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COMBINATION OF SOYBEAN MEAL AND *Hibiscus tiliaceus* LEAF IN THE GOAT DIET: EFFECT ON SOME PARAMETERS OF PROTEIN METABOLISM

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ABSTRAK

Enam belas ekor kambing Peranakan Etawa digunakan untuk mengkaji pengaruh saponin daun waru yang dikombinasikan dengan suplementasi protein bungkil kedelai terhadap beberapa parameter dalam metabolisme protein. Kambing memiliki rerata bobot badan sekitar 16 kg dengan rerata umur 7 bulan. Pakan perlakuan terdiri dari: T_0 = Pakan komplit (Saponin 0,90%, PK 8%, TDN 62%), $T_1 = T_0$ + 3% protein bungkil kedelai, $T_2 = T_0$ + 6% protein bungkil kedelai, $T_3 = T_0$ + 9% protein bungkil kelapa. Penelitian dilakukan berdasarkan rancangan acak lengkap. Parameter yang diamati dalam penelitian ini yaitu konsumsi bahan kering (BK) dan protein kasar (PK), kecernaan bahan kering dan protein kasar, konsentrasi amonia rumen, konsentrasi VFA total, urea darah, retensi nitrogen, kecernaan bahan organik dalam rumen (KBOR), allantoin urin, estimasi sintesis nitrogen mikroba. Konsumsi bahan kering, KBOR, konsentrasi allantoin urin dan estimasi sintesis nitrogen mikroba tidak dipengaruhi oleh perlakuan secara nyata. Konsumsi PK, kecernaan BK dan PK, konsentrasi NH_3 dan VFA total cairan rumen, urea darah dan retensi nitrogen meningkat ($P<0,05$) seiring dengan peningkatan level bungkil kedelai. Keseimbangan level energi harus dipertimbangkan pada suplementasi protein pakan kambing yang mengandung Hibiscus tiliaceus.

Kata Kunci : suplementasi protein, Hibiscus tiliaceus, pemanfaatan protein, kambing

ABSTRACT

Sixteen Ettawah cross bred goats were used to study the effect of waru leaf (*Hibiscus tiliaceus*) sapponin combined with soybean meal protein supplementation on some parameters of protein metabolism. Goats had body weight average of 16 kg and aged at 7 months. The experimental diets were: T0 = total mixed ration (0.9% saponin of hibiscus leaf, 8% CP, 62% TDN), $T_1 = T_0$ + 3% soybean meal protein, $T_2 = T_0$ + 6% soybean meal protein, and $T_3 = T_0$ + 9% soybean meal protein. The treatments were allocated in a completely randomized design. The parameters observed in this study were dry matter (DM) and crude protein (CP) intakes, DM and CP digestibilities, ruminal amonia and VFAs concentrations, blood urea level, nitrogen retention, digestible organic matter in rumen (DOMR), urinary allantoin, and estimated microbial nitrogen (N) synthesis. DM intake, DOMR, urinary allantoin and estimated microbial N synthesis were not affected significantly ($P>0.05$) by treatments. CP intake, DM and CP digestibilities, ruminal amonia and VFAs concentrations, blood urea level and nitrogen retention increased ($P<0.05$) with increasing levels of soybean meal protein. Balancing energy level should be considered for the dietary protein supplementation in *Hibiscus tiliaceus* leaf contained diet of goat.

Keywords: protein supplementation, Hibiscus tiliaceus, protein utilization, goat

INTRODUCTION

Ruminants partly rely on rumen microbial protein for productive purposes. Singh *et al*. (2007) reported that microbial protein is a major protein supply contributing to the growth in calf. Dietary protein is also needed especially to ensure growth performance in young ruminant besides supply of microbial protein (Preston and Leng. 1987). Soybean meal is well known as protein source for ruminant.

Some tropical fodder trees have capability to reduce or eliminate rumen ciliates (Monforte-Briceno *et al*., 2005). Istiqomah *et al*. (2011) reported the mechanism of *Hibiscus tiliaceus* leaf as a potent defaunating herb. *Hibiscus tiliaceus* are also commonly used as a forage source for goat. However, there is a little information concerning the defaunation effect of *Hibiscus tiliaceus* leaf in young goat.

