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Feed Intake and Growth Performance of Goats Offered Napier Grass (*Pennisetum purpureum*) Supplemented with Concentrate Pellet and Soya Waste

(Prestasi Pengambilan dan Pertumbuhan Kambing yang Diberi Rumput Napier (*Pennisetum purpureum*) Ditambah dengan Pati Pelet dan Sisa Soya)

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ABSTRACT

The experiment was conducted to determine the feed intake and body weight (BW) change of Boer goats supplemented with a commercial concentrate pellet and combinations of concentrate and soya waste. Twelve male goats were divided into three groups. Each group was randomly allocated to each of the three treatment diets: Napier grass (Pennisetum purpureum) ad libitum *and concentrate pellet at rate of 2.0% of BW, daily (T1); Napier grass* ad libitum *and concentrate pellet at rate of 1.4% of BW and soya waste at rate of 0.5% of BW, daily (T2) and Napier grass* ad libitum *and concentrate pellet at rate of 0.9% of BW and soya waste at rate of 0.5% of BW, daily (T3). The results indicated that supplementation of concentrate pellet together with soya waste (T2 or T3) significantly (*$p<0.05$*) decreased intakes of grass dry matter (DM), total DM and total crude protein compared to the solely concentrate pellet group (T1). However, BW gain was significantly (*$p<0.05$*) higher in T2 treatment compared with the T1 or T3 treatments. Supplementation of concentrate pellet with soya waste (T2 or T3) significantly (*$p<0.05$*) improved the feed conversion efficiency and reduced the feed cost of goats compared with solely concentrate pellet group (T1). The results indicated that grass intake and feed cost can be reduced by replacing concentrate pellet with soya waste in the diet of goats where soya waste is available.*

Keywords: Concentrate; crude protein; feed conversion ratio; soya waste

ABSTRAK

Satu kajian telah dijalankan untuk menentukan tahap pengambilan makanan dan berat badan (BW) kambing Boer yang digantikan dengan pati pelet komersial serta kombinasi pati pelet dan sisa soya. Dua belas ekor kambing jantan dibahagikan kepada tiga kumpulan. Setiap kumpulan secara rawak diperuntukkan dengan setiap satu daripada tiga rawatan diet. Diet satu ialah daun rumput Napier (Pennisetum purpureum) ad libitum *dan pati pelet pada kadar 2.0% daripada BW, setiap hari (T1), Diet 2 ialah rumput Napier* ad libitum *dan pati pelet pada kadar 1.4% daripada BW dan sisa soya pada kadar 0.5% daripada BW, setiap hari (T2) dan Diet 3 ialah rumput Napier* ad libitum *dan pati pelet pada kadar 0.9% daripada BW dan sisa soya pada kadar 0.5% daripada BW, setiap hari (T3). Hasil kajian menunjukkan bahawa tambahan pati pelet dengan sisa soya (T2 atau T3) dengan ketara (*$p< 0.05$*) menurunkan pengambilan rumput bahan kering (DM), jumlah DM dan jumlah protein kasar berbanding dengan kumpulan yang mengambil pati pelet sahaja (T1). Walau bagaimanapun, kadar BW adalah signifikan (*$p< 0.05$*) lebih tinggi dalam rawatan T2 berbanding rawatan T1 atau T3. Tambahan pati pelet dengan sisa soya (T2 atau T3) dengan ketara (*$p< 0.05$*) meningkatkan kecekapan penukaran dan mengurangkan kos makanan kambing berbanding dengan kumpulan yang mengambil pati pelet sahaja (T1). Hasil kajian menunjukkan bahawa pengambilan rumput dan kos makanan dapat dikurangkan dengan menggantikan pati pelet dengan sisa soya dalam diet kambing.*

Kata kunci: Nisbah penukaran makanan; pati; protein kasar; sisa soya

INTRODUCTION

Supplementing commercial concentrates with low-quality grass is known to improve intake and digestibility of roughages. However, because of the high cost and uncertain availability of traditional concentrates, farmers search for alternatives. Alternative feeds are usually by-products and waste products from the processing of various food and fiber crops, or crop residues. These alternative feeds can fit into a feeding program as the primary roughage, as a supplement to a regular ration, or as a replacement for part of the ration (Myer 2003).

