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Effect of Napier grass ensiled with or without inclusion of soy waste on the performance of growing goats

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Abstract

Utilization of soy waste as a ruminant feed is low due to storage problems and transportation costs. An experiment was carried out with fifteen goats to assess the feeding value of Napier grass (*Pennisetum purpureum*) ensiled with or without soy waste. Grass ensiled without soy waste was termed as NM silage, while grass ensiled 30% soy waste (w/w) was termed as NMS silage. In both silages, 1.0% molasses (w/w) were incorporated to enhance the fermentation process. After 2 months of ensiling, three diets were formulated and assigned to one of three groups: (i) Napier grass *ad libitum* plus 1% pellet of body weight (BW) on a dry matter (DM) basis (T1), (ii) NM silage *ad libitum* plus 1% soy waste of BW on a DM basis (T2), and (iii) NMS silage *ad libitum* (T3). The NMS silage showed a lower pH (4.04 vs. 4.64) than NM silage. The NMS silage exhibited higher proportions of DM, organic matter (OM), and crude protein (CP) compared to NM silage. Animals received T1 diet showed higher ($p<0.05$) DM, OM and neutral detergent fibre intake compared to the animals received T2 and T3 diets. However, animals received T2 diet showed higher CP intake than the animals received T1 and T3 diets. Similarly, animals received T2 diet showed higher ($p<0.05$) BW gain (49.4 vs. 16.5 g/d) than the goats fed T3 diet. In conclusion, the T3 diet may have limited goat performance, which needs further study to improve the quality of silage.

1. INTRODUCTION

Due to health benefits in humans, the use of soybean products has currently increased. Baize (2013) reported that the global total soybean production, including soybean products, has reached 284 million metric tonnes. The global production of soybean in 2018 was about 346.02 million metric tons and Malaysia imported about 653000 metric tons soybean in 2017 (INFO source 2018). Besides the production of soybean products, there are a lot of soybean by-products during the extraction procedure, which requires to be thrown away, including soy waste. This by-product is suitable to use as a feedstuff for ruminant animals because it is high in nutrition, and it can be accessed easily and cheaply. However, the high content of moisture in soy waste makes it difficult to keep for a longer period of time. It can result in aerobic deterioration by growing mould and yeast, which can create an environmental problem.

Fresh soy waste can be fed to ruminants due to its high nutritional values. Rahman et al. (2015) reported that goats fed Napier grass with supplementation of fresh soy waste showed higher feed intake and body weight (BW) gain compared to the goats fed the control diet (common feeding practice at farm). Fresh soy waste as supplementation has been fed to the goats successfully (Rahman et al. 2014; Harthan and Cherney 2017), but the use of soy waste as a feedstuff for ruminant animals is still low due to storage problem and transportation cost, which requires to find out the sustainable solution. To overcome this problem, fresh soy waste must be ensiled or dried as early as possible so that it can be utilised efficiently for a long duration. For drying process, it is required specialised equipment and the resultant cost is high in relative to the product value. It can possible to mix soy waste with other feed ingredients or forage grasses down to 65-70% moisture, which is ideal moisture for silage making. Making of silage is an alternative method to increase the quality, and consequently, it can lead to stimulating intake and dry matter (DM) digestion in ruminant animals (Bureenok et al., 2012).

Although Napier grass (*Pennisetum purpueum*) is considered an inferior quality feedstuff (Ishii et al. 2005), the inclusion of soy waste may increase the quality of Napier grass silage due to high nutritional quality of soy waste. Based on the literature, there is little information on the effect of Napier grass ensiled with soy waste on the

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feeding value of goats. Therefore, the aim of this experiment was to assess the effects of ensiling the Napier grass with or without the inclusion of soy waste on performance in growing goats.

2. MATERIALS AND METHODS

2.1. Experimental site and silage formulation

This experiment was conducted at the goat farm in Rumpun Asia Sdn. Bhd. (RASB) (3° 28′ N latitude and 101° 38′ E longitude), Selangor, Malaysia. The research procedures applied in this experiment were approved by the Institutional Animal Care and Use Committee, the University of Malaya (Ref. No. ISB/11/08/2014/MMR-R). Soy waste was received from a local supplier, while molasses were purchased from the local market. Re-growth of Napier grass was cut at 45 days of plant maturity at the goat farm in RASB. Napier grass was cut mechanically into small pieces (2–3 cm). Two types of silages were prepared: (i) Napier grass ensiled with molasses at a rate of 10 g/kg fresh basis which may be termed as NM silage, and (ii) Napier grass ensiled with molasses at a rate of 10 g/kg fresh basis and soy waste at a rate of 300 g/kg fresh basis which may be termed as NMS silage. After mixture, it was stored anaerobically in plastic drums of about 60-liter capacity (dimensions: 62 cm high and 36 cm wide) and ensiled for 2 months. After 2 months of fermentation of silage, a feeding trial was initiated with growing goats.