Defaunation is one of some attempts to improve ruminal fermentability which in turn increasing productive performance of ruminants. In defaunated lambs, depressed protozoa population decreases ruminal ammonia concentration. This is due to lowering degradation of feed and bacterial proteins by protozoa (Jouany, 1996; Kiran and Mutsvangwa, 2010). Eugene *et al*. (2004) summarized, dietary nitrogen level affected ruminal ammonia concentration in the defaunated ruminant. It is plausible that there is an interactive effect between defaunation and dietary protein on protein metabolism in ruminant. This research was aimed to clarify the effect of *Hibiscus tiliaceus* leaf sapponin combined with soybean meal protein on some parameters of protein metabolism in young goat.

MATERIALS AND METHODS

Experimental Animal and Diet

This experiment used sixteen Ettawah grade bred male goats with average body weight of 16 kg and aged at 7 months old. Animals were housed individually in metabolic cages. The experimental diets were: T0 = total mixed ration (0.90% of *Hibiscus tiliaceus* leaf sapponin; 8.69% of CP; 62.11% of TDN), T1 = T0 + 3% soybean meal protein; T2 = T0 + 6% soybean meal protein; T3 = T0 + 9% soybean meal protein (Table 1). Drinking water was available throughout the experimental period. The treatments were allotted into a completely randomized design.

Experimental Methods

After five weeks of adjustments period to experimental diet and enviroment, feces and urine from goats were collected for 10 days. Feces and urine samples were collected to determine nutrient intake and digestibility, protein retention, urinary allantoin. One week after urine and feces sampling, rumen fluid was taken from each goat using the aspirated stomach tube. The collection of rumen fluids were conducted after one night fasting (before feeding) and 3 hours after feeding. Rumen fluid was collected to determine ruminal NH_3 and VFA concentrations. One week after that blood sampling from jugular vein was also conducted in each goat using spoit for determination of blood urea concentrations.

Dry and organic matter and protein content in diet, feces and urine were estimated using the method of AOAC (1990). The NH_3 concentration of rumen fluid were analyzed by mikrodifusi conway method (Conway, 1962). The VFAs concentration was assayed by chromatography gas method based on Jouany (1982). The Blood urea concentration measurement was according to Barthelot method (Chaney and Marbach , 1962). The digestible organic matter on rumen (DOMR) was calculated using a formula of Liang *et al*. (1994). Urinary allantoin content was analyzed according to colorimetric method (Young and Conway, 1942). The microbial nitrogen synthesis was estimated on the basis of urinary allantoin according to Chen and Gomes (1992).

Data Analysis

Data parameters were tested using analysis of covariance and followed by Duncan's multiple range test.

RESULTS

Daily dietary dry matter consumption was not significantly affected by the treatment of protein supplementation but the daily dietary crude protein consumption was increased ($P<0.05$) as increasing the level of protein consumption (Table 2). The treatment of protein supplementation increased ($P<0.05$) dietary dry matter and crude protein digestibilities. The highest dietary dry matter and crude protein digestibilities were achieved when the crude protein concentration in diet at a level of 14%.

Table 2 shows that ruminal concentrations of ammonia (NH_3) and volatile fatty acids (VFAs)

Table 1. Ingredients and Nutrient Compositions of the Experimental Diets

Ingredients and Composition	Crude Protein Level of Experimental Diets, %			
	8.69	11.28	14.01	17.00
Ingredients, % DM				
Hibiscus tiliaceus leaf	3.65	3.65	3.65	3.65
Setaria sphacelata	18.35	18.35	18.35	18.35
Rice bran	23.50	19.50	19.50	21.00
Ground corn	23.00	21.00	16.50	10.00
Copral meal	6.00	6.00	6.00	8.00
Ground peanut shell	16.50	16.50	16.00	14.00
Molasses	8.00	7.00	5.00	3.00
Mineral vitamin mixtures	1.00	1.00	1.00	1.00
Soybean meal	0.00	7.00	14.00	21.00
Nutrients composition, %				
Crude protein	8.69	11.28	14.01	17.00
Extract ether	3.84	4.09	4.19	4.66
Crude fiber	22.63	25.82	27.84	29.22
Nitrogen free extract	52.62	47.78	43.85	36.03
Ash	12.22	11.02	10.11	13.08
Sapponin	0.90	0.90	0.90	0.90
[1]Total digestible nutrients	62.11	62.76	62.72	62.78

[1] Values were calculated based on Hartadi *et al*. (2005).

before and after feeding were increased (P<0.05) by the treatment of protein supplementation. The highest ruminal NH_3 and VFAs concentrations before and after feeding were achived when the crude protein concentration in diet at a level of 14%. Blood urea concentrations before and after feeding were incerased as increasing the level of protein supplementation. The blood urea concentrations before and after feeding were still increased until the protein supplementation at a level 9% above control. The daily amounts of excreted nitrogen via urine and amounts of retained nitrogen were increased (P<0.05) as increasing the level of crude protein consumption.