Soya waste is a by-product of soybean processing for tofu, soya milk and soya sauce production. In recent years, the supplementation of soya waste for ruminant feeding has increased owing to its availability and low cost in Malaysia. Large amounts of this by-product are produced locally almost all year round from large factories in the urban and peri-urban areas. Soya waste is high in crude protein (CP) (23.8 g/kg DM) and high in metabolisable energy (ME) (11.2 MJ/kg) contents (Dong et al. 2005). Inclusion of soya waste in the diet of sheep has been shown to increase the glucogenic propionate concentration in the rumen without

any negative effects on ruminal fermentation (Xu et al. 2001). Nevertheless, research regarding the use of soya waste as ruminant feed on the growth performance of goats has been limited. Thus, additional studies are required to promote the utilisation of this by-product as a ruminant feed.

We hypothesized that soya waste can replace commercial concentrate in the diet of goat without any adverse effects on growth performance due to its high protein and energy contents. Improved utilisation of residue generated by the food industry such as soya waste could reduce feed cost and environmental problems. The objective of this study was to determine the effects of supplementing soya waste on intake and growth performance of growing goats.

Materials and Methods

All experimental procedures, including animal care and sampling, were performed according to the Guidelines for Animal Experiment, University of Malaya, Malaysia. The experiment was conducted at the Goat Farm of Rumpun Asia Sdn. Bhd. (3° 28′ N latitude and 101° 38′ E longitude), Batang Kali, Selangor, Malaysia. Napier grass (*Pennisetum purpureum*) was established at the Goat Farm and fertilised with goat manure at 200 kg N ha^{-1} annually. Goat manure was applied twice over a 12 months period. The grass was harvested from four equal plots so that its maturity was controlled by cutting at different times in order to obtain similar quality throughout the experimental period. Each plot was used for 15 consecutive days and re-growths of three of the previously used plots were used again for completion of the experiment. The harvested grass was mechanically chopped to 5 to 7 cm length and fed to animals on a fresh basis. Soya waste was bought every week at a local soybean processing factory, stored in plastic containers and kept airtight (anaerobically). A total of 12 young (8-10 months old) male goats (Boer) with an average body weight of 17.1±1.1 kg (BW±SEM) were used and housed in an individual pen in this study. Before the commencement of the experiment, goats were treated for internal parasites with Bomectin as prescribed by the manufacturers of the product (Bomac Laboratories Ltd., Auckland, New Zealand). Goats were adapted to the feeding management for 14 days before the start of data collection, during which time they were fed Napier grass *ad libitum* and the commercial pellet (FFM Marketing Sdn. Bhd., Selangor, Malaysia) at a rate of 1.0% of BW. Four goats were randomly assigned to each of the treatments shown below in a completely randomized design:

T1 is the Napier grass *ad libitum* and concentrate pellet at 2.0% of BW, daily; T2 is the Napier grass *ad libitum* and concentrate pellet at 1.4% of BW and soya waste at 0.5% of LW, daily and T3 is the Napier grass *ad libitum* and concentrate pellet at 0.9% of BW and soya waste at 0.5% of BW.

Approximate ME from daily offered pellet and soya waste (except Napier grass) for T1, T2 and T3 diets were 4.16, 4.05 and 3.01 MJ, respectively. Similarly, approximate CP from daily offered pellet and soya waste (except Napier grass) for T1, T2 and T3 diets were 53, 63 and 50 g, respectively. The ME and CP intakes should be 6.8 MJ/d and 94.6 g/d, respectively, to meet the requirements of a goat weighing 17.4 kg and growing at 100 g/d, according to NRC (2007). It was hypothesized that goats can take the rest of the ME and CP from daily offered *ad libitum* Napier grass.

