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ENERGY AND NITROGEN RETENTION OF BALI HEIFERS (*Bos sondaicus*) FED DIET CONTAINING DIFFERENT ENERGY PROTEIN LEVEL

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ABSTRACT

Database of Bali heifer particularly on their nutrient digestibility, energy and nitrogen balance of various ration formulas on their growth performance were limited. A randomized block design with four types rations of metabolizable energy (ME) and crude protein ratios, i.e. of 2,045.38 kcal ME/kg:12.06% (Treatment A), 2,103.57 kcal ME/kg:13.11% (Treatment B), 2,201.85 kcal ME/kg:13.97% (Treatment C) and 2297.60 kcal ME/kg:15.05% (Treatment D) were conducted to evaluate nutrient digestibility, energy and nitrogen retention of Bali heifers. The rations consisted of concentrate, urea, molasses, king grass, coconut oil and vitamin-mineral mix. Results showed that Treatment D improved significantly of the 7,814.34 kcal/d digestible energy, 49.87 g/d digestible nitrogen, 11,015.06 kcal/d energy intake, 423.53 g/d nitrogen intake, 67.76 kcal/d energy retention, 7.91 g/d nitrogen retention, 0.33 kg/d daily weight gain (ADG), (P<0.05). In summary, ration for Bali heifer should contain at least 2,297.60 kcal ME/kg:15.05% crude protein for better average daily weight gain.

***Keywords**: Bali heifers, digestibility, energy and protein rations, retention.*

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INTRODUCTION

Bali cattle that are domesticated from originally known as wild banteng (Hardjosubroto, 1994) are indigenous and unique breed. There were about 4.8 million Bali cattle in Indonesia that contributed about 32% of total Bali cattle in Indonesia in 2018. The breed is spread throughout provinces of Indonesia providing beef supply more than 20% or the highest percentage of Indonesian meat demand (BPS, 2018).

Bali cattle are also reared in Northern Australia, South East Asia, up to Madagascar (Mohamad *et al.*, 2012). Database of Bali cattle on nutrient digestibility and energy balance of various ration formulas available locally were limited although it had big impact on the growth performance of Bali Heifer, including data and its impact on the growth performance. The knowledge will benefit the government of Indonesia as well as various countries in Asia and Africa providing sustainable meat for its inhabitants.

The energy and protein rations of beef cattle feeding system that meet the energy and protein requirements by replacement heifers are critical to achieve proper daily weight gain to their ages and body sizes. This is required for proper first mating, gestation period, first calving thus achieve their optimal productivity (Ma *et al.*, 2016). Little information about the energy and protein rations required by Bali heifers aged 9 months as well as manipulation of feedstuffs that available in smallholder farming system in Bali Province. As it is well understood, the nutrition plays an important role in the growth_performance, production and reproduction (Funston *et al.*, 2010).

This should be valid for Bali cattle. In the traditional cattle rising in Indonesia, the animals are mostly fed with low quality nutrition. Average weight gain is very low because there is no *et al.* for Bali cattle. To be able to produce Bali cattle with maximum body weight gain according to its genetic potential, it is necessary to start from heifers given nutrition that meet their requirement. Therefore, they will be able to produce healthy newly born calves achieving optimal birth weights as well as sufficient quantity of milk for their calves. This study was conducted to analyse nutrient digestibility and energy balance of various ration formulas and its impact on the growth performance of Bali heifer aged of 9 months.

MATERIALS AND METHODS

Treatments and Rations

Four ration treatments had various metabolizable energy (ME) and crude protein (CP) ratios, i.e. of 2045.38 kcal ME/kg:12.06% (Treatment A), 2103.57 kcal ME/kg:13.11% (Treatment B), 2201.45 kcal ME/kg:13.97% (Treatment C) and 2297.60 kcal ME/kg:15.05% (Treatment D) were evaluated on the digestibility and growth performance of 12 Bali heifers using a randomized block design. Twelve Bali heifers that aged of 9 months old were allocated into the four ration treatments and were observed for 12 weeks started from May to August 2016 in Sobangan Bali Cattle Breeding Centre, Bali Province. The rations consisted of concentrate, urea, molasses, king grass, coconut oil and vitamin-mineral mix (Table 1).

