THE EFFECTS OF SAPONIN FROM *SAPINDUS RARAK* FRUIT ON RUMEN MICROBES AND PERFORMANCE OF SHEEP

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ABSTRAK

THALIB, A., Y. WIDIAWATI, H. HAMID, D. SUHERMAN, dan M. SABRANI. 1996. Pengaruh saponin buah *Sapindus rarak* terhadap mikroba rumen dan kinerja domba. *Jurnal Ilmu Ternak dan Veteriner* 2 (1).

Delapan belas ekor domba lokal berbobot 15 kg secara acak dibagi ke dalam 3 kelompok perlakuan. Semua hewan mendapatkan campuran rumput gajah dan rumput alam (50:50) *ad libitum* + konsentrat (0,5% bobot badan). Perlakuan yang diberikan adalah: (I) tanpa aditif, (II) penambahan plasebo dan, (III) penambahan ekstrak metanol buah *Sapindus rarak* (MES) pada level 0,07% bobot badan. Plasebo dan MES diberikan secara oral setiap 3 hari sekali. Perlakuan pemberian makanan berlangsung selama 14 minggu. Cairan rumen dari semua hewan diambil pada minggu ketiga dan diobservasi untuk ekosistem rumen dan kecernaan dalam rumen. Pertambahan bobot badan dan konsumsi pakan juga diukur. Hasil percobaan menunjukkan bahwa MES dapat mengeliminasi populasi protozoa 57% dan mengakibatkan peningkatan populasi bakteri 69% bila dibandingkan dengan kontrol (I). Penurunan populasi protozoa tidak berpengaruh terhadap produksi asam laktat dan asam-asam lemak terbang dan dengan demikian tidak mengubah pH (P>0,05). Namun, penurunan populasi protozoa menurunkan kandungan N-NH_3 (P<0,05). Produksi gas kumulatif yang dihasilkan dari substrat (jerami padi) yang difermentasi oleh cairan rumen dari domba yang diberi ransum III meningkat 13% bila dibandingkan dengan kontrol (I). Dibandingkan dengan kontrol (I), penambahan bobot badan harian dari domba yang diberi ransum III meningkat 44% dengan perbaikan efisiensi 28%.

Kata kunci : Saponin, protozoa, bakteri, kinerja domba

ABSTRACT

THALIB, A., Y. WIDIAWATI, H. HAMID, D. SUHERMAN, and M. SABRANI. 1996. The effects of saponin from *Sapindus rarak* fruit on rumen microbes and performance of sheep. *Jurnal Ilmu Ternak dan Veteriner* 2 (1) :

Eighteen local sheep weighing approximately 15 kg were randomly divided into 3 treatment groups. All animals received a mixture of elephant and native grasses (50:50) *ad libitum* + concentrate (0.5% of liveweight). The treatments given were: (I) no additive, (II) addition of placebo and (III) addition of methanol-extracted *Sapindus rarak* fruit (MES) at level of 0.07% of liveweight. Placebo and MES were given orally every 3 days. Feeding treatments were conducted for 14 weeks. Rumen liquor of all animals were collected in the third week and observed for rumen ecosystem and ruminal digestibility. Bodyweight gain and feed consumption were measured. The results showed that MES eliminates the protozoal population by 57% and sequently increases bacterial population by 69% when compared to control (I). Lowered protozoa population has no effect on lactic acid and total volatile fatty acids productions, and a consequence, does not change pH (P>0.05). However, lowered protozoa population decreased NH_3-N content (P<0.05). Cumulative gas production resulting from substrate (rice straw) fermented by rumen liquor from sheep fed MES-added diet (III) increased by 13% when compared to control (I)). Compared to control (I), average daily gain of sheep fed MES-added diet (III) is increased by 44% with an improved efficiency by 28%.

Key words : Saponin, protozoa, bacteria, performance of sheep

INTRODUCTION

Productivity of ruminant animals can be improved by manipulation of microbial ecosystem in the rumen. Defaunation approach for improving ruminal digestibility is in under debate. Elimination of rumen protozoa reduces bacterial turnover and methanogenesis up to 45% (JOUANY, 1991) and increases the flow of dietary amino acids in the duodenum of ruminants (USHIDA *et al.*, 1989). Besides that, it was also reported by JOUANY *et al.* (1981) that defaunation lowers fibre digestion and increases rumen starch degradation. However, ruminal digestion of rice straw was found to be increased when protozoa population was suppressed (THALIB *et al.*, 1994). It was suggested by VAN NEVEL and DEMEYER (1988) that the balance of all interrelated effects must be considered when defaunation system is conducted to improve ruminal fermentation. They observed that de-

faunation can be useful to improve the growth of ruminants that are fed diets short in available protein.