The pellets were offered twice a day at 0900 and 1500 h after dividing it into two equal portions, while the soya waste was offered in the morning meal throughout the feeding period which lasted for 90 days. Each animal had free access to a mineral block and water. Amounts of feeds offered and refused were recorded daily to estimate intake. Sub-samples of offered feed and residue were taken weekly for dry matter (DM) determination. To monitor BW change, goats were weighed every fortnight early in the morning before feed was offered. The rates of pellet and soya waste feeding were adjusted biweekly to account for BW changes.

Dry matter content of the feeds and refusals was determined by drying the samples at 70°C for 48 h. Feeds were analysed for nitrogen (N) and ash according to AOAC (1990). Organic matter (OM) was determined by subtracting ash from 100. Crude protein content was calculated as N×6.25. Neutral detergent fibre (NDF) was determined as described by Van Soest et al. (1991). The calcium (Ca) concentration in the feeds was determined by the flame atomic spectroscopy method after wet digestion with nitric acid and hydrogen peroxide (Laboratory of Agricultural Chemistry, the University of Tokyo 1978). Soluble oxalate was determined as described by Rahman et al. (2007). Data on feed intake and BW gain were analyzed using the General Linear Model procedure of SPSS (version 12.0, SPSS Inc., Chicago, IL, USA) as a completely randomised design with repeated measures. Least significant difference test was used to test the significant differences among treatment means when $p<0.05$.

Results

The chemical composition of feeds used in this experiment is shown in Table 1. Soya waste contained 279.5 g CP/kg DM, which was higher than the pellet (150 g CP/kg DM). Napier grass had low CP content (91.1 g/kg DM). The Ca concentration in pellet, soya waste and Napier grass was 11.5, 2.5 and 2.9 g/kg DM, respectively. The soluble oxalate content in Napier grass was 13.9 g/kg DM, while no soluble oxalate was found in pellet and soya waste. The mean daily DM and nutrient intakes of the experimental goats during the feeding trial are presented in Table 2. All of the daily offered pellet and soya waste were consumed. Intake of grass DM was significantly ($p<0.05$) higher at T1 treatment compared with the T2

TABLE 1. Chemical composition (g/kg DM) of the feeds

Parameter[#]	Concentrate pellet	Soya waste	Napier grass
DM	880.0	222.6	207.9
OM	933.0	946.9	902.9
NDF	240.6	305.2	670.4
CP	150.0	279.5	91.1
Ca	11.5	11.6	2.9
Soluble oxalate	ND	ND	13.9
ME (MJ/kg DM)[*]	11.7	11.2	7.45

[#]DM, dry matter; OM, organic matter; NDF, neutral detergent fibre; CP, crude protein; Ca, calcium; ND, not detected
[*]The ingredient compositions of concentrate pellet were grains (maize, wheat), brans (wheat bran, rice bran), soya bean meal, sesame meal, molasses, limestone, dicalcium phosphate, salt and feed additives.
[*]Calculated value (ME (MJ/kg DM) = 0.016 DOMD (g digestible organic matter/kg DM (AFRC 1998))

TABLE 2. Effects of soya waste and concentrate pellet on dry matter (DM) and nutrient intakes of goats

Parameter	Treatment		
	T1 (Mean ± SEM)	T2 (Mean ± SEM)	T3 (Mean ± SEM)
Grass DM intake (g/d)	396±23.7[a]	235±9.1[b]	229±14.3[b]
Concentrate intake (g/d)	352±18.2[a]	264±22.5[b]	176±13.8[c]
Soya waste intake (g/d)	-	83.8±8.0	83.5±7.7
Total DM intake (g/d)	742±26.4[a]	584±10.3[b]	489±16.0[c]
Total DM intake (g/kg $W^{0.75}$/d)	79.0±4.2[a]	60.0±3.2[b]	52.2±3.1[b]
Total DM intake (% BW)	3.8±0.2[a]	2.8±0.2[b]	2.5±0.2[b]
Total OM intake (g/d)	681±23.8[a]	539±9.3[b]	450±14.5[c]
Total OM intake (g/kg $W^{0.75}$/d)	72.5±3.8[a]	55.4±2.9[b]	48.1±2.8[b]
Total CP intake (g/d)	88.3±2.4[a]	84.5±0.9[a]	70.6±1.5[b]
Total CP intake (g/kg $W^{0.75}$/d)	9.4±0.4[a]	8.7±0.5[ab]	7.6±0.5[b]
ME intake (MJ/d)	7.0±0.2[a]	5.8±0.1[b]	4.7±0.1[c]