Each heifer was housed in an individual cage and fed with various formulations of a mixture of forage and concentrate that were given twice a day at 08.00 am and 15.00 pm. The nutrient content was calculated based on nutrition analysis at the Laboratory of Nutrition and Forage Science of Udayana University using the standard protocol of macro Kjeldahl method for protein, bomb calorie meter for energy (AOAC, 1990) (Table 2).

Table 1. The composition (%) of four rations fed to Bali heifers aged of 9 months

Composition	Treatment			
	A	B	C	D
Concentrate	36.5	40.6	44.0	47.25
Urea	0.6	0.65	0.5	0.75
Molasses	2.4	3.25	5.0	5.0
King grass	60.0	55.00	50.0	45.0
Coconut oil	0.0	0.0	0.0	1.5
Vitamin/Mineral	0.5	0.5	0.5	0.5
Total	100.0	100.0	100.0	100.0

Table 2. The nutrient content (%) of four rations fed to Bali heifers aged of 9 months

Nutrient of ration	Treatment			
	A	B	C	D
Crude Protein	12.06	13.11	13.97	15.05
ME (kcal/kg)	2,045.38	2,103.57	2,201.85	2,297.60
Crude Fiber	27.21	26.24	25.02	23.92
Calcium	0.20	0.60	1.29	1.47
Phosphor	0.57	1.02	1.81	1.97

Digestible of Nutrient

Digestible dry matter (DM), digestible organic matter (OM) and digestible nutrient were calculated based on McDonald *et al.* (2002). Dry matter and nutrient digestible were measured by total collection period for 7 days that were observed from 08:00 am until 8:00 am in the next day. Daily ration and their left over were taken and collected for the sampling of feed intake at the end of the total collection period. Individual feces collection was taken 200 g/d/head for nutrient content analysis purpose.

Energy and Nitrogen Balance

Energy and nitrogen balances were calculated based on Orskov (1990), which included Digestible energy, ME and nitrogen balances. The nitrogen balances were nitrogen intake, defecated nitrogen, absorbed nitrogen, urine nitrogen excretion, and nitrogen retention. Heifers were weighed every two weeks for the ADG and final weight. Regression and correlation were calculated by Steel and Torrie (1995).

Data Analysis

Data were computed and analysed for ANOVA and Orthogonal test using CoStat Statistic the 26th version.

RESULTS AND DISCUSSION

Digestible of Nutrient

Result showed the digestible energy of Bali heifers aged of 9 months increased by increasing protein and energy rations. The highest digestible dry matter was 70.31% that resulted in heifers treated with D ration ($P<0.05$).

Consistently, the D ration fed to Bali heifers resulted in the highest digestibility in organic matter, crude protein, crude fiber and ether extract ($P<0.05$). Increased protein and energy rations from 12.06% CP and 2,045,38 kcal ME/kg to 15.05% CP and 2,297.60 kcal ME/kg increased the digestible organic matter, crude protein and ether extract 72.07%, 73.58% and 75.27% respectively. The digestibility of crude fiber of all rations was not difference ($P>0.05$). The findings of this study indicated that increase in ME and CP levels improved the digestibility (Tabel 3) and average daily weight gain of Bali heifers aged of 9 months (Tabel 5).

