Effect of Urea or Coconut Cake Supplementation on Nutrient Intake and Digestion of Bali Cows Maintained on Tropical Grass Hay

I.G.N. JELANTIK and H.L.L. BELLI

Faculty of Animal Science, The University of Nusa Cendana Kupang, Indonesia

(Diterima dewan redaksi 22 Juni 2010)

ABSTRAK

JELANTIK, I.G.N dan H.L.L. BELLI. 2010. Pengaruh penambahan urea atau bungkil kelapa terhadap konsumsi dan kecernaan pada sapi Bali yang diberi jerami rumput tropis. *JITV* 15(3): 196-204.

Sebanyak tiga ekor sapi Bali betina induk yang dilengkapi dengan kanula rumen diberi tiga jenis ransum yang berbeda yaitu pakan dasar berupa 2 kg bahan kering (BK) hay berkualitas sedang (Protein Kasar, PK = 7,47%) bersama-sama dengan hay berkualitas rendah yang diberikan secara *ad libitum* (HH) atau disuplementasi dengan urea (HU) atau bungkil kelapa (HC) pada aras nitrogen yang sama. Penelitian ini dirancang menurut rancangan bujur sangkar latin 3 x 3 dengan tujuan mengkaji pengaruh suplementasi urea atau bungkil kelapa terhadap konsumsi hay berkualitas rendah, pasokan nutrisi dan pemanfaatan nitrogen oleh Sapi Bali. Perubahan lingkungan rumen dan degradasi bahan kering dan protein di dalam rumen juga dikaji dalam penelitian ini. Suplementasi urea maupun bungkil kelapa tidak mampu meningkatkan konsumsi hay, akan tetapi konsumsi secara keseluruhan lebih tinggi (P < 0,05) pada ternak yang mendapatkan suplemen bungkil kelapa (HC) dibandingkan dengan ternak yang mendapatkan perlakuan lainnya (HH dan HU). Suplementasi bungkil kelapa juga meningkatkan kecernaan lemak kasar (EE), karbohidrat (CHO) dan energi bruto (GE) tetapi tidak mampu meningkatkan kecernaan NDF. pH cairan rumen meningkat (P < 0,05) dengan pemberian urea dan menurun (P < 0,05) dengan suplementasi bungkil kelapa. Kedua jenis suplemen yang diberikan meningkatkan konsentrasi ammonia rumen. Namun demikian, konsentrasi VFA, baik total maupun secara individu (asam asetat, propionate dan butirat) tidak dipengaruhi oleh pemberian kedua suplemen tersebut. Degradabilitas bahan kering dan NDF di dalam rumen cenderung meningkat pada ternak yang mendapatkan suplementasi urea tetapi tidak pada ternak yang mendapatkan suplemen bungkil kelapa. Suplementasi bungkil kelapa secara nyata meningkatkan imbangan protein pada ternak sapi Bali yang mengkonsumsi hay rumput alam. Sebaliknya suplementasi urea gagal meningkatkan imbangan protein pada ternak tersebut. Disimpulkan bahwa bungkil kelapa merupakan suplemen yang lebih baik dibandingkan dengan urea untuk meningkatkan kecernaaan dan suplai nutrisi pada sapi Bali yang mengkonsumsi hay rumput alam berkualitas rendah.

Kata Kunci: Sapi Bali, Urea, Bungkil Kelapa, Kecernaan

ABSTRACT

JELANTIK, I.G.N and H. L.L. BELLI. 2010. Effect of urea or coconut cake supplementation on nutrient intake and digestion of Bali cows maintained on tropical grass hay. *JITV* 15(3): 196-204.

