EFFECT OF RUMEN UNDEGRADED PROTEIN LEVEL ON NUTRIENT DIGESTIBILITY AND RUMEN FERMENTATION PARAMETERS OF DAIRY COW

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ABSTRACT

Studies on feed protein degradation in Indonesia had shown evidence of a great variation among feed. Excess of rumen degraded protein supply had caused a higher concentration of endogenous blood urea and decreasing fertility. The objective of this study was to investigate the effect of undegraded protein (UDP) level on nutrient digestibility and microbial protein synthesis on dairy cows. Four dry dairy cows (initial body weight 284.75 ± 12.32 kg) fitted with rumen canulae were used in a 4 x 4 Latin square design. Cows were fed with four treatment diets (60 % forage and 40 % concentrate), namely control containing cassava and molasses (C), the other three diets were each containing 15 % UDP (15-UDP), 30 % UDP (30-UDP) and 45 % UDP (45-UDP). Al the concentrate except the control contained 18 CP and 2.0 Mcal/kg. Data was analyzed using variance analysis, followed by Duncan's multiple range test to determine the differences between means. Organic Matter (OM) intake of 45-UDP were higher than 15-UDP, 30-UDP and control diet ($P<.05$), and the digestibility of OM among treatments were not significantly differente. The lowest OM intake of control diet was caused by its low protein content, OM intake has positive respond due to protein intake. Level of UDP significantly affected ($P<0.05$) NH_3-N concentration.

(Key words: Dairy cow, Undegraded protein, Rumen fermentation).

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PENGARUH LEVEL *RUMEN UNDEGRADED PROTEIN* TERHADAP KECERNAAN NUTRIEN DAN PARAMETER FERMENTASI RUMEN

INTISARI

Degradasi protein pakan dalam rumen di Indonesia sangat bervariasi. Kelebihan protein terdegradasi dalam rumen menyebabkan kadar urea darah meningkat dan menurunkan fertilitas. Penelitian bertujuan untuk mengetahui pengaruh aras *Rumen undegraded protein* (RUP) terhadap kecernaan nutrient dan parameter fermentasi rumen. Empat sapi perah Peranakan Friesian Holstein kering berfistula rumen (berat 284,75 ± 12,32 kg) digunakan dalam rancangan latin square 4 x 4. Ransum berupa rumput Raja dan konsentrat (60 : 40) diberikan 2 kali, yaitu kontrol berupa cassava dan molasses (K), 15% UDP (UDP-15), 30% UDP (UDP-30) dan 45% UDP (UDP-45). Semua konsentrat kecuali kontrol mengandung 18 PK dan 2,0 Mcal/kg BK. Data yang diperoleh dianalisis dengan analisis variansi dan bila berbeda nyata dilanjutkan uji Duncan. Konsumsi bahan organik (BO) ransum UDP-45 paling tinggi dibanding UDP-15, UDP-30 dan kontrol ($P<.05$), dan kecernaan BO antara perlakuan tidak berbeda nyata. Konsumsi BO terendah pada ransum kontrol disebabkan rendahnya protein ransum, konsumsi BO memberikan respon positif disebabkan oleh konsumsi protein. Level UDP berpengaruh nyata ($P<0,05$) terhadap konsentrasi N- NH_3.

(Kata kunci : Sapi perah, Undegraded protein, Parameter fermentasi rumen).

Introduction

Crude protein synthesis has been used for the long period of time as a standard in evaluating the dairy cows protein requirement. It is now generally recognized that protein value is best represented by the amount and pattern of aminoacids absorbed from the small intestine (Verite and Peyraud, 1988). Aminoacids flowing to the intestine is originated mainly from microbes and undegraded feed and also from a small amount of endogenous protein. Some experiments showed that increasing crude protein level in diet high yielding dairy cows was not respond significantly, but the diet content low rumen degradable protein was increase milk yield of early lactation dairy cows (Broderick *et al.*, 1989). This phenomena indicated that the excess of nitrogen intake highly degraded in rumen was not used maximally for microbial growth. The excess of ammonia in rumen will be turned and carried into liver on the process of going to urine.