The treatment of protein supplementation did not effect on daily amounts of ruminally digested organic matter (Table 2). The level of daily urinary allantoin and amounts of microbial nitrogen synthesis were unaffected significantly by the treatment of protein supplementation.

DISCUSSION

Nutrient Intake and Digestibility

The present study discussed some parameters of protein metabolism in Ettawah cross bred goat fed on *Hibiscus tiliaceus* leaf combined with different levels of soybean meal. While amount of dry matter intakes were similar among treatment groups, amount of crude protein intakes were increased according to the portions of soybean meal in diets (Table 2). This fact indicated that goats consumed same sapponin level of *Hibiscus tiliaceus* leaf with different level of protein intake from soybean meal. Istiqomah *et al*. (2011) reported that sapponin of *Hibiscus*

Table 2. Experimental Results[1]

Parameters	Crude Protein Level of Experimental Diets, %			
	8.69	11.28	14.01	17.00
Daily nutrient intake, g•kgBW$^{0.75}$				
Dry matter	44.41 ± 11.71	47.96 ± 4.31	41.57 ± 6.16	47.56 ± 5.56
Crude protein	3.86 ± 1.02^{c}	5.41 ± 0.49^{b}	5.83 ± 0.86^{b}	8.09 ± 0.95^{a}
Nutrient digestibility, %				
Dry matter	47.24 ± 5.11^{b}	41.69 ± 2.38^{c}	55.43 ± 2.36^{a}	46.17 ± 2.84^{bc}
Crude protein	50.06 ± 5.33^{b}	54.66 ± 9.57^{b}	70.85 ± 3.04^{a}	68.54 ± 4.43^{a}
Ruminal concentration, mM				
NH_3, before feeding	9.31 ± 3.23^{c}	15.65 ± 2.95^{b}	21.15 ± 4.47^{ab}	23.27 ± 5.15^{a}
NH_3, after feeding	8.88 ± 1.61^{b}	15.23 ± 4.98^{ab}	18.19 ± 1.61^{a}	20.72 ± 6.26^{a}
VFAs, before feeding	59.17 ± 3.06^{b}	73.06 ± 3.66^{a}	67.68 ± 6.73^{a}	66.91 ± 2.87^{a}
VFAs, after feeding	67.41 ± 4.06^{b}	73.18 ± 5.01^{ab}	78.13 ± 5.33^{a}	71.51 ± 8.44^{ab}
Daily estimated of DOMR, g	205.29 ± 44.56	211.17 ±20.51	242.62±54.55	228.50 ±21.52
Blood urea, mM				
Before feeding	31.25 ± 9.53^{c}	40.50 ± 5.44^{bc}	55.25 ±10.46^{b}	74.75 ±18.37^{a}
After feeding	32.75 ± 9.32^{c}	44.00 ± 4.16^{bc}	56.50 ± 7.85^{ab}	71.75 ±15.39^{a}
Daily urinary nitrogen, g	0.09 ± 0.03^{c}	0.24 ± 0.10^{bc}	0.40 ± 0.09^{b}	0.69 ± 0.14^{a}
Daily retained nitrogen, g	5.17 ± 1.28^{d}	8.11 ± 1.21^{c}	11.23 ± 2.67^{b}	15.20 ± 1.60^{a}
Urinary allantoin, mM	1.86 ± 1.29	3.04 ± 2.06	3.93 ± 2.24	5.72 ± 2.28
Daily estimated microbial nitrogen synthesis, g	1.87 ± 0.06	2.76 ± 1.41	2.85 ± 2.20	4.63 ± 2.19

[1] Values are means from 4 goats (±SD), ^{a,b,c,d} $P<0.05$; DOMR: digestible organic matter in rumen

tiliaceus leaf as a potent defaunating agent.

The dry matter intake of goat was in a range level of other result experiments, although animal breed, age, physiological status and diet type may reflect on feed intake. The daily dry matter intake of nonpregnant Granadina goat was in a range of 45–51 g per kg BW$^{0.75}$ (Cantalapiedra-Hijar *et al*., 2009). Kearl (1982) recommended that daily feed dry matter intake in young goat should be 3–4% of body weight.