Three rumen cannulated Bali cows were fed basal diet consisting of about 2 kg DM of medium quality grass hay (CP = 7.47%) together with *ad libitum* amount of low quality grass hay (CP = 3.5%) (HH). In the supplemented rations, this basal ration was supplemented with isonitrogenous amount of urea (HU) or coconut cake (HC). The experimental was on design 3 x 3 *latin square* aiming to study effects of different source of nitrogen supplementation on the intake of poor quality hay (PQH), total diet, nutrients supply and nitrogen utilisation by the animals. Changes in rumen environment and dry matter and protein degradation after supplementation were also investigated. Neither urea or coconut cake (CC) supplementation increased hay intake but the total dry matter intake was significantly higher (P < 0.05) in HC than in HH and HU. Digestibility of EE, CHO and GE but not NDF were also improved with CC supplementation. In contrast, CC supplementation tended to depress CF apparent digestibility. Rumen pH was significantly elevated (P < 0.05) with urea but it was reduced (P < 0.05) with CC supplementation. Both supplements increased rumen ammonia concentration, while total as well as individual VFAs remained unaffected. Dry matter and NDF rumen degradability tended to increase with urea but not with CC supplementation. Supplementation with coconut cake markedly improved protein balance while it was unimproved with urea supplementation.

Key Words: Bali Cows, Urea, Coconut Cake, Digestion

INTRODUCTION

Cattle production in west Timor is very much relying on herbage available at natural pastures. JELANTIK (2001) reported that grass availability and particularly quality are greatly fluctuated according to season. Reasonable grass quality is only available in a short period during early rainy season and it falls to very low quality as approaching maturity and advancing dry season. Thus, for most of the time, Bali cattle shall live on poor quality grass with 2 – 4% CP with only 40% digestibility (JELANTIK, 2001). When the diet is solely composed of such grass, supplementation with protein rich feeds is strongly needed (JELANTIK *et al*., 2008). Due to its extremely high nitrogen content and low price, urea has been the most commonly utilised source for such purpose either given directly, sprayed or with different carriers. However, in areas where urea is not available or it becomes unaffordable by smallholder tenant farmers, locally available protein source will be very much in favour.

Coconut cake is one example of various protein sources that are available in west Timor. It is the soluble fraction after traditional oil extraction by boiling. In Timor, coconut cake has not been used much in cattle feeding although it has been traditionally constituted a major part of pig diets. Its potency as a ruminant feed was shown by JELANTIK (2002) since supplementation of coconut cake significantly improved utilisation of low quality grass by Kacang goats. This could indicate that it may have great potential as a supplement to cattle particularly during the dry season.

The purpose of the present experiment is to asses whether coconut cake, in comparison to urea, has beneficial effect on the utilisation of grass hay by mature Bali cows.

MATERIALS AND METHOD

Animals, experimental design and diets

Three mature dry Bali cows fitted with permanent rumen fistula and weighing 189.3 kg in average were used in this experiment which was done based on a 3 x 3 *Latin* square experimental design. All animals were allowed to *ad libitum* access to poor quality hay (PQH). In addition, all cows were offered 2 kg DM medium quality hay (MQH) and either supplemented with 74 grams of urea (HU) or 0.677 kg coconut cake (HC), which was made iso-nitrogenous to HU. Diets were offered twice daily at 08^{30} and 16^{30} in equal amount. The supplements were given before PQH was offered to the cows. Urea was mixed with the MQH. The rations and the chemical composition of feeds used to compose the rations are presented in Table 1 and 2. Cows supplemented with urea also received 5.7 grams of sodium sulphate in a ratio of 1:13 to urea. Water was offered more than six times a day in a plastic bucket, thereby it might be considered as free access.

This experiment was run for three periods each lasting for three weeks. Each period consisted of two weeks adjustment and followed by one week collection.

Table 1. The composition of experimental diets in three treatments, i.e. hay alone (HH), and supplemented with urea (HU) and coconut cake (HC)

Ingredient	HH	HU	HC
Poor quality hay (PQH)	*ad libitum*	*ad libitum*	*ad libitum*
Medium quality hay (MQH) (kg DM)	2.015	2.015	2.015
Coconut cake (CC) (kg DM)	-	-	0.667
Urea (kg DM)	-	0.074	-
Sodium sulphate (kg DM)		0.0057	-

Table 2. Chemical composition of feeds used in the experiment (% of DM)

Chemical composition	Poor quality hay	Medium quality hay	Coconut cake	Urea
Crude protein (CP)	3.40	6.47	35.30	288
Ether extract (EE)	1.52	1.77	16.70	-
Crude fibre (CF)	27.10	24.4	2.04	-
Ash	4.70	6.7	12.70	-
Organic matter (OM)	95.30	93.3	87.30	100
Neutral detergent fibre (NDF)	72.70	70.8	10.10	-

Parameters, measurements and calculations

Hay refusal was removed daily before morning feeding and it was composed only by PQH since MQH was completely consumed. Daily sampling of feeds on offered and refusal was done during the last week of each period. The daily collected refusal was sampled to be immediately determined for dry matter content. The feed samples were bulked and stored for the whole experiment.