This was in agreement with Eastridge (2006) who stated that the quality of ruminant livestock feed was determined by its digestibility. Furthermore, Xu *et al.*

(2014) stated that the digestibility of the feed was related to its chemical composition and its crude fiber hence essential to keep rumen condition healthy to support synthesis of microbial proteins in rumen. Ration digestibility that was defined as the part of the ration that was not excreted in the feces and urine was expressed as dry matter basis (McDonald *et al.*, 2002). Results of the present study indicated that Bali heifers required at least 15.05% CP and 2,297.60 kcal ME. Previous publications indicated that high quality of feedstuffs stimulated the IGF-I and insulin hence improved performance of ruminant livestock (Sartori *et al.*, 2013). Result of the present study showed the D ration contained of 2,297.60 kcal ME/kg ration and 15.05% CP generated digestible energy 7,814 kcal/d (Table 4) was lower than digestible energy 12,208.86 kcal/d of ration containing 3,109 kcal GE/kg ration and 12.05% CP when fed to fattening Bali cattle (Suryani *et al.*, 2019). This finding was similar to Dong *et al.* (2017) who reported that The dry matter, crude protein, and energy digestibility increased significantly by increasing CP: GE rations fed to Chinese Holstein heifers.

Table 3. Effect of level energy protein rations on digestible nutrient (g/d) of Bali heifers aged of 9 months

Variables	Treatment				SEM
	A	B	C	D	
Digestible dry matter %	59.88[a]	64.08[ab]	65.32[ab]	70.31[b]	2.35
Digestible organic matter %	60.80[a]	65.13[ab]	66.76[ab]	72.07[b]	2.28
Digestible crude protein %	63.58[a]	68.25[ab]	70.09[ab]	73.58[b]	2.54
Digestible crude fiber %	65.68	61.88	64.59	67.48	4.01
Digestible ether extract %	57.72[a]	59.68[a]	65.25[ab]	75.27[b]	3.34

Means in a row with different superscripts differed significantly at the .05 level.
The means were compared using Duncan method
SEM = *"Standard Error of the Treatment Means*".

Energy digestibility had high positive correlation with energy intake that had an equation of Y = 0.7825x + 5000.3 and R^2=0.908 (P<0.05) as shown by C and D rations fed to Bali heifers. The availability of energy and protein contents as well as digestible energy and digestible protein of C and D rations increased the energy (Tabel 4) and nitrogen intake (Tabel 5) of Bali heifers aged 9 months. Heifers showed significant increase of ADG when fed C and D rations containing 2,201.85 to 2,297.60 kcal ME/kg ration and 13.97 to 15.05% CP (Table 5). The correlation between energy intake and ADG had an equation of Y = 0.0145x + 199.55 and R^2 =0.8834; then between nitrogen intake and ADG that had an equation of Y = 0.2363x + 191.44 and R^2 =0.80739.

Nutrient digestibility and growth performance of Bali heifers were important in preparing first puberty, first mating, gestation period, calving and first milk production (Lohakare *et al.*, 2012; Brown *et al.*, 2005). This was in agreement with Lohakare *et al.* (2012) who stated that providing sufficient energy and protein content of rations stimulated growth performance for proper body size and age of puberty, hence early mating and early calving thus improve productivity of livestock. Furthermore, sufficient concentrations of dietary CP promoted rapid growing pre-pubertal heifers may stimulate mammary development and increased first lactation yield. It is recommended that ration containing 14 to 15% CP for pre-pubertal heifers (Heinrichs, 2017) and a balanced diet (Koch *et al.*, 2017). Heifers feeding with high diet at the beginning period will reduce growth rate after weaning (Brown *et al.*, 2005). Growth performance was affected by level of DE: CP and breed of livestock (Li *et al.*, 2014).