The Indonesian feeds protein degradation has shown evidence of a great variation among feeds (Widyobroto *et al.*, 1997), so that variable amount of UDP feeds protein were absorbed in gastrointestinal tracts. Verite and Peyraud (1988) argued that microbial rumen consisting 80 % amino acid, 80 % nitrogen amino acid of microbial rumen was absorbed by host animal (Orskov, 1992). Microbial protein can supply 65 – 70 % protein which was absorbed in high yielding dairy cows (Kaufmann and Lupping, 1982). Optimal rumen degraded protein (RDP) diet of high yielding dairy cows is 65 %, but when the feed energy supply deficient, this RDP decreased turn to 55 % or less (Kaufmann and Lupping, 1982). In the same way, Broderick (1989) stated that sufficient protein supply increased milk production with no stress of over ammonia could be applied with reducing the feed protein degradation in average 70 % to 60 % or less. Excess of rumen degraded protein supply may cause a higher endogen concentration of blood urea and decreasing fertility (Ferguson *et al.*, 1989). Chiou *et al.*

(1995) showed that dry matter intake of dairy cow was influenced by UDP level. Average values of dry matter intake were 18.2; 17.8; and 16.7 kg for diets high protein-low UDP, high protein-high UDP and low protein-low UDP respectively. Average NH_3, VFA and pH in the rumen were not affected by protein level and UDP level. Yet it still tends to have low pH in cow fed with high protein and low UDP (Chiou *et al.*, 1995).

The aimed of this research was to determine the effect of undegraded protein level on nutrien digestibility and rumen fermentation parameters of dairy cows.

Materials and Methods

Animals and experiment design

Four lactating Friesian Holstein Crossbreed fitted with a rumen cannula (average initial body weight of 284.75 ± 12.32 kg) were used in the experiment. The cows were housed in individual pens equipped with individual feeding and drinking, and Chopped King grass were offered before concentrates were given ad libitum twice a day at 08.00 and 17.00 h.

Diets were assigned in a 4 x 4 Latin square design. Experimental periods were 30 d; with d 1 to d 12 for adaptation to diet and d 16 to d 27 for sample collection. All ration except the control diet (Table 1) were isonitrogenous and isocaloric according INRA (1988) requirements. The four types of concentrates being used were 1) control, consisting cassava and molasses; 2) 15 % UDP (15-UDP); 3) 30 % UDP (30-UDP) and 4) 45 % UDP (45-UDP).

Sampling and Analysis

During each collection period, the grass was sampled every three days whereas refused rations were weighed and sampled 200 g every morning. Samples collected were grouped for analysis of DM, OM, NDF, ADF and N.

Faeces and urine were collected for seven days at the end of each period. Total faeces was collected for 24 hours, and 2 % by weighed was collected for sampling. Samples were dried and grouped for each treatment accordingly for DM, OM, NDF, ADF and N analysis.

Urine was collected for 24 hours into container in which 200 ml of 10 % H_2SO_4 was added. Urine was weighed and 0.5 % of which was collected, and sub samples then was frozen and stored at -20°C for N analysis. Samples of the ration, refusal and faeces were analyzed for OM, CP according to AOAC procedures (1975); and for neutral detergent fiber (NDF) and acid detergent fiber (ADF) according to Van Soest procedures (1994).

Rumen samples were collected on d 27 at 0, 2, 4, 6, 8, 10, 12, 16, 18, 20, 22 h after the morning feeding. pH was measured immediately after sample collection, and then fluid was strained through four layer of cheesecloth; 5 ml of 20 % NaCl was added to 5 ml rumen fluid for N-NH_3 analysis by method of Conway (1962) and 1 ml of $HgCl_2$-H_3PO_4 was added to 10 ml rumen fluid for VFA analysis by gas chromatography (Jouany, 1982).