2.2. Feeding trial

Fifteen male crossbred (Saanen × local) growing goats with an age of 4-5 months and an average initial body weight (BW) of 17.6 ± 4.5 (mean ± standard deviation) kg were distributed into three groups of 5 goats each. Prior to the start of the experiment, animals were dewormed to remove the gastrointestinal parasite. Goats in Group 1 were received fresh Napier grass *ad libitum* basis and commercial pellet at 1.0% of their BW/day on a DM basis (T1 diet as control). Goats in Group 2 were received the NM silage *ad libitum* plus fresh soy waste at 1.0% of BW/day on a DM basis (T2 diet), whereas goats in Group 3 were received the NMS silage *ad libitum* basis (T3 diet). The trial lasted for 98 days, comprising 14 days adjustment period and 84 days for the recording of data. Each animal was housed in an individual pen throughout the experimental period. Animals had free access to water.

2.3. Measurement of parameters

Twenty (20) g of silage was soaked in 100 ml distilled water, and pH of silage was recorded using pH meter. The daily feeds offered and refused were weighed. Feed intake was calculated by deducting the weight of the leftover feed from the weight of the feed given. Body weight of the experimental goats was recorded prior to starting the experiment, 14–day interval, and at the finishing of the experiment. Feeds and refusal samples were collected quantitatively once a week and dried at 70^0C for 48 hours for the determination of dry weight. The total collection of feed samples at the expiration of the feeding trial was pooled and ground to pass a 1.0 mm sieve for chemical analysis.

2.4. Chemical analysis

The proximate components of feed samples were analysed for DM, crude protein (CP) (nitrogen × 6.25), and ash using standard methods of AOAC (2005). Organic matter (OM) was estimated by subtracting the ash from 100. Neutral detergent fibre (NDF) was measured according to the procedure of Van Soest et al. (1991) without alpha-amylase and expressed inclusive of residual ash.

2.5. Statistical analysis

Data on intake and growth performance were subjected to one-way ANOVA using the Statistical Package for Social Science (SPSS) software version 12.0 (2005). Differences between significant mean values were separated using Duncan's multiple range test at $P < 0.05$.

3. RESULT AND DISCUSSION

The chemical composition of Napier grass, pellet, soy waste, and silages is presented in Table 1. The soy waste used in this experiment had low DM and NDF contents, while it had the highest CP content. The higher value of CP in soya waste has also been reported in our previous studies (Rahman et al. 2014; 2015). The DM contents of silages were lower (21.8-22.0%) than the DM value of 30% for ideal silage as suggested by Viana et al. (2013). This lower DM might be due to Napier grass and soy waste, which had low DM contents, i.e. 21.6% and 22.9%, respectively (Table 1). Molasses had little effect on the DM content because the amount used in silages was very small (10 g kg^{-1} fresh matter). The purpose of adding molasses in silage was to speed up the silage fermentation process.

Relative to the roughage feed, a lower NDF level in soy waste and the commercial pellet was desirable since it is considered as concentrate feed. The NMS silage had a lower pH value (4.04) compared to the NM silage, which had a pH value of 4.64. Duniere et al. (2013) stated that reducing pH silage prevented the growth of undesirable microorganisms. However, pH values of NM silage and NMS silage in this experiment were above than quality silage pH of 4.2, as suggested by Kung (2010). This higher pH value may be attributed due to the high fibre content of tropical forage (e.g., Napier grass). In this study, the inclusion of 1% molasses ensiled with Napier grass was shown insufficient to reduce the pH value to 4.2, which is thought to be the critical pH (Kung 2010).

Table 1: The pH of silages and chemical composition (g kg^{-1}, DM basis) of Napier grass, commercial pellet, soy waste, and silages.

Parameter	Napier grass	Commercial pellet¶	Soy waste	NM silage	NMS silage
pH	-	-	-	4.64	4.04
DM	216	895	229	218	220
OM	916	933	959	915	929
CP	98	150	272	87	142
NDF	673	241	278	653	554

NM silage, Napier grass ensiled with 10 g molasses/kg fresh matter; NMS silage, Napier grass enisled with molasses and soy waste (10 and 300 g/kg fresh matter, respectively); DM, dry matter; OM, organic matter; CP, crude protein; NDF, neutral detergent fibre.
¶The commercial pellet contained maize, wheat, wheat bran, rice bran, soybean meal, sesame meal, molasses, limestone, dicalcium phosphate, salt, and feed additives (FFM Marketing Sdn. Bhd., Selangor, Malaysia).

The fatty acid profile allows us to understand whether silages were properly ensiled, and anomalous fermentations were avoided or, at least, limited (Alves et al. 2011). Ammonia nitrogen content of silages is also

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important information in order to assess the overall quality of silages. However, in this study, fatty acid profile and ammonia nitrogen of silages were not measured due to a lack of laboratory facilities for analysis. As a result, conclusions from our data are limited in some respects. Nevertheless, we believe that the present findings can be generalized to a wide variety of applications and limitations of the study did not prevent the achievement of the stated objective. Further studies will have to investigate the fermentation characteristics of silages and its effect on rumen digestibility.