Energy and Nitrogen Balance

Results in the present study indicated that increase of energy and protein in C and D rations increased significantly energy intake and digestible energy of Bali heifers ($P<0.05$) while metabolizable energy and energy retention were significantly higher in Bali heifers fed with D ration ($P<0.05$) (Table 5). It is predicted that feeding Bali heifers longer than 12 weeks of observation with ration containing 2,297.60 kcal ME/kg: CP 15.05% will improve digestible energy, digestible protein, energy intake, nitrogen intake, energy retention, nitrogen retention, and ADG. Reported that Fries Holstein heifers aged 9 months that had initial body weight of 240.7 kg when were fed with 2470 kcal ME/kg: CP 10.2% resulted in ADG 799.9 g/d with the crude protein intake was 695.3 g/d. The present study showed that Bali heifers aged 9 months that had initial body weight of 101.7 kg when were fed with 2,297.60 kcal ME/kg with the crude protein intake was 423.53 g/d. Calculations were taken due to that Bali heifers were beef cattle that had lower initial body weights, dry matter intake were lower than of FH breed. Dry matter intake of Bali heifers in the present study was 2.33% of final body weight while dry matter intake of fattening Bali bulls aged 18 months was 2.29% (Suryani *et al.*, 2012) and dry matter intake of Bali heifers aged 24 months was 1.91% (Suryani *et al.*, 2017). This finding was confirmed by Suryani *et al.* (2012) and (2017) who reported that Bali cattle aka small size tropical cattle breed had lower dry matter intake (1.91%-2.33%) along with the lower quality rations due to higher crude fiber.

Table 4. Effect of level energy protein rations on energy balance (kcal/d) of Bali heifers aged of 9 months

Variable	Treatment				SEM
	A	B	C	D	
Energy intake	9,531.6a	9,509.7^{a}	10,740.5^{b}	11,015.1^{b}	232.39
Fecal energy	3,897.0	3,385.8	3,738.7	3,200.7	211.91
Digestible energy	5,634.7^{a}	6,123.9^{ab}	7,001.8^{bc}	7,814.3^{c}	381.25
Urinary energy	300.4^{a}	343.8^{a}	429.6^{b}	491.0^{b}	23.79
Methane energy	762.53^{a}	760.78^{a}	859.24^{b}	881.21^{b}	18.59
Metabolizable Energy	4,571.8^{a}	5,019.3^{a}	5,712.9^{ab}	6,442.2^{b}	342.98
Energy Retention	610.6^{a}	614.8^{a}	661.9^{ab}	730.7^{b}	25.72
Heat production	3,769.9^{a}	4,202.4^{a}	4,885.5^{ab}	5,552.6^{b}	362.40

Energy balances were calculated based on standard method Ørskov (1990).
Means in a row with different superscripts differed significantly at the .05 level.
The means were compared using Duncan method
SEM = *"Standard Error of the Treatment Means*".

Other findings of this study were that the increased energy ration enhanced energy intake, digestible energy, metabolizable energy, energy retention, as well as the digestible nutrien. However, high energy ration were also excreted in urine as the results showed that urine energy and methane energy as well as urine nitrogen were also significantly increased in our study. Therefore, it is recommended to feed Bali cattle with higher crude protein with sufficient energy ration. This was confirmed by Koch *et al.* (2017) that a balance of primarily for crude protein was 13.85 to 14.64% for pre pubertal heifers.

The increase of nitrogen retention of treatment B, C, and D in this study was due to the increase of nitrogen intake. Protein degradation has been reported to influence the ruminal fermentation, thus influence nutrient absorption. Optimum microbe protein synthesis enhanced the efficiency of N-use and decreased its secretion in urine (Gabler and Heinrichs, 2003).

Table 5. Effect of level energy protein rations on nitrogen balance (g/d) of Bali heifers aged of 9 months

Variable	Treatment				SEM
	A	B	C	D	
Nitrogen intake	51.42[a]	53.67[a]	62.85[b]	67.76[c]	1.37
Fecal Nitrogen	18.60	17.03	18.77	17.90	1.06
Digestible Nitrogen	32.82[a]	36.66[a]	44.08[b]	49.87[b]	2.00
Urinary Nitrogen	25.67[a]	29.38[a]	36.72[b]	41.96[b]	2.03
Nitrogen Retention	7.15	7.26	7.36	7.91	0.37
Average Daily Weight Gain (ADG)	0.27[a]	0.27[a]	0.32[b]	0.33[b]	0.82

Means in a row with different superscripts differed significantly at the .05 level.
The means were compared using Duncan method
SEM = *"Standard Error of the Treatment Means*".