The daily crude protein intake of goats in this study were designed to be increased according to levels of protein supplementation in dietary experiment, although nutrient requirement of Ettawah breed goats has not been established yet. Mathius *et al*. (2002) reported that average of daily crude protein intake in young Ettawah cros bred goat was 4.40 g per kg BW$^{0.75}$. The daily crude protein intake of Bligon goats were in a range from 6.82 to 11.03 g per kg BW$^{0.75}$ (Tahuk *et al*., 2008).

The digestibility of dietary crude protein and dry matter were increased in similar manner according with increasing level of protein supplementation (Table 2). The increasing protein supplementation may increase the ratio of dietary protein to energy which in turn increases crude protein digestibility in goat (Mathius *et al*., 2002).

In the present study, experimental diets were designed to be isoenergy with different levels of crude protein. Furthermore, depressed rumen protozoa population in defaunated ruminant may give more chance for proteolitic bacteria to degrade dietary protein (Wina *et al.*, 2006; Mao *et al.*, 2010; Istiqomah *et al.*, 2011).

Ruminal Feed Fermentability

Ruminal NH_3 and VFAs concentrations are reflected mainly by the degradabilities of dietary protein and carbohydrate, respectively, in rumen (Preston and Leng, 1987). Before and after feeding concentrations of ruminal NH_3 were significantly increased as increasing the protein supplementation, but before feeding ruminal NH_3 concentrations slightly higher than those of after feeding for all treatment groups (Table 2). Jouany (1996) and Kiran and Mutsvangwa (2010) established that the depressed ruminal NH_3 concentration in defaunated animals is caused by lowering degradation of dietary and bacterial proteins in rumen. Probably, this effect may be profounded during period of post feeding. The supplementation of dietary nitrogen ameliorates the depressed ruminal NH_3 concentration in defaunated ruminant (Eugene *et al*., 2004).

The protein supplementation increased before and after feeding ruminal VFAs concentrations signifigantly, and after feeding concentrations of VFAs in rumen slightly higher than those of before feeding (Table 2). A protein supplementation using dried whole whey in a diet combined with defaunation increases after feeding VFAs concentration in steers (Grummer *et al.*, 1983). Perston and Leng (1987) stated that the elevated after feeding ruminal VFAs concentration is a result of dietary carbohydrate degradation by rumen bacteria intensely.

Dietary Protein Utilization

The aim of this experiment was mainly to clarify how sapponin of *Hibiscus tiliaceus* leaf combined with protein of soybean meal would increase the supplies of dietary and microbial proteins thereby improving the growth of young goat. Dietary protein intake, protein digestibility, urinary nitrogen, and nitrogen retention were increased in same manner as increasing dietary protein supplementation. However, urinary allantoin and estimated microbial nitrogen synthesis, as indicatives of microbial protein supply, were unaffected significantly by the protein supplementation (Table 2).

The protein supplementation did not effect on amount of rumen digestible organic matter significantly, but before and after feeding blood urea concentrations were increased by the protein supplementation (Table 2). This phenomenon presumably contributed to the unaffected microbial protein supply. Degradation of feed organic matter in rumen generates VFAs which in turn providing carbon skeleton for bacterial amino acids synthesis (Preston and Leng, 1987). The bacterial amino acids synthesis mainly uses nitrogen and carbon skeleton from ruminal NH_3 and VFAs, respectively.

Cantalapiedra-Hijar *et al.* (2009) reported that balancing high dietary energy and protein increases ruminal amount of digestible organic matter and VFAs concentration in goat, accordingly. While the after feeding ruminal VFAs concentrations in Granadina goat fed on different quality diets ranged from 68 to 93 mmol/L (Cantalapiedra-Hijar *et al.*, 2009), the after feeding ruminal VFAs concentrations in this experiment ranged from 67 to 78 mM. The unmatched between ruminal VFAs and NH_3 productions for bacterial amino acids synthesis caused surplus in NH_3 which in turn increasing blood urea level. Eventually, excretion of urinary nitrogen were increased by the treatment of dietary protein supplementation (Table 2).

CONCLUSION

The increasing protein of soybean meal level in *Hibiscus tiliaceus* leaf contained diets increased protein digestibility, ruminal NH_3 and VFAs concentrations, and nitrogen retention in young Ettawah cross bred goat. Accordingly, blood urea level and urinary nitrogen were also increased by the dietary protein supplementation. However, the dietary protein supplementation did not effect on estimated rumen digestible organic matter and microbial nitrogen synthesis. Balancing energy level should be considered for the dietary protein supplementation in *Hibiscus tiliaceus* leaf contained diet of goat.

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