Preliminary report on the use of saponin from *Sapindus rarak* to improve productivity of sheep fed grass with an extremely minimum level of concentrate has been extended (THALIB *et al.*, 1995) and is now detailed in this paper. Efficient methods of defaunation specified by JOUANY (1991), must eliminate protozoa completely and have no negative effects on host animals, bacteria and fungi. In this work, protozoa were not eliminated completely and, therefore, the system used is considered as a partial defaunation.

MATERIALS AND METHODS

Eighteen local sheep with a mean liveweight of 14.67 ± 1.34 kg were randomly divided into 3 treatment groups. Each group consisted of 6 animals. All animals were fed a mixture of elephant and native grasses (50:50) *ad libitum* + concentrate, CP 16% (0.5 % of live weight).

The treatment groups were : I. No additive, II. Addition of placebo and III. Addition of methanol-extracted *Sapindus rarak* containing 14.6% saponin (MES) at level of 0.07% of liveweight. MES was obtained from previous work (THALIB *et al.*, 1994).

Feeding treatments were conducted for 14 weeks including 2 weeks adaptation period. Placebo (empty capsule) and MES were given orally every 3 days. Rumen liquor of all animals were collected in the third week and measured for populations of protozoa (universal whitlock method) and bacteria (roll tube method according to procedure of OGIMOTO and IMAI, 1981); pH (pH meter); concentrations of lactic acid, volatile fatty acids (gas chromatography) and NH_3-N (conway method); and ruminal digestibility using a new laboratory procedure developed by THEODOROU and BROOKS (1990). Rumen parameters (including the ruminal digestion of the substrate) were measured for each treatment with 6 replications. Measurements for host animals were bodyweight and feed consumption. Dry matter intake was measured 8 weeks after the treatment diets were fed and lasted for 2 weeks. The intake of grasses and feed refusal were measured every day.

Data were subjected to the analysis of variance based on a completely randomised design. Differences between treatment means were examined using the least significant difference test (STEEL and TORRIE, 1980).

RESULTS AND DISCUSSION

Ecosystem of rumen

It is shown that methanol-extracted *Sapindus rarak* fruit (MES) eliminates protozoal population by 57% and sequently increases bacterial population by 69% as compared to the control animals (Table 1). Increment of bacterial population caused by lowered protozoal population is in agreement with the results of previous *in vitro* study as reported by KURIHARA *et al.* (1978) and by THALIB *et al.* (1994).

Table 1. Ecosystem of rumen liquor of sheep

Measurements	Treatments		
	I	II	III
Protozoa ($X\ 10^4$ cell/ml)	67.9^b	62.6^b	29.1^a
Bacteria ($X\ 10^8$ colony/ml)	24.0^a	23.5^a	40.6^b
pH	6.74	6.76	6.72
Lactic acid (mg/ml)	0.11	0.14	0.12
Total VFA* (mg/ml)	5.23	5.30	5.20
NH_3-N (mg/L)	50.92^b	51.94^b	36.61^a

Means in the same row with different superscripts showed significant difference ($P<0.01$ for protozoa; $P<0.05$ for bacteria and NH_3-N)
* Volatile fatty acid

Lowered protozoal population has no effect on lactic acid and total VFA productions, and as a consequence, does not change pH. The inverse relationship between lactic acid production and the presence of ciliate protozoa was indicated by NAGARAJA and TOWNE, (1990). Unchanged content of lactic acid in the lowered protozoa count (treatment III) is likely due to changing compositions in both protozoa and bacteria and as a result of their interaction in the rumen. Fermentation of lactic acid in the rumen are usually associated with the bacteria (NAGARAJA and TOWNE, 1990), so that, any increment of lactate in lowered protozoal population would be fermented by bacteria which was higher in the rumen (treatment III). Defaunation either brings on the decrease in total VFA production (JOUANY *et al.*, 1981) or has no effect on the total VFA (ITABASHI *et al.*, 1982; GRUMMER *et al.*, 1983). Decreased NH_3-N content caused by lowered protozoal population agree with a

report of JOUANY (1991). However, NH_3-N content in medium fermentation of treatment III affecting microbial synthesis is shown to be lower than optimal requirement (50 mg/L). Hence, it is predicted that increased rumen bacterial population in treatment III is mainly due to a lower predatory action of protozoa to bacteria.

Ability of treated rumen as digester of fibrous substrate

Cumulative gas production resulting from fermentation of the substrate (rice straw) by rumen liquor from sheep fed MES-added diet increased by 13% and it is in implied conformity with the digestion degree measurement of dry matter and organic matter (Table 2).

Table 2. Ruminal digestion of substrate (rice straw) for 96 hours incubation

Measurements	Treatments		
	I	II	III
Tot. gas production (ml)	165[a]	166[a]	187[b]
DMD (%)	48.17[a]	48.04[a]	50.56[b]
OMD (%)	47.81[a]	47.52[a]	50.27[b]

Means in the same row with different superscripts showed significant difference (P<0.05)
DMD : Day matter digestibility
OMD : Organic matter digestibility

Directly proportional relationship between gas production and dry matter and organic matter digestibilities agree with a previous *in vitro* study (THALIB *et al.*, 1994). Improvement of ruminal digestion is expected to happen before 48 hours fermentation as it is shown in Figure 1 that the peak of gas production appeared in 24 hours incubation, suggesting that there is a prospective effect of MES on rumen ability to degrade fibrous forages.