Dry matter intake (DMI) was calculated as the difference between offered DM and refusal DM. Nutrient intake was estimated as dry matter intake times its nutrient content. Daily faecal production was estimated by total faecal collection for five consecutive days during the third week of each period. One-day collected faeces was weighed every morning, mixed thoroughly, about 5% was sampled to form a composite sample by cow and immediately frozen. Dry matter determination was done daily on faecal samples to assess dry matter of faecal output. At the end of each experimental period, the composited faeces were thawed, mixed, sub-sampled and dried at low temperature (40^{o}C) in a forced air oven for two days. Dried faecal samples were further ground to pass 1 mm screen and stored before chemical analyses (proximate and detergent analyses). Digestibility coefficient of DM, OM, EE, NFE, CP and NDF were calculated by each difference.

In sacco nylon bag technique was used in this study to estimate ruminal degradation of dry matter, protein and protein-free dry matter. The last was estimated by subtracting protein from DM residues. Feeds were ground to pass 1.5 mm screen and about 1 g of the sample was then weighted into 7.5 x 10 cm bag made of nylon cloth with a pore size of 37 x 37 μm^2. The bags were tied on a rubber stopper, which was mounted to a plastic tube with a 200 gram sinker. The bags were thereafter incubated in the rumen for 0, 4, 8, 16, 24, 48, and 96 hours. At time of removal, the bags were then directly frozen. After all bags have been removed from the rumen, they were washed under running tap water for 1 hour. The residues were transferred from the bag into nitrogen-free filter paper and dried at 105°C for 20 hours.

The disappearance of DM as well as other nutrients from bags after rumen incubation and washing was used to estimate their degradability in the rumen. The degradation data were then fitted to the exponential equation using a simultaneous model (MLAY *et al*., 2003):

$$Y(t) = a \qquad \text{for } t \le t_0$$

$$Y(t) = a + b\ (1-e^{-c\,(t - t_0)}) \qquad \text{for } t > t_0$$

Where:

Y(t) = the degraded part at time t
a = the water soluble fraction
b = the insoluble but potentially degradable fraction
c = the degradation rate constant (in h^{-1})
t = the incubation time (in h)
t_0 = the lag time (in h)

Whereas, the effective degradability (ED) was calculated as:

$$ED = a + ((bc/(c+k)) \times e^{-kt_0})$$

where = a, b and c values are from the previous model and k is the fractional rate of passage.

Nitrogen balance was estimated at the same time as the digestion trial. Daily urine was collected using a funnel fixed onto the vulva and collected in a properly sealed big plastic jar in which about 200 ml of 17% (w/v) H_2SO_4 was added. The 24-hour collected urine was recorded and sampled before morning feeding and the samples were immediately frozen and composited by cow in that period. The urine sample was then analyzed for total nitrogen. Nitrogen balance was estimated by difference between nitrogen intake and that recovered in urine and faeces.

The protein balance in the rumen (PBV) was calculated as: PBV, g/kg DM = crude protein, g/kg DM x degradability in the rumen - microbial protein produced. Microbial protein synthesis was estimated to be 179 g/kg digestible carbohydrate (MLAY *et al*., 2003).

To estimate rumen pH and ammonia concentration as well as the diurnal variations, rumen fluid was collected over 24 hours at the last day of the third week. It was collected using a vacuum pump at 2 hours interval. The collected rumen fluid was directly measured for pH and thereafter centrifuged and acidified to pH < 4 and frozen until analysis for ammonia and VFA. VFA concentration was determined on pooled sample per cow and period.