Statistical analysis

Data were analyzed following 4 x 4 Latin Square design using the GLM procedures of SAS (SAS, 1988). The statistical model use was : $Y_{ijk} = \square + period_i + cow_j + ration_k + e_{ijk}$, where Y_{ijk} = all dependent variables; $\square$ = mean population; $period_i$ = mean effect of period I; cow_j = mean effect of cow j; $ration_k$ = mean effect of ration k, and e_{ijk} = residual random (assumed to be normally distributed), followed by Duncan's multiple range test to determine differences between means.

Table 1. Ingredient and chemical composition of experimental diets (DM basis)

Ingredient (%)	Diet			
	Control	15-UDP	30-UDP	45-UDP
Corn	-	10.00	10.00	26.00
Soybean meal	-	20.22	-	-
Cottonseed meal	-	-	-	5.00
Urea	-	4.00	3.00	-
Blood meal	-	-	4.00	10.00
Fish meal	-	-	3.00	5.00
Soybean meal +HCHO	-	-	15.00	26.00
Molasses	4.76	5.00	5.00	5.00
Rice Bran	-	25.00	30.00	17.00
Cassava	95.24	36.00	30.00	6.00
Chemical composition				
DM (%)	89.30	89.74	89.71	89.84
OM (%)	91.83	91.41	91.17	90.10
CP (%)	8.31	12.78	12.42	15.45
UDP (%)[a]	17.69	32.50	37.00	42.50
NDF (%)	47.52	49.49	49.77	49.21
ADF (%)	41.48	42.13	42.30	43.88
Nel (Mkal/kg)[b]	1.67	1.55	1.55	1.60

[a] calculated based on *in sacco* degradation which forage : concentrate ratio (60 :40)
[b] based on INRA (1988) recommended

Table 2. Effect of UDP level on nutrient intake of Friesian Holstein grade cows

Nutrient	Diet				S.E
	Control	15-UDP	30-UDP	45-UDP	
	Nutrient intake (kg/d)				
DM	5.26^b	7.42^a	6.98^a	7.54^a	0.41
OM	4.70^b	6.54^a	6.14^a	6.54^a	0.34
CP	0.60^c	1.11^b	1.12^b	1.55^a	0.07
NDF	2.81^b	4.29^a	4.07^a	4.47^a	0.33
ADF	1.82^b	2.87^a	2.74^{ab}	3.17^a	0.27

[a,b,c] Means in the same row with different superscripts differ significantly (P<0.05).

Results and Discussion

The UDP level influenced significantly DM, OM, CP, NDF and ADF intake (P< .05). The lowest of dry matter intake was on cows receiving control diet (5.26 Kg DM/d) and the values were not different between 15-UDP, 30-UDP and 45-UDP (Table 2). Its low protein content caused the lowest of DM intake by cows receiving control diet, supported also by the lowest of NH_3 and VFA rumen concentration (Table 4). Improvement of DM intake with a low rumen degradable protein (15-UDP, 30-UDP and 45-UDP VS control diet) was related to increase flow of CP reaching the duodenum and improved digestibility of nutrient (Table 3).

This result supported by Robinson et al. (1991), that DM intake of cows fed concentrate of low degradable protein in the rumen was higher than that concentrate of high degradable protein (24.5 VS 24 kg/d).

Crude protein intake of diet 45-UDP was higher ($P < 0.05$) than those of 30-UDP, 15-UDP and control diet (1.55; 1.12; 1.11 and 0.6 kg/d respectively). The highest of CP intake at this diet was supported by highest of DM intake and CP content of diet (8.31, 12.78, 12.42 and 15.45% for control, 15-UDP, 30-UDP and 45-UDP diet). According to Oldham (1984) DM intake had a positive correlation with crude protein intake and milk production. The same condition was found with NDF and ADF intake, at 45-UDP was found highest then followed by 30-UDP, 15-UDP while the lowest was with control diet. Those results was in line with dry matter intake, while the NDF, ADF content were not considerably difference.