The ingestion of bacteria by protozoa is selective (KURIHARA *et al.*, 1968). Hence, increased microbial activity in treatment III is assumed not only affected by increased bacterial population but also by changed composition of the bacterial mixture in the rumen. Furthermore, fungal digestion of the substrate in treatment III might be increased, as indicated by ROMULO *et al.* (1986) that defaunation results in an increase in sporangia and zoospores in the rumen.

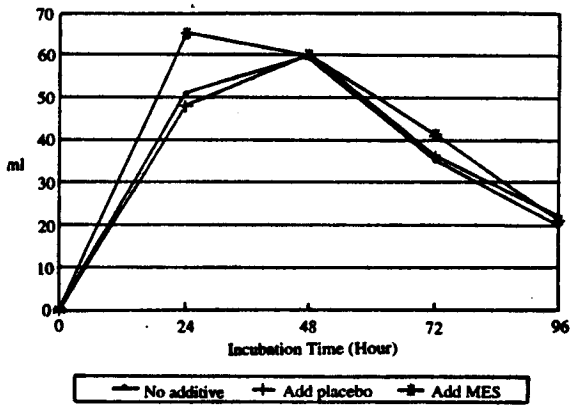

Figure 1. Rate of gas production resulting from substrate (rice straw) fermented by the rumen liquor of sheep

Effect of MES on performance of sheep :

Average bodyweight of sheep fed MES-added diet is consistently higher than other two dietary treatments during measurement of animals growth (Figure 2). Negative bodyweight gain found after adaptation period is due to accident of grass shortage that all animals had got

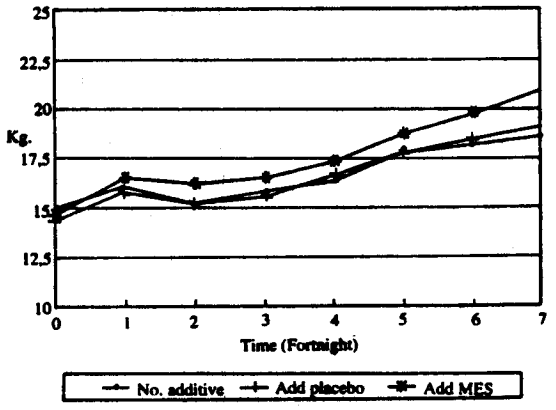

Figure 2. Curve of bodyweight changes of sheep

inadequate amount of grass. Compared to non-treated diet (treatment I), average daily gain of sheep fed MES-added diet (treatment III) is increased by 44% with an improved efficiency by 28% and it is in good conformity with the value of *in vivo* dry matter digestibility (Table 3).

Contradictory results of the effects of protozoa on fibre digestion in the rumen and performance of host ani-

Table 3. Growth rate, dry matter intake and *in vivo* drymatter digestibility.

Measurements	Treatments		
	I	II	III
Initial bodyweight (kg)	14.97	14.37	14.67
Final bodyweight (kg)	18.58[a]	19.07[ab]	20.93[b]
Average daily gain (g)	38.10[a]	44.76[ab]	54.82[b]
Dry matter intake (g/head/day)	695[a]	736[b]	724[b]
in vivo dry matter digestibility (%)	62.36[a]	63.68[ab]	64.91[b]

Means in the same row with different superscripts showed significant difference (P<0.05)

mals were documented in many literatures. Positive effects of lowered protozoa on host animals obtained are in related-discussion with the report of BIRD and LENG (1984). They found that weight gain and wool production were higher in defaunated than in faunated lambs. However, partial defaunation introduced in this work, means that protozoa in the rumen were not eliminated completely. Therefore, any positive effect of protozoa in the digestion system may have contribution in some extent.

Effectiveness of defaunation is determined by characteristic of defaunating agent used (VAN NEVEL and DEMEYER, 1988; JOUANY, 1991). Saponins have many possible chemical structures where the structure determines the characteristic of saponin. Thus, it is predicted that saponin prepared and used in this experiment has molecule structure which is effective for defaunating rumen protozoa.

CONCLUSION

The use of saponin from *Sapindus rarak* fruit in eliminating rumen protozoa can improve ruminal fermentation of organic matter by sheep resulting in a better performance without negative effects on the animals. Elimination of protozoa induces modification in other parameters of the rumen ecosystem such as bacterial population by which digestion of substrate is predominated by bacterial action. However, composition of bacterial population in the defaunated rumen should be examined due to selective ingestion of bacteria by protozoa.

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