Chemical analyses

Dietary ingredients, residues, and faeces were analysed for nutrient contents. The samples were dried in a forced-air oven at 40^{o}C for 72 hours, ground using a willey mill (1 mm screen) and analysed for crude protein, EE, ash, CF, and NDF. Ash content was determined by ignition in a furnace at 600^{o}C for 4 hours. Total nitrogen content was determined using Kjeldahl technique and crude protein is calculated as N x 6.25. Those analyses were following AOAC (1990). NDF content was determined using detergent analysis excluding the use of alpha-amylase enzyme. Individual

VFAs were assayed using HPLC and the sum was assigned as total VFA. Ammonia-nitrogen was determined using steam distillation technique. Whereas, the energy value of feedstuffs and faecal matter was calculated from their content of crude protein, ether extract and carbohydrates.

Statistical analyses

All data were statistically analyzed using the general linear model procedure (SAS Institute, 2000). The model used was suited to Latin square experimental design:

$$Y = \mu + C + P + T + E$$

where:
μ = overall mean
P = effect of period
C = effect of cow
T = effect of treatment
E = residual error

RESULTS AND DISCUSSION

Dry matter and nutrients intake

Supplementation of both urea and coconut cake to poor quality hay (PQH) tended to increase the hay intake comparably. Consequently, similar trend was observed for total hay intake since medium quality hay (MQH) was given at similar level to all cows. Those increases however did not reach significant level. In contrast, total dry matter intake and the intake of OM, EE, NFE, CHO and GE were significantly higher in HC than in HU and HH. The increase in the intake obtained by urea supplementation was small and insignificant. The superiority of CC over urea was undetected for fibre intake (CF and NDF) where in general treatment effect was also absent. Whereas, for CP intake, as planned, both supplements significantly increased intake at comparable level.

The average hay intake in the present experiment is apparently 15 to 61% higher compared even to the highest total DM intake after fishmeal supplementation in the previous experiment (JELANTIK, 2001). This higher intake was obtained by replacing about half of PQH with medium quality grass hay which contains about 7.5% crude protein. The result demonstrates that intake can be considerably increased by simply replacing part of the poor quality hay with a better one. In addition to additional protein supply, LENG (2003) described this effect as a natural phenomenon when more easily fermentable carbohydrates is supplemented to LQR, this will soon be heavily colonised by microbes and in turn ‘seed’ bacteria onto the less digestible cell wall. This is likely to occur since microbes colonising the newly entering feed is coming from particle-associated micro-organism rather than from free-floating microbes.

The increase of DM intake resulted from urea supplementation in the present experiment was small and insignificant. This indicates that urea cannot be effective to increase the utilisation of medium quality

Table 3. Effect of supplementation of urea (HU) or coconut cake (HC) to poor quality tropical grass hay (HH) on dry matter and nutrients intake of Bali cattle

Intake	Treatment			SEM	P
	HH	HU	HC		
Poor quality hay (kg/d)	1.46	1.64	1.67	0.07	0.30
Total grass (kg/d)	3.48	3.66	3.69	0.07	0.30
Total (kg/d)	3.48[a]	3.74[b]	4.35[c]	0.07	0.02
Organic matter (kg/d)	3.27[a]	3.52[b]	4.05[c]	0.07	0.03
Crude protein (g/d)	200.00[a]	420.00[b]	442.00[b]	2.38	<0.01
Ether extract(g/d)	57.90[a]	60.60[a]	172.00[b]	1.06	<0.01
Crude protein (kg/d)	0.89	0.94	0.96	0.02	0.20
Carbohidrate (kg/d)	3.01	3.04	3.44	0.06	0.07
Nitrogen fee extract (kg/d)	2.13[a]	2.10[a]	2.48[b]	0.04	0.04
Neutral detergent fibre (kg/d)	2.49	2.62	2.71	0.05	0.20
Digestible energy (MJ/d)	26.60	29.90	39.10	1.93	0.08
Gross energy (MJ/d)	59.00[a]	64.80[a]	76.10[b]	1.19	0.02

Values at the same row followed by different letter show significant difference ($P < 0.05$)

grass hay. Compared to result of the previous experiment by JELANTIK (2001) where urea was highly effectively improve intake of low quality grass hay containing 3.53% crude protein, the quality hay in the present experiment was higher, i.e. 6.4%. This finding demonstrates a need for different supplementation strategies for different quality grass hay basal diets. For medium quality grass hay, supplementation of coconut cake as applied in this experiment is far more beneficial compared to urea supplementation. It is shown in this experiment that even when supplementation of CC seems to depress rumen degradation, all the CC offered was completely consumed by Bali cows without any apparent depression in hay intake. Consequently, coconut cake supplementation increased total intake significantly without any apparent substitution effect.