Table 2: Effect of Napier grass ensiled with or without soy waste on nutrient intake and growth performance of growing goats (n = 5 for each mean).

Parameter	Treatment diet (Mean ± standard error)			Sig. level
	T1	T2	T3	
Daily intake, g				
Total DM	608^{a}±61.9	464^{b}±23.2	388^{c}±17.9	*
Total OM	561^{a}±57.1	435^{b}±21.6	360^{b}±16.7	***
Total CP	60.9^{b}±36.3	83.4^{a}±3.9	55.1^{b}±2.3	***
Total NDF	309^{a}±32.4	216^{b}±11.5	215^{b}±9.9	*
Body weight, kg				
Initial	17.2±2.2	17.4±1.7	18.0±2.5	NS
Final	20.6±2.4	22.3±2.3	19.7±2.5	NS
Gain (g/d)	34.5^{ab}±3.5	49.4^{a}±7.9	16.5^{b}±8.3	*
FCR	19.0^{ab}±3.6	10.6^{b}±1.9	51.7^{a}±18.5	*

n, number of observation; DM, dry matter; OM, organic matter; CP, crude protein; NDF, neutral detergent fibre; FCR, feed conversion ratio. T1, Goats fed *ad libitum* Napier grass plus goat pellet at a rate of 1% of body weight (BW) on a dry matter (DM) basis; T2, Goats fed *ad libitum* NM silage and fresh soy waste at a rate of 1% of BW on a DM basis (T2); T3, Goats fed *ad libitum* NMS silage; ^{a,b,c}Means in the same row with different superscripts differed significantly (P <0.05). Sig., significance; NS, not significant (p>0.05); *, p<0.05; ***, p<0.001.

Results for the intake and daily BW gain of experimental goats are shown in Table 2. The animals received T1 diet had higher (P <0.05) DM, OM, and NDF intakes than those of the goats fed T3 diet. Differences were also observed on DM, OM and CP intakes between animals fed T2 and T3 diets, apart from NDF intake. Goats fed T2 diet showed the highest CP intake, which had resulted in higher average daily weight gain. The higher intake in animals received T2 diet, versus those fed the T3 diet, are probably due to the intake of fresh soy waste which was not ensiled with Napier grass, and the consequently higher daily BW gain was observed in T2 diet. In addition, growth performance of goats fed T3 diet was low possibly due to lower DM intake which provided lower energy. Yagoub and Babiker (2008) reported that DM intake was reduced at a low dietary energy (8.5 MJ/kg) possibly due to slow passage of ingesta and the diet that consisted of 8.5 MJ/kg metabolisable energy just enough to maintain goat's body condition. Experimental goats fed T2 diet received fresh soy waste at a rate of 1.0% of BW/day (DM basis) to maintain a similar adjusted dietary energy and CP concentration with animals fed T3 diet. The FCR of goats fed with T2 diet containing fresh soy waste was significantly (p<0.05) better compared to those fed with T3 diet containing ensiled soy waste. In addition, goats fed with control diet did not show any significant difference with the other dietary treatments. Both T2 and T3 diets would be performed the same way since the feed composition of T2 and T3 diets were similar, but it was varied in some parameters. Although the T3 diet showed better nutrient quality in terms of higher CP and lower NDF, animal consuming this diet performed poorly compared to the other two diets, and the cause may be due to too acidic condition (pH 4.04) in T3 silage (Table 1).

Silage quality could be improved by the addition of carbohydrate-rich ingredients (Chen et al. 2014). However, the inclusion of 1% molasses in this study was shown insufficient to improve silage quality. Based on the results of this study, we speculated that the addition of corn grain or high level of molasses in silage would cause greater intake and growth performance. Therefore, a further study is needed for improvement of silage quality, in which a high level of molasses or corn may be added during silage making. To better characterise the silage and to better justify the results achieved, there is still much research to be done to further investigate soy waste as a silage feed especially in terms of fermentation characteristics (fatty acids, ammonia nitrogen, non-fibre carbohydrate, lignin, and fat contents) and its effects on rumen digestibility.

4. CONCLUSION

Napier grass ensiled with soy waste showed a decrease in pH value and moderate intakes of DM and CP by goats, which had an influence on the goat's growth performance. The goats fed T3 diet showed lower daily BW gain than those of the animals fed T1 and T2 diets. However, fresh soy waste can be offered to goats fed NM silage (T2 diet), as the growth performance was highest in this study. The use of soy waste as feed is not only beneficial to livestock farmers but also helps to eliminate disposal problems faced by soybean manufacturers. More researches are needed to further investigate the silage fermentation characteristics in terms of volatile fatty acids and ammonia-nitrogen concentrations.

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