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Effects of Neem (*Azadirachta indica*) and Leucaena (*Leucaena leucocephala*) Fodders on Digestibility, Rumen Fermentation and Nitrogen Balance of Goats Fed Corn Silage

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Abstract: Eighteen crossbred (Thai native x Anglo-Nubian) goats were chosen from a commercial farm on the basis of similar bodyweight (17.0±3.8 kg). The goats were randomly allocated to three treatments in Randomized Complete Block Design (RCBD). Each goat was given corn silage as roughage plus the respective treatment diets. The diets were iso-nitrogenous and iso-energetic containing cassava pulp, molasses, urea and commercial mineral and vitamin mix. The experimental treatments were Soybean Meal (SBM), partial substitution of SBM with Neem (*Azadirachta indica*) fodder or partial substitution of SBM with Leucaena (*Leucaena leucocephala*) fodder. Nutrients intakes, ruminal characteristics (pH, ammonia nitrogen and volatile fatty acids), nitrogen balances, plasma urea nitrogen were not significantly different among treatments. The present results indicate that protein foliages locally grown shrubs and trees can substitute imported feedstuffs concentrate (e.g., SBM) as protein supplement for goat production.

Key words: Neem, leucaena, corn silage, digestion, goats

INTRODUCTION

Ruminant feeding systems based on poor quality roughage, where protein is one of the first limiting factors may require additional protein to maintain an efficient rumen ecosystem that will stimulate nutrient intake and improve animal performance (Preston and Leng, 1987). However, the supplementation of high protein and energy concentrates involves extra cost.

On the other hand, foliages from locally grown shrubs and trees such as Neem (*Azadirachta indica)* and Leucaena (*Leucaena leucocephala*) fodders have been successfully tested as protein supplements for ruminants (Arunachal *et al*., 2002; Kahindi *et al*., 2007).

The results of Kahindi *et al*. (2007) and Radihakrishnan *et al*. (2007) showed that local fodders or foliages have been successfully used as a protein source for ruminants. Based on these results, we selected Neem and Leucaena fodders to compare with a common protein source that is Soybean Meal (SBM) in a feeding trial in this experiment.

The purpose of the present study was to evaluate the effectiveness of the supplementation of protein fodders from Neem and Leucaena as compared to the control treatment (SBM) of growing goats based on corn silage as roughage.

MATERIALS AND METHODS

Eighteen crossbred (Thai native x Anglo-Nubian) goats were chosen from a commercial farm on the basis of similar body weight (17.0±3.8 kg). The goats were housed in individual pens and allowed 3 weeks to adapt to the experimental conditions.

The goats were allocated to three treatments in Randomized Complete Block Design (RCBD). The experimental diets were iso-nitrogenous and iso-energetic and based on corn silage, SBM, dried Leucaena and Neem fodders, cassava waste, molasses, urea, mineral and vitamins. Rations were formulated in accordance with NRC (1981). Drinking water was freely available to the animals. Feed intake was recorded and the refusal was sampled daily for chemical analysis. Goats were fed twice daily at 08:30 and 16:30. The experiment consisted of three weeks of adaptation, followed by 90 days of measurements feed intake and average daily gain. The latter consisted of 2 days of adaptation to the metabolic crates, 7 days of digestibility and N balance studies. Samples of feed refusal, faeces and urine were collected before feeding in the morning to determine digestibility and N balance.

Daily fecal output of each goat was measured and a 10% sub-sample collected and stored at -20°C. The samples were dried (60°C), ground through 1 mm sieve

and stored for chemical analysis. Daily urine excreta were collected into a plastic container (containing 25 mL of 10% H_2SO_4). About 10% of the urine was sampled later and frozen and stored at -20°C until the analysis for N contents. Rumen fluid samples from all goats were collected using a stomach tube at 0, 2, 4 and 6 h post-feeding during the digestibility trial of each period. Each sample was strained through 4 layers of muslin cloth and pH measured immediately using pH meter fitted with a combined electrode. The rumen fluid was then acidified with concentrated H_2SO_4 and kept at -20°C for analyses of ammonia (NH_3-N) and Volatile Fatty Acids (VFAs).

Blood samples were collected from the jugular vein at 0, 2, 4 and 6 h post feeding and after rumen fluid sampling during the penultimate day of digestibility trial. The blood samples were kept in ice prior to plasma separation by centrifugation (3,000 x g for 15 min) and plasma stored at -20°C for plasma urea analysis.

Feed samples were collected twice a week. Representative samples of feed and faeces collected during the digestibility trial were analyzed according to AOAC (1990) and fiber components (Van Soest *et al*., 1991). Apparent digestibility coefficients were calculated using equations of Schneider and Flatt (1975).

Total VFA and molar proportions of acetic, propionic and butyric acids of rumen fluids were determined by gas chromatography. Urea in plasma was determined by using the urea test kit (Sigma Diagnostics INFINITY™ BUN Reagent). Plasma urea N was analyzed by Spectrophoto meter and urea nitrogen standard.

Data were analyzed using the general linear model procedure of the (Statistical Analysis System Institute) SAS (1989). Duncan's new multiple range test was used to compare treatment means.

RESULTS

Nutrient compositions of the diets are given in Table 1. The DM content of diet used in this experiment ranged from 91.9-93.5% and the CP content ranged from 15.2-15.6%, while that of NDF ranged from 48.8-55.8% DM. The DMI, apparent digestibility and BW gain are shown in Table 2. Average DMI (g kg^{-1} $BW^{0.75}$), DM, OM, CP, NDF and ADF digestibility's were not significantly different among the treatments. The BW gain of goats did not differ among diets.