Digestibility

Despite the notable effect of supplementation on nutrient intake, there was no significant effect observed for their apparent digestibility. However, improvement did occur, though numerically, in CP, EE, CF, CHO and gross energy. Digestibility of CP is higher in urea supplemented cows than in coconut cake supplemented cows. In contrast, improvement in digestibility of EE, CHO, GE was higher with coconut cake than with urea supplementation. Whereas, NDF digestibility was not different among treatments. There was apparently a slight depression in CF digestibility with CC supplementation (Table 4).

Rumen parameter

Both supplements significantly ($P < 0.05$) affected the average rumen pH. Urea supplementation elevated rumen pH. Conversely, it was depressed with coconut cake addition. Across treatments, diurnal fluctuation was apparent in HU and HH but not in HC. Rumen pH increased after feeding and being low during midnight. At all times, it was consistently highest in HU and lowest in HC. Significant level occurred at only one time, i.e. at 23.00.

Rumen ammonia concentration was very much improved by supplementation. As expected, the average concentration was highest in HU (217 mg/l) and the lowest in HH (26.7 mg/l), while HC was intermediate (62.5 mg/l). The diurnal pattern of ammonia concentration followed the pattern of pH. Ammonia concentration in HH remained low throughout the day. Whereas, both urea and coconut cake increased ammonia concentration with a peak soon after feeding. The expected different diurnal pattern between the two supplements was not observed.

As presented in Table 6, supplementation in general did not modify the product of fermentation in the rumen and so other parameter. In fact, total VFA concentration is the highest in control group and the lowest in animal that were supplemented with coconut cake. However, the proportion of propionate was increased by supplementation. The propionate proportion appeared to be high (30 – 34%), while butyrate (1.4 – 3.4%) was low for normal forage-fed animals.

The failure to obtain an improved intake and rumen degradation in the present experiment is quite surprising since rumen ammonia concentration is significantly improved by supplementation of both urea and coconut cake. Moreover, average rumen ammonia concentration in HH is well below 50 mg/l as suggested by SATTER and SLYTER (1974) to be the threshold under which rumen fermentation is sub-optimal. This therefore indicates that the inclusion of better quality hay was still unable to eliminate the nitrogen shortage in the rumen. If the rumen fermentation is limited by nitrogen then the rumen degradation of grass hay and

Table 4. Digestibility coefficients of dry matter and different nutrients in Bali cattle consuming low quality grass hay (HH) supplemented with either urea (HU) or coconut cake (HC)

Parameter	Treatment			SEM	P
	HH	HU	HC		
Dry matter (%)	42.4	42.2	48.5	2.53	0.3
Crude protein (%)	33.0	66.2	52.1	8.41	0.2
Ether extract (%)	54.2	56.8	71.3	6.11	0.3
Crude fibre (%)	26.2	26.6	22.4	5.95	0.9
Organic matter (%)	45.2	44.8	50.4	2.51	0.4
Neutral detergent fibre (%)	41.3	39.9	41.6	2.56	0.9
Carbohydrates (%)	45.8	41.6	49.2	2.93	0.4
Gross energy (%)	45.0	46.0	51.3	2.35	0.3

Table 5. Daily digestible nutrients intake by cows fed native grass hay (HH) supplemented with either urea (HU) or coconut cake (HC)

Parameter	Treatment			SEM	P
	HH	HU	HC		
DDMI (kg)	1.48	1.58	2.11	0.12	0.10
DCPI (g)	65.70	278.00	230.00	19.60	0.03
DEEI (g)	31.00	34.40	123.00	4.80	0.01
DCFI (kg)	0.24	0.25	0.21	0.06	0.90
DOMI (kg)	1.48	1.58	2.05	0.11	0.10
DNDFI (kg)	1.03	1.05	1.13	0.09	0.70
DCHOI (kg)	1.39	1.27	1.69	0.11	0.20
TDN (kg)	1.48	1.58	2.05	0.11	0.10
DE (MJ/d)	26.60	29.90	39.10	1.93	0.08

