention average in post-weaning Bali cattle fed with field grass, Corypha elata robx and *Leucaena L* showed not significantly different (P> 0.05). This pattern of protein retention is the same as protein consumption, i.e treatment B tend to be lower. The low consumption of protein (treatment B) also results in the amount of protein that is retained lower in the ration mixed with Corypha elata robx (treatment B and D) (Table 3).

Protein retention data showed that there was a positive protein balance for all feed levels, and higher level of protein than several previous studies: Mariani (2013) reported protein retention in Balinese cattle, the age of growth ranged from 52.72 -93.49 g/day or an average of 78.45 g/day. Brown (1977) reported that tissue proteins are dynamic. Constantly tissue proteins undergo demolition and re-synthesis (constant tear and wear). To maintain the stability of tissue protein, it is necessary to input protein from the food consumed. Protein deficiency can cause slow growth and hypotonic or weak muscles (Irianto, 2017).

Energy and Protein Calculation

Based on the calculation of ME and RE, it was found that the production of heat for basic living every day in weaning Bali cattle was 0.64 MJ / W0.75, while the energy requirements for growth were 14.98 MJ/kg x body weight gain. Bali cattle with a body weight of 75 kg with an increase in body weight of 0.50 kg require 16.31 MJ / h of basic energy to live and energy for growth of 7.49 MJ/day, so that the total energy requirement is 23.80 MJ/day. If body weight is 0.75 kg/day, then the energy requirement for basic life is 16.31 MJ/day and the energy to grow is 11.24 MJ/day and the total total energy requirement is 27.55 MJ/day (Table 4).

Based on these calculations, the protein requirement for staple life in Bali cattle is 8.18 g /$W^{0.75}$/day, and protein retention for every 1 kg increase in body weight is 226.14g /kg body weight gain. Balinese beef with a body weight of 75 kg with an increase in body weight of 0.50 kg requires a basic protein for life of 153.81 g/day and protein for growth of 113.07 g/day, so the total protein requirement is 339.21 g/day. Furthermore, the total protein requirements as in Table 4.

Table 4 Protein and energy requirements for basic life and growth in weaning Balinese cattle in East Timor.

W (Kg)	Δ W (kh/day)	Protein Maintenance (g/day)	ME. Maintenance (MJ/day)	Protein for growth (g/day)	ME for Growth (MJ/day)	Total Protein (g/day)	Total ME (MJ/day)
50	0	153.81	12.03	0	0.00	153.81	12.03
	0.25	153.81	12.03	56.54	3.75	210.34	15.78
	0.5	153.81	12.03	113.07	7.49	266.88	19.52
	0.75	153.81	12.03	169.61	11.24	323.41	23.27
	1	153.81	12.03	226.14	14.98	379.95	27.01
75	0	208.47	16.31	0	0.00	208.47	16.31
	0.25	208.47	16.31	56.54	3.75	265.01	20.06
	0.5	208.47	16.31	113.07	7.49	321.54	23.80
	0.75	208.47	16.31	169.61	11.24	378.08	27.55
	1	208.47	16.31	226.14	14.98	434.61	31.29
100	0	258.67	20.24	0	0.00	258.67	20.24
	0.25	258.67	20.24	56.54	3.75	315.21	23.98
	0.5	258.67	20.24	113.07	7.49	371.74	27.73
	0.75	258.67	20.24	169.61	11.24	428.28	31.47
	1	258.67	20.24	226.14	14.98	484.81	35.22

Information:

W: body weight; Δ W: Weight gain / day; ME.HP: Thermetabolis energy for basic life; HP Protein: Protein for basic living; ME: Thermetabolis energy.

CONCLUSION

1. The energy and protein requirements for maintenance of post-weaning cattle in East Timor are: 0.64 $W^{0.75}$ MJ /day and 8.18 g / $W^{0.75}$ g / day, while for growth are 14.98 ΔW MJ / day and 226.14 ΔW g/day.
2. In order to grow a catlle 0.5 kg/day, it is recommended to provide rations with a protein content of 13-15% and metabolic energy of 11.5 MJ / kg or 2400 - 2700 K.cal / kg.

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