As protein intake increased and so did the growth performance of Bali heifers aged 9 months which is reflected by the weight gain (ADG) ($P<0.05$) (Table 5). However, the dry matter intake and ADG in the present study were lower than 4,650 g/d and 1,170 g/d, respectively, of Friesian crossbred heifers reported by Devant *et al.* (2000). This seemed to be related to genetic factor of Bali cattle as well as the low level of growth hormone as previously published (Suwiti *et al.*, 2017).

CONCLUSION

Based on these result, it can concluded that energy and protein ration containing 2,297.60 kcal ME/kg:15.05% improved all parameters significantly on digestible energy, digestible protein, energy intake, energy retention, nitrogen retention, and 0.33 kg/d daily weight gain (ADG). Result suggest that ration for Bali heifer should contain at least 2,297.60 kcal ME/kg:15.05% crude protein for better growth performance.

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CONFLICT OF INTEREST DECLARATION

We certify that there is none of the authors has any conflict of interest to declare.

REFERENCES

AOAC. (1990). *Official Method of Analysis*.

Brown, E. G., VandeHaar, M. J., Daniels, K. M., Liesman, J. S., Chapin, L. T., Keisler, D. H., & Nielsen, M. S. W. (2005). Effect of increasing energy and protein intake on body growth and carcass composition of heifer calves. *Journal of Dairy Science*, *88*(2), 585–594. https://doi.org/10.3168/jds.S0022-0302(05)72722-3

Cole, H., & Ronning, M. (1974). *The Biology of Domestic Animals and Their use by Man*. Animal Agricultural.

Devant, M., Ferret, A., Gasa, J., Calsamiglia, S., & Casals, R. (2000). Effects of protein concentration and degradability on performance, ruminal fermentation, and nitrogen metabolism in rapidly growing heifers fed high-concentrate diets from 100 to 230 kg body weight. *Journal of Animal Science*, *78*(6), 1667–1676. https://doi.org/10.2527/2000.7861667x

Dong, L. F., Zhang, W. B., Zhang, N. F., Tu, Y., & Diao, Q. Y. (2017). Feeding different dietary protein to energy ratios to Holstein heifers: effects on growth performance, blood

metabolites and rumen fermentation parameters. *Journal of Animal Physiology and Animal Nutrition*, *101*(1), 30–37. https://doi.org/10.1111/jpn.12493

Eastridge, M. L. (2006). Major advances in applied dairy cattle nutrition. *Journal of Dairy Science*, *89*(4), 1311–1323. https://doi.org/10.3168/jds.S0022-0302(06)72199-3

Funston, R. N., Larson, D. M., & Vonnahme, K. A. (2010). Effects of maternal nutrition on conceptus growth and offspring performance: Implications for beef cattle production. *Journal of Animal Science*, *88*(suppl_13), E205–E215. https://doi.org/10.2527/jas.2009-2351

Gabler, M. T., & Heinrichs, A. J. (2003). Altering soluble and potentially rumen degradable protein for prepubertal holstein heifers. *Journal of Dairy Science*, *86*(6), 2122–2130. https://doi.org/10.3168/jds.S0022-0302(03)73802-8

Hardjosubroto, W. (1994). *Aplikasi Pemuliabiakan Ternak di Lapangan*. Gramedia.

Heinrichs, J. (2017). Precision Feeding Dairy Heifers: Strategies and Recommendations. *Penn State Extention*. The Pennsylvania State University

ILCA. (1990). *Livestock Systems Research Manual*. International Livestock Centre for Africa.