DDMI = Digestible DM intake
DCPI = Digestible CP intake
DEEI = Digestible EE intake
DCFI = Digestible CF intake
DOMI = Digestible OM intake
DNDFI = Digestible NDF intake
DCHOI = Digestible CHO intake
TDN = Total digestible nutrient calculated as DCPI + DEEI + DCHOI
DE (digestible energy) calculated as DCPI(kg)* 24.237 MJ+ DEEI(kg)* 34.116 MJ + DCHOI (kg)*17.3 MJ

Table 6. pH, rumen ammonia and VFA concentration Bali cows maintained on hay (HH) or supplemented with urea (HU) or coconut cake (CC)

Parameter	Treatment			SEM	P
	HH	HU	HC		
pH	6.75[a]	6.79[a]	6.69[b]	0.026	0.02
Ammonia-N (mg/l)	26.70[a]	117.00[c]	62.50[b]	25.400	0.05
Acetate (mmol/l)	63.30	55.00	57.60	9.750	0.80
Propionate (mmol/l)	27.60	31.50	18.40	7.040	0.50
Butyrate (mmol/l)	2.95	2.95	0.91	1.740	0.70
Total (mmol/l)	93.80	89.40	76.90	4.490	0.20
Acetate (% of total)	70.20	62.40	68.60	8.260	0.80
Propionate (% of total)	26.30	34.20	30.00	8.260	0.80
Butyrate (% of total)	3.52	3.36	1.41	1.930	0.70

the corresponding apparent digestibility at least for NDF must have been depressed. Our results suggest that it is not the case. As ruminal ammonia concentration was elevated to 217 and 62.5 mg/l when the grass hay was supplemented with urea and coconut cake respectively, rumen degradation and apparent digestibility remains unchanged. In contrast, in the previous experiment JELANTIK and BELLI (2008) found that improvement of rumen ammonia concentration was followed by an increase in rumen dry matter degradation of low quality grass hay basal diet. Similarly, ORTIZ-RUBIO *et al*. (2007) reported that supplementation of different sources of nitrogen increased both ammonia concentration and rumen degradation of sugar cane top. Those improvements were obtained at rumen ammonia concentration between 90 to 110 mg/l.

Rumen pH may express the net balance between the product of fermentation and the buffering capacity and VFA absorption. The product of carbohydrate fermentation, i.e. VFA lowers pH. In contrast, the product of protein breakdown, i.e. NH3, although considered to be a weak base it has the capacity to raise the rumen pH. Most buffering capacity comes from saliva and hence it is affected by chewing activity. In this experiment, pH was the highest in HU and lowest in HC. The high pH in urea supplemented cows is probably associated with the raise in rumen ammonia concentration. Assuming that the production of VFA remains constant, the marked increase in ammonia concentration in HU may be enough to elevate the rumen pH. The relationship between pH and NH3 as shown in figure 3 is also reasonably close only in urea supplemented cows but not in the others.

The depression of pH with coconut cake supplementation is most likely a result of higher fermentation rate of coconut cake. Despite the lower rumen pH, rumen VFA concentration is in fact also the lowest among treatment. The mechanism behind this observation is not clear. With lower fibre digestion, it seems as if the animal needs longer time to chew and hence higher production of buffering capacity. This should increase the rumen pH. But this is not the case. It should also be borne in mind that VFA concentration is not a perfect measure of the VFA production. What is measured is the balance between what is produced and what is absorbed. Marked increase in absorption while production is constant will result in the drop of VFA concentration in the rumen. It is not clear whether some factors related to coconut cake may accelerate VFA absorption. Nevertheless, rumen pH falls in the level favourable for maximal cellulolytic microbes in all treatments.

Effect of supplementation on rumen degradation

A higher rumen ammonia concentration apparently failed to improve fermentation in the rumen to any large extent although supplementation with urea did affect the degradation of protein free-dry matter of medium and poor quality grass hay (Table 7), but this was not significant.