The average of rumen fermentation parameters is shown in Table 4. The average of rumen pH during 24 h was not affected by UDP level. The pH at control, 45-UDP, 30-UDP and 15-UDP diet were not significantly differente. But those values were still out of pH range in which the growth of cellulolytic microorganism could be inhibited at pH 6.2 ± 0.5 (Van Soest, 1994). Highest rumen pH in cows receiving control diet due to lower acetate proportion than other treatments, but it also has higher propionate proportion (Widyobroto, 1999). According to Djikstra (1988), soluble carbohydrate fermentation in the rumen caused high amount propionate.

The average of NH_3-N concentration (Table 4) at 15-UDP was higher ($P<0.05$) than 30-UDP, 45-UDP and control diet (12.33, 10.16, 8.47 and 2.66 mg/100 ml respectively). NH_3-N concentration decreased with increasing inclusion of UDP (protein resistant to ruminal degradation). Those values except on control were still in above minimal concentration requirement for microbial growth which was 2 – 5 mg/100 ml (Slyter and Satter, 1974). Highest rumen ammonia at 15-UDP, was caused by the content of degradable protein of this diet which was higher than diets 30-UDP and 45-UDP (Table 1).

Concentration of total ruminal VFA 15-UDP diet was higher than that control diet (90.45 VS 72.13 mmol/l), the high concentration of VFA in 15-UDP diet was consistent with the low ruminal pH (Table 3) observed with this diet. The acetate proportion at 45-UDP was highest ($P<0.05$), because it had the highest fiber content and fiber digestibility. According Keerey *et al* (1993) acetate concentration in the rumen is associated with digestible fiber. Meanwhile, propionate proportion at control diet was highest ($P<0.05$), it supported by fiber content which has lowest among treatments.

Table 3. Effect of UDP level on nutrient digestibility of Friesian Holstein grade cows

Item	Diet				S.E
	Control	15-UDP	30-UDP	45-UDP	
	Apparent digestibility(%)				
DM	66.34[a]	67.53[a]	66.95[a]	65.50[a]	1.55
OM	68.15[a]	66.79[a]	68.96[a]	67.57[a]	1.48
CP	61.91[a]	72.78[a]	72.84[a]	73.29[a]	3.62
NDF	54.61[a]	60.47[a]	60.65[a]	60.86[a]	2.43
ADF	37.06[a]	47.44[a]	45.84[a]	47.76[a]	4.30

[a,b,c] Means in the same row with different superscripts differ significantly ($P<0.05$).

Table 4. Effect of UDP level on rumen fermentation of Friesian Holstein grade cows

	Diet				S.E
	Control	15-UDP	30-UDP	45-UDP	
PH	6.72[a]	6.48[a]	6.53[a]	6.59[a]	0.07
NH_3-N (mg/100 ml)	2.66[b]	12.33[a]	10.16[a]	8.47[ab]	1.87
Total VFA (mmol/l)	72.13[c]	85.81[ab]	90.45[a]	75.41[bc]	3.46
VFA proportion (% total)					
Acetate	56.17[b]	62.19[ab]	61.91[ab]	64.40[a]	2.04
Propionate	30.62[a]	22.50[ab]	24.67[ab]	21.24[b]	2.50
Butyrate	8.20[a]	10.31[a]	8.42[a]	9.37[a]	0.77

[a,b,c] Means in the same row with different superscripts differ significantly ($P<0.05$)

Conclusions

Dry matter and organic matter intake of animal being fed with control diet were lower than others, but the nutrient digestibility was not affected by treatments. Average of rumen NH_3-N and VFA were significantly influenced by types of experimental diets.

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