Koch, L. E., Gomez, N. A., Bowyer, A., & Lascano, G. J. (2017). Precision-feeding dairy heifers a high rumen-undegradable protein diet with different proportions of dietary fiber and forage-to-concentrate ratios. *Journal of Animal Science*, *95*(12), 5617–5628. https://doi.org/10.2527/jas2017.1974

Li, L., Zhu, Y., Wang, X., He, Y., & Cao, B. (2014). Effects of different dietary energy and protein levels and sex on growth performance, carcass characteristics and meat quality of F1 Angus × Chinese Xiangxi yellow cattle. *Journal of Animal Science and Biotechnology*, *5*(1), 21. https://doi.org/10.1186/2049-1891-5-21

Lohakare, J. D., S체dekum, K.-H., & Pattanaik, A. K. (2012). Nutrition-induced changes of growth from birth to first calving and its impact on mammary development and first-lactation milk yield in dairy heifers: a review. *Asian-Australasian Journal of Animal Sciences*, *25*(9), 1338–1350. https://doi.org/10.5713/ajas.2012.12282

Ma, T., Xu, G.-S., Deng, K.-D., Ji, S.-K., Tu, Y., Zhang, N.-F., & Diao, Q.-Y. (2016). Energy requirements of early-weaned Dorper cross-bred female lambs. *Journal of Animal Physiology and Animal Nutrition*, *100*(6), 1081–1089. https://doi.org/10.1111/jpn.12481

McDonald, P., Edwards, A., Greenhalg, J. F., & Morgan, C. (2002). *Animal Nutrition* (6th ed.). Longman Scientific and Technical Co.

Mohamad, K., Olsson, M., Andersson, G., Purwantara, B., Van Tol, H., Rodriguez-Martinez, H., Colenbrander, B., & Lenstra, J. (2012). The origin of Indonesian cattle and conservation genetics of the Bali cattle breed. *Reproduction in Domestic Animals*, *47*, 18–20. https://doi.org/10.1111/j.1439-0531.2011.01960.x

Ørskov, E. (1990). *Energy Nutrition in Ruminant*. Elsevier Applied Science.

Sartori, R., Guardieiro, M. M., Surjus, R. S., Melo, L. F., Prata, A. B., Ishiguro, M., Bastos, M. R., & Nascimento, A. B. (2013). Metabolic hormones and reproductive function in cattle. *Anim. Reprod*, *10*(3), 199–205.

Steel, R. G., & Torrie, J. (1995). *Priciples and Procedures of Statistic*. McGraw-Hill Book Co. Inc.

Suryani, N.N. (2012). *Activities of mirobial rumen and productivity of Bali cattle fed with different type and composition of forage*. Udayana University.

Suryani, N.N, Mahardika, I., & Sarini, N.

(2017). *Accelaration of fulfioment of national meat demand through improvement of quality cows and calves of Bali cattle*.

Suryani, Ni Nyoman, Mahardika, I. G., Sujaya, N., & Gunawan, A. A. (2018). Increased gliricidia sepium in ration containing rice straw on rumen fermentation and microbial protein synthesis of indigenous Bali cattle. *Advances in Animal and Veterinary Sciences*, *7*(3), 193–199. https://doi.org/10.17582/journal.aavs/2019/7.3.193.199

Suwiti, N. K., Besung, I. N. K., & Mahardika, G. N. (2017). Factors influencing growth hormone levels of Bali cattle in Bali, Nusa Penida, and Sumbawa Islands, Indonesia. *Veterinary World*, *10*(10), 1250–1254. https://doi.org/10.14202/vetworld.2017.1250-1254

Xu, J., Hou, Y., Yang, H., Shi, R., Wu, C., Hou, Y., & Zhao, G. (2014). Effects of forage sources on rumen fermentation characteristics, performance, and microbial protein synthesis in midlactation cows. *Asian-Australasian Journal of Animal Sciences*, *27*(5), 667–673. https://doi.org/10.5713/ajas.2013.13604

Zhang, B., Wang, C., Liu, H., Liu, J., & Liu, H. (2016). Effects of dietary protein level on growth performance and nitrogen excretion of dairy heifers. *Asian-Australasian Journal of Animal Sciences*, *30*(3), 386–391. https://doi.org/10.5713/ajas.16.0214