Table 7. Degradation parameters of medium quality hay and low quality hay i.e. water solubility (a, %), insoluble but potentially degradable (b, %), degradation rate (c), lag time (hour), fill, and effective degradability assuming passage rate of 1%/h (ed1, %) and 2 %/h (ed2, %) in Bali cows maintained on hay (HH) or supplemented with urea (HU) or coconut cake (CC)

Parameter		Treatment			SEM	P
		HH	HU	HC		
Medium quality hay						
	a	11.100	10.900	10.600	0.300	0.50
	b	51.800	55.900	47.800	4.400	0.50
	c	0.038	0.017	0.034	0.005	0.20
	Lag	7.690	2.050	3.620	1.190	0.10
	Fill	1.260	1.370	1.280	0.020	0.07
	ED_1	48.600	43.900	46.100	1.040	0.20
	ED_2	39.700	34.200	38.400	0.800	0.07
Poor quality hay						
	a	9.100	8.300	8.400	0.210	0.20
	b	54.200	51.500	49.300	5.600	0.80
	c	0.023	0.029	0.024	0.006	0.80
	Lag	3.150	2.860	1.580	1.126	0.60
	Fill	1.350	1.320	1.370	0.007	0.05
	ED_1	44.400	45.200	42.300	1.300	0.40
	ED_2	35.100	36.700	34.100	0.300	0.05

ED1 = Effective degradability assuming passage rate of 1%/hour
ED2 = Effective degradability assuming passage rate of 2%/hour

The increase of total intake in Bali cows supplemented with coconut cake was not apparently due to an increase in ruminal degradation of both grass hay and coconut cake. Supplementation of both urea and coconut cake in fact failed to improve rumen degradation parameters of grass hay. The increase of total intake in coconut cake supplemented animals would therefore be resulted from increased passage rate. This may occur as coconut cake contains considerable proportion of fat which suppress population of cilliate protozoa in the rumen and hence increase passage rate (NHAN *et al*., 2007).

Crude fibre digestibility in this experiment was slightly depressed in HC. However, this depression cannot be attributed to low pH. PH was indeed lowest in HC, but the level was not low enough to be adversal for fibre digestion. This may be attributed to the lower digestibility of CF of coconut cake compared to grass CF, while coconut cake contributes quite a proportion of the diet in HC, i.e. 15% of the consumed dry matter. However, CC contain very little CF therefore its effect will be negligible. This depression is more likely due to the negative effect of fat on fibre digestion (BEAUCHEMIN *et al*. 2008). Although saturated fat is not considered to have an adverse effect on fibre degradation in the rumen, BAAH *et al*. (2007) reported that some saturated fatty acids may reduce fibre degradation. In their study, medium chain length saturated fatty acid (C12 and C14) significantly depressed NDF degradation *in vitro*. Coconut oil cake contains significant amount of those fatty acids.

Despite comparable crude protein intake between urea and coconut cake (CC) supplementation, nitrogen retained in the body was much higher with CC supplementation. One explanation could be due to the fact that urea is quickly and completely digested in the rumen and this results considerable nitrogen loss through urine. In contrast, CC contains high proportion of by-pass protein which is utilised in higher efficiency by the animal. Another explanation for the better effect of CC over urea in increasing nitrogen retention in Bali cows is the energy availability in the rumen. When nitrogen is no longer deficient in the rumen, energy availability is likely to limit rumen fermentation and it means that those excess can be more efficiently utilised when source of energy is also provided. Significantly higher nitrogen retention observed for HC may be explained by the higher ability of CC to provide additional energy or increase the energy intake which stimulates better utilisation of absorbed protein. TDN and DE intake was increased by 30 to 40% in CC supplemented group compared to urea supplemented and unsupplemented animals. In the present experiment the relationship between retained protein is closer to energy intake, which may be expressed as DOMI, TDN or DE intake, than to protein intake. Thus, the utilisation of crude protein in the present experiment is more limited by energy rather than level of protein. The higher nitrogen retention in Bali cows supplemented with coconut cake compared to those supplemented with urea could be attributed to high fat content in coconut cake. Linoleic acid in the coconut cake has been known to suppress population of cilliate protozoa in the rumen and improves non-ammonia nitrogen and nitrogen utilisation by ruminant animals (BAAH *et al*., 2007; NHAN *et al*., 2007) and probably reduces methan production and emissions from the rumen (GRAINGER *et al*. 2008).

