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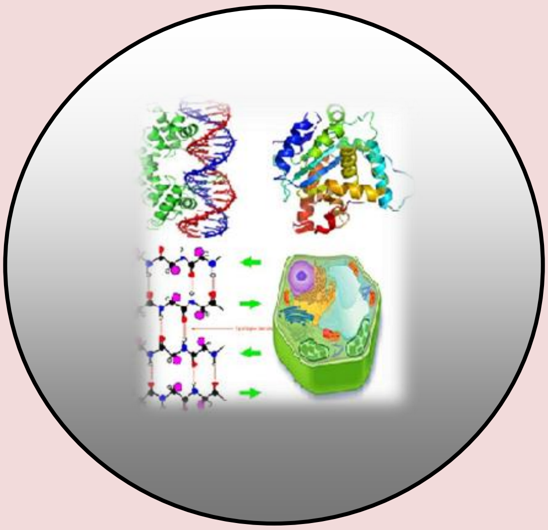

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RESEARCH PAPER

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Energy and Protein Requirement of Bali catlle Post-Weaning in East Timor

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ABSTRACT

Post-weaning cattle require a certain amount of energy and protein in order to grow optimally. This study aims to calculate the energy and protein requirements of male Bali cattle in East Timor. Randomized Block Design consisted of four ration treatments with four blocks of live weight 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% Coryphaelatarobx); C: (field grass 80%+20% Leucaena L); and D: (grass field 80%+10% Coryphaelatarobx+10% Leucaena L), repectively. 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 $W^{0.75}$. *Results showed that the treatments caused not significantly different* ($P<0.05$) *in feed consumption, weight gain, energy and protein retention. It was concluded that energy and protein requirement for maintenance of post-weaning cattle in East Timor were* $0.64W^{0.75}$ *MJ/d and 8.18* $g/W^{0.75}$ *g/d, while the energy and protein requirement for growth were 14.98* ΔW *MJ/d and 226.14* $\Delta W/d$.

Keywords: Local Feed, Energy And Protein Requirement and 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, *Coryphaelatarobx* and *Leucaena leucocepala.*

Field grass is a foor quality feed ingredient, because of its high content of crude fiber (29.96%) and low protein (10.5%), and *Coryphaelatarobx* is an alternative feed ingredient that has potential as an energy source (3880 K.cal/kg), while *Leucaena* 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 has a 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

Animals, treatments, and experimental design: 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. Randomized Block Design consisting of 4 treatments with 4 groups of body weight as replications.

Diet and Drinking Water: The four experimental diets (Table 1) based on dry matter were A: (100% field grass); B: (80% field grass+20% *Coryphaelatarobx*); C: (field grass 80%+20% Leucaena); and D: (grass field 80%+10% Coryphaelatarobx+10% Leucaena), repectively. Through all the experimental period, cattle were allowed *ad libitum* access to feed and water. The composition of ration compiler substances and nutrient which is used in diets can be seen in Table 1.

Table 1. Chemical composition of field grass, *Coryphaelatarobx*, and *Leucaena leucocepala* in East Timor.

Feed/Nutrient content (% DM)	Field grass	*Leucaena leucocepala*	*Coryphae-latarobx*
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
Ingredients extract without nitrogen (BETN)	26.77	27.95	65.21
Total digestible nutrient (TDN)	24.59	50.82	74.88
Neutral Detergent Fiber (NDF)	64.27	56.17	57.83
Acid Ditergent Fiber (ADF)	35.90	30.62	32.60
Hemicellulosa	28.37	25.56	25.23
Energi (K.cal/kg)	3560	3880	3460

Analysed at Nutrition and Chemical Laboratorium of Udayana University, Denpasar, Indonesia

The feed given was field grass, *Coryphaelatarobx* and *Leucaena* which adopting a dose of feed use by farmers in East Timor, the composition of the research ration consisted of four tratments. Nutrient content of feed ingredients is as presented in Table 2.

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 blood stream through the jugular vein.

Table 2. Nutrient Content of Ration (DM basis).

Nutrient (% DM)	Treatment			
	A	B	C	D
Dry matter	91.47	91.43	91.43	91.43
Organic matter	87.97	89.57	88.82	89.20
Crude Protein	10.5	9.15	12.96	11.05
Crude Fibre	29.96	25.32	27.75	26.54
Ether Extract	12.22	12.09	12.57	12.33
Ingredients extract without nitrogen (BETN)	26.77	34.46	27.01	30.73
Total digestible nutrient (TDN)	24.59	34.65	29.84	32.24
Neutral Detergent Fiber (NDF)	64.27	56.17	57.83	57.00
Acid Ditergent Fiber (ADF)	35.90	30.62	32.60	31.61
Hemicellulosa	28.37	25.56	25.23	25.39
Gross Energy (K.cal)	3560	3540	3624	3582

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 BW (Rule *et al.,* 1986)

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

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

Information:

RU = Urea room (%)

BW = Body Weight (Kg)

Nutrient deposition can be calculated by converting daily body weight gain based on body composition, while deposition of fat and protein were 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 gains

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 were determined by the following formula:

RE = (DP 5.5) + (DL 9.32)

Note:

RE = Energy retention (K.cal/day)

DP = protein deposition (g/day)

DL = Fat Deposition (g/day)

Protein retention were 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 were calculated by the formula: Energy requirements = (Metabolizable energy-energy retention) x 70%. Energy for growth, it was calculated using the formula: (energy retention/weight gain) x 70%.