OM, organic matter; CP, crude protein; ME, metabolisable energy; [a,b,c] Means in the same row having different superscripts are significantly different (p<0.05); SEM, standard error of mean

and T3 treatments which had similar (p>0.05) values. There were also significant (p<0.05) differences in total DM, OM and CP intakes among treatments and replacement with soya waste reduced the total DM, OM and CP intakes. The total DM intake decreased (p<0.05) from 742 to 489 g/d and the total OM intake decreased (p<0.05) from 681 to 450 g/d when pellet was replaced with soya waste. Similarly, the goats showed a reduced intake of CP (g/kg $W^{0.75}$/d) when pellet was replaced with soya waste. The total CP intake (g/d) was significantly (p<0.05) lower at T3 treatment followed by T2 and T1 treatments.

The effect of replacement of concentrate with soya waste on BW change and feed conversion ratio (FCR) of goats fed Napier grass as a basal diet are presented in Table 3. Animals in T2 treatment showed higher final BW and average BW gain (p<0.05) compared with T2 and T3 treatment which had similar (p>0.05) values. There were also significant (p<0.05) differences in FCR values among treatment groups, in which goats supplemented with solely pellet (T1) had significantly (p<0.05) higher FCR than goats in T2 and T3 treatments. The highest BW gain and the best FCR of DM and CP were observed in T2 treatment. The feed cost was significantly (p<0.05) lower in the T2 or T3 treatments compared with T1 treatment.

DISCUSSION

The soya waste in the present study had a reasonably higher DM (222.6 g/kg) and CP (279.5 g/kg) contents than that reported by Dong et al. (2005). However, the NDF content (305.2 g/kg) of the soya waste was consistent with the value (322.0 g/kg) reported by Dong et al. (2005). The CP content of Napier grass used in this experiment was lower (91.1 g/kg) compared with the result (120.0 g/kg) obtained by Manaye et al. (2009). Feeds with high oxalate content could lower the availability of minerals since there is a negative relationship between oxalate and availability of minerals (Rahman et al. 2012). Soluble oxalate content of Napier grass is of concern, being reported as relatively high (Rahman et al. 2006). The level of soluble oxalate in the Napier grass used in this study was low (13.9 g/kg) and this level was not in the range where toxicity has been recorded in ruminants (Rahman et al. 2012).

In the present study, supplemented soya waste in the diet appeared to depress the intake of grass. This might be due to the high moisture content (78%) of soya waste. High moisture may cause a decrease in palatability which leads to a decrease in roughage DM intake as well as the filling effect of rumen. Some researchers reported that DM intake decreased with wood fibers of high moisture content

TABLE 3. Average daily body weight (BW) gain, feed conversion ratio (FCR) and feed cost in goat fed Napier grass supplemented with solely pellet or combinations of pellet and soya waste

Parameter	Treatment		
	T1 (Mean±SEM)	T2 (Mean±SEM)	T3 (Mean±SEM)
Initial BW (kg)	17.5±1.7	16.9±2.4	16.8±2.3
Final BW (kg)	22.5±1.7	23.5±2.9	21.6±2.8
BW gain (g/d)	56.1±2.5[b]	73.1±5.3[a]	53.3±6.8[b]
FCR (kg DM/kg BW gain)	13.4±0.8[a]	8.1±0.5[b]	9.4±0.7[b]
FCR (kg CP/kg BW gain)	1.6±0.08[a]	1.2±0.07[b]	1.4±0.11[ab]
Feed cost (RM)¶ for 90 days			
Grass	30.9	18.3	17.9
Pellet	36.0	27.0	18.0
Soya waste	0.0	8.4	8.4
Total cost	66.9±2.4[a]	53.7±0.7[b]	44.3±1.1[c]
Feed cost/kg BW gain (RM)	13.3±0.6[a]	8.3±0.6[b]	9.6±1.0[b]