CONCLUSION

High intake is obtained by replacing part of poor quality grass hay with medium quality hay. Urea is not a suitable supplement for those grass hays and coconut cake was a better supplement as the total dry matter as well as energy intake and protein retention are notably improved by coconut cake but not by urea supplementation. The superiority of coconut cake over urea is due to higher fat and energy content which is the limiting factor when the N requirement of the rumen micro-organism is satisfied and rumen degradation is under normal range.

REFERENCES

AOAC. 1990. Official Methods of Analysis. 15th Ed. Assosication of Official Analytical Chemist. Arlington, VA.

BAAH, J., M. IVAN, A. N. HRISTOV, K. M. KOENG, L. M. RODE, and T. A. MCALLISTER. 2007. Effects of potential dietary anti protozoa supplements on rumen fermentation and digestibility in heifers. *Anim. Feed Sci. Technol*. 137: 126 – 137.

BEAUCHEMIN, K.A., M. KRUEZER, F.O. O'MARA and T.A. MCALLISTER. 2008. Nutritional management for enteric methane abatement: a review. *Aust. J. Exp. Agric*. 48: 21-27.

GRAINGER, C., T. CLARKE, K.A. BEAUCHEMIN, S.M. MCGinn and R.J. ECKARD. 2008. Supplementation with whole cottonseed reduced methane emissions and can profitably increase milk production of dairy cows offered a forage and cereal grain diet. *Aust. J. Exp. Agric*. 48: 495-501.

JELANTIK, I-G.N. 2001. Improving Bali Cattle (*Bos sondaicus*, Wagner) Production through Protein Suplementation. PhD Thesis. The Royal Veterinary and Agricultural University, Copenhagen, Denmark.

JELANTIK, I G. N. 2002. Effect of fishmeal or coconut cake supplementation on intake and digestibility by Kacang goats maintained on tropical grass hay basal diets. *Bull. Nut*. 5: 57-64.

JELANTIK, I-G.N., H.L.L. BELLI and W.M.M. NALLEY. 2008. Effect of different level and sources of rumen degradable protein on nitrogen metabolism in Bali cows fed low quality tropical grass hay. Proc. of International Seminar "Management Strategy of Animal Health and Production Control on Anticipation Global Warming for Achievement of Millennium Development Goals. Surabaya, 2-4 Juni 2008. Faculty of Veterynary Medicine Airlangga University. Surabaya. pp. 137-141.

JELANTIK, I-G.N. and H.L.L. BELLI. 2008. Effect of Protein Supplementation on Rumen Environment and *In Sacco* Rumen Degradation in Bali Cows. Competition for Resources in a Changing World: New Drive for Rural Development: Book of Abstracts. Tropentag 2008. University of Hohenheim, Stuttgart-Hohenheim. pp. 420.

LENG, R.A. 2003. Drought and Dry Season Feeding Strategies for Cattle, Sheep and Goats. Penambul Books, Queensland, Australia.

NHAN, N.T.H., N.T. NGU, N. THIET, T.R. PRESTON and R.A. LENG. 2007. Determination of optimum level of a soybean oil drench with respect to rumen ecosystem, feed intake and digestibility in cattle. *Liv. Res. Rural Dev*. 19: Artic-117.

ORTIZ-RUBIO, M.A., E.R. ØRSKOV, J. MILNE and H.M.A. GALINA. 2007. Effect of different sources of nitrogen on *in situ* degradability and feed intake of Zebu cattle fed sugar cane tops. *Anim. Feed Sci. Technol*. 139: 143-158.

SATTER, L.D. and L.L. SLYTER. 1974. Effect of ammonia concentration on rumen microbial protein production *in vitro*. *Brit. J. Nutr*. 32: 199-218.

SAS. 2000. SAS/STAT User's Guide. SAS Institute Inc. Cary, NY.