Statistical Analysis

All data were subjected to a one-way analysis of variance test. Statistical significances among treatment means were determined by method of New Multiple Range Test of Duncan when the F value was significant at 5 % level (Steel and Torrie, 2006).

RESULTS AND DISCUSSION

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 *Coryphaelatarobx* was 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 *Coryphaelatarobx* was lower, in addition the mixture of field grass and *Coryphaelatarobx* causes consumption decreased resulting available energy was insufficient and protein precursor (N). The low of body weight gain also due to *Coryphaelatarobx* has a low protein content, therefore, to use *Coryphaelatarobx* as feed should mixed with the higher nutrient quality feed. According Yuliaty (2013), used of 100% *Leucaena* on Bali cattle found weight gain of Bali cattle at the fattening phase was 0.26 kg/day (± 0.24). Magno (2018) reported that offered of 100% *Leucaena* on Bali cattle found an increase body weight gain of 0.50 kg/day, but if *Leucaena* 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* were used as a supplementary material with field grass in East Timor especially when the feed is rare. The body weight gain was not significant due tothe 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; *Coryphaelatarobx* has a low protein content but contains high energy so that it can function as a source of energy and *Leucaena were* 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).

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

Variable	Treatment				SEM
	A	B	C	D	
Feed Consumption (kg DM/d)	3.70[a]	3.20[a]	3.08[a]	3.58[a]	0.40
Initial Body weight (kg)	102.13	97.25	89.59	87.25	3.87
Body weight gain (kg)	0.59[a]	0.47[a]	0.50[a]	0.57[a]	0.05
In vivo Digestibility (%)					
Dry matter digestibility (%)	61.59[a]	60.88[a]	56.79[a]	67.03[a]	1.61
Organic matter digestibility (%)	63.49[a]	71.10[a]	62.67[a]	71.16[a]	1.52
Crude protein digestibility (%)	64.58[a]	65.63[a]	68.22[a]	72.19[a]	1.32
Crude fibre digestibility (%)	67.69[a]	64.31[a]	61.16[a]	69.94[a]	1.94
Body Composition (%):					
Empty body water (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
ProteinConsumption (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

Note:
A: ration with 100% field grass
B: rations with 80% field grass and 20% *Coryphaelatarobx*
C: ration with 80% field grass and 20% Leucaena L
D: ration with 80% field grass and 10% *Coryphaelatarobx* and 10% *Leucaena leucocepala*
Different superscripts on the same line were significantly different (P <0.05)
SEM: "Standard Error of The Treatment Means"

The average of empty body water (EBW) not significantly (P>0.05) 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 *Gliricidiasepium* 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, sex, 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 (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). According Berg and Butterfield (1976), the body fat was in the normal range in cattle were 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) reported, 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. The average energy consumption, metabolic energy, energy retention, showed not significantly different (P>0.05). Metabolic energy was 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 the lowest in treatment B. Data in Table 3 showed that the ration containing 20% *Coryphaelatarobx* in the ration (treatment B) produced the lowest energy retention followed by adding 20% *Leucaena* (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 *Coryphaelatarobx* in rations of post-weaning Bali cattle in East Timor caused by lower energy retention compared to when cattle fed *Coryphaelatarobx* mixed with *Leucaena* and field grass and also lower when compared to just using field grass as single feed. Therefore, using *Coryphaelatarobx* 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). The average consumption of crude proteinpost-weaning Bali cattle fed field grass, *Coryphaelatarobx* and *Leucaena* showed not significantly different (P>0.05) (Table 3).

The lower consumption of protein in ration without *Coryphaelatarobx* is caused by *Coryphaelatarobx* 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, *Coryphaelatarobx* and *Leucaena* 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 *Coryphaelatarobx* (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).

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
125	0	305.80	23.93	0	0.00	305.80	23.93
	0.25	305.80	23.93	56.54	3.75	362.33	27.67
	0.5	305.80	23.93	113.07	7.49	418.87	31.42
	0.75	305.80	23.93	169.61	11.24	475.40	35.16
	1	305.80	23.93	226.14	14.98	531.94	38.91

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

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/$W^{0.75}$, 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/$W^{0.75}$ per day and protein retention for every 1 kg increase in body weight is 226.14 g/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 (Table 4).

CONCLUSION

It was concluded that the energy and protein requirements for maintenance of post-weaning cattle in East Timor were 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. In order to grow a catlle 0.5-0.75 kg/day, it was recommended to provide rations with a protein content of 13-15% and metabolic energy of 10-11.5 MJ/kg or 2400-2700 K.cal./kg.

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