[a,b,c] Means in the same row having different superscripts are significantly different ($p<0.05$); SEM, standard error of mean; ¶The costs of 1 kg of fresh feeds were: Napier grass=0.18 Malaysian Ringgit (RM), commercial pellet=1 RM, soya waste=0.25 RM. 1$US = 3.19 RM

(Clarke & Dyer 1973; Fifield & Johnson 1978) and it may be due to the filling effect of rumen capacity. The result of the present study also indicated that the total OM and the total CP intakes were significantly higher ($p<0.05$) in concentrate (T1) group compared with soya waste (T2 or T3) groups (Table 2) and this may be explained by feeding effect of soya waste which affected lower than grass DM intake. Although digestibility of nutrients was not measured, goats receiving T2 diet showed higher BW gain compared with T1 or T3 diets. This indicates greater digestibility of the grass, supplement or both when goats were supplemented with soya waste and pellet rather than solely pellet.

All the experimental goats showed moderate growth performances throughout the experimental period, which indicates that all the experimental diets had nutrient content above the threshold level for maintenance requirement of goats. The ME and CP intake should be 6.8 MJ/d and 94.6 g/d, respectively, to meet the requirements of a goat weighing 17.4 kg and growing at 100 g/d, according to NRC (2007). In this study, however, all the treatments showed a deficit in ME (except for T1 treatment) and CP intakes throughout the experimental period to achieve optimum growth. Rashid et al. (2005) reported that the BW gain of Boer goats for yearling was about 82 g/d. In another experiment, the BW gain of Boer goats was about 113 g during the 6-12 months of age (Javanmard et al. 2008), comparatively higher than the present findings. In this study, the weight gains attained in all groups were well below the potential of growing goat for growth and fattening. The expected weight gain for a profitable fattening should be double the weight gains achieved from 2.0% concentrate pellet feeding (T1) in this experiment. The relatively low weight gain in all groups might be explained by poor feeding management of kids after born as well as pregnancy period of does, which affected subsequently on kids weight gain and became stagnant. As a result, the experimental goats did not response properly on the treatment diets to achieve the optimum weight gain. Although replacement of pellet with soya waste resulted in decrease total CP and DM intakes, BW gain was higher in T2 treatment compared with other treatments. This result might be explained by the nutritional properties of soya waste used in this present study that has high in CP (238 g kg^{-1} DM), ME (11.2 MJ/kg) and Ca (11.6 g kg^{-1} DM) contents. Because of the relatively high CP, ME and Ca contents of the soya waste, the goats in soya waste groups (T2 or T3) may able to satisfy their nutrient requirements for reasonable weight gain. Inclusion of soya waste in the diet of sheep has been shown to increase the glucogenic propionate concentration in the rumen (Harjanti et al. 2012; Xu et al. 2001). Harjanti et al. (2012) reported that the inclusion of soya waste in the diets of sheep could ensure a positive N balance and resulted in similar plasma amino acid and glucose kinetics with commercial concentrate when formulated in the same energy intake.

Decreasing levels of replacement of pellet with soya waste had an effect on the FCR of DM. Similarly, replacing pellet with soya waste had also significant effect on feed cost per kilogram BW gain among diets. Feed costs were numerically reduced to around 35% (4.9 RM/kg weight gain), when 30-55% of the commercial pellet in the diet was replaced with soya waste (Table 3). In agreement with the current results, previous study has suggested that soybean curd residue silage could be used to replace commercial concentrate in the diet of sheep (Harjanti et al. 2012).

CONCLUSION

Supplementation of locally available soya waste with lesser amount of commercial pellet can significantly reduce grass DM intake and feed costs. Goats could be fed soya waste with pellet during growing period without compromising

their growth performance. Therefore, soya waste is a viable option to reduce the use of commercial pellet and the feed cost for production of goats where commercial pellet cost is high and grass production is limited.

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