Ruminal pH, NH_3-N and PUN concentrations are given in Table 3. Ruminal pH decreased gradually and reached minimum at 4 h after feeding and thereafter increased. pH values ranged between 6.6-6.9 were not significantly influenced by time of sampling and diets. In all cases, the maximum NH_3-N was achieved at 4 h after feeding. In all cases, the maximum NH_3-N was achieved by 4 h after feeding. Although, overall ruminal NH_3-N concentration of the control treatment was numerically higher than the treatment groups these values were not significantly different. Similarly, PUN concentrations were

Table 1: Ingredients and chemical composition of the diets (DM%)

	Dietary treatments		
Ingredients	Control	Neem fodder	Leucaena fodder
Corn silage	40.00	40.00	40.00
Soybean meal	13.00	7.00	7.00
Neem fodder	0.00	12.00	0.00
Leucaena fodder	0.00	0.00	12.00
Ground corn	8.00	8.00	8.00
Cassava pulp	29.40	18.40	18.40
Molasses	5.00	10.00	10.00
Urea	2.40	2.40	2.40
Salt	1.00	1.00	1.00
Sulphur	0.20	0.20	0.20
Premix (min/vit)*	1.00	1.00	1.00
Total	100.00	100.00	100.00
Chemical compositions (DM %)			
Dry matter	92.40	93.50	91.90
Crude protein	15.60	15.20	15.50
Organic matter	91.50	89.80	91.20
Neutral detergent fiber	48.80	55.80	53.60
Acid detergent fiber	23.30	27.60	26.90

*Commercial mineral/vitamin premix

Table 2: Dry Matter intake (DMI), digestibility and body Weight gain (BW gain) of goats fed protein fodders supplementation

	Dietary treatments			
Ingredients	Control	Neem fodder	Leucaena fodder	SEM
DMI (day/g/kg $BW^{0.75}$	88.4	85.7	86.4	2.10
Apparent digestibility (%)				
Dry matter	69.3	67.6	68.9	1.90
Organic matter	70.3	68.8	67.1	2.91
Crude protein	58.6	57.9	57.3	1.97
Neutral detergent fiber	55.0	54.5	55.2	1.93
Acid detergent fiber	51.7	50.6	51.8	2.05
BW gain (g day^{-1})	55.5	52.0	53.5	2.11

Table 3: Effects of soybean meal substitution with fodders on ruminal pH, ruminal ammonia Nitrogen (NH_3-N) and Plasma Urea Nitrogen (PUN) in goats fed a corn silage-based diet

	Dietary treatments			
Ingredients (h)	Control	Neem fodder	Leucaena fodder	SEM
Ruminal pH				
0	6.8	6.9	6.9	0.01
2	6.7	6.8	6.7	0.01
4	6.5	6.7	6.6	0.01
6	6.7	6.8	6.8	0.01
Ruminal NH_3-N (mg dL^{-1})				
0	13.1	12.2	12.9	0.56
2	17.4	18.2	16.9	0.77
4	18.1	19.2	17.8	0.86
6	15.9	15.6	16.2	0.42
PUN (mg dL^{-1})				
0	16.1	16.7	15.9	0.33
2	18.2	17.5	16.8	0.41
4	18.9	18.7	18.5	0.49
6	16.2	15.9	16.2	0.34

SEM = Standard Error of Means

Table 4: Effects of soybean meal substitution with fodders on total Volatile Fatty Acid (VFA) and proportion of VFAs in rumen fluid in goats fed corn silage-based diet

	Dietary treatments			
Ingredients	Control	Neem fodder	Leucaena fodder	SEM
Total VFA (mM L^{-1}) (h)				
0	61.30	61.90	60.60	2.47
2	63.20	66.50	64.20	3.01
4	69.30	68.80	67.90	3.44
6	64.20	63.70	64.00	2.83
VFA proportions (% Molar)				
Acetic	66.00	65.90	67.10	2.27
Propionic	22.60	21.90	21.40	0.51
Butyric	11.40	12.20	11.50	0.44
Acetic:propionic ratio	2.92	3.01	3.14	0.13

SEM = Standard Error of Means

Table 5: Effects of SBM substitution with fodders on daily Nitrogen (N) balance in goats fed corn silage-based diet

	Dietary treatments			
Ingredients	Control	Neem fodder	Leucaena fodder	SEM
N intake (g)	45.2	47.0	47.1	2.46
N excretion (g)	-	-	-	-
Faeces N	18.7	19.8	20.1	1.23
Urine N	16.6	16.2	15.9	0.96
N digested (g)	26.5	27.2	27.0	1.43
N digested (%)	58.6	57.9	57.3	1.97
N retention (g)	9.9	11.0	11.1	2.02

maximum at 4 h after feeding and also not significantly ($p>0.05$) different among goats fed different protein sources.

The pattern of total VFA concentration (Table 4) was similar to the pattern of ruminal NH_3-N and PUN concentrations. Concentrations and proportion (molar%) of individual VFAs were not significantly ($p>0.05$) affected by goats fed different protein sources.

The ration of acetic to propionic acids (C2:C3) were not significantly ($p>0.05$) affected by goats fed different protein sources. No significant differences among the three treatments were found for N intake, faeces and urine N, N absorption and retention (Table 5).

DISCUSSION

Replacing Neem and Leucaena fodders did not significantly affect the average nutrient and digestible nutrient intake. No significant differences were found in ruminal pH, ruminal NH_3-N, PUN, total VFA and individual VFA concentrations between goats fed the control, Neem and Leucaena fodders was found. The marginally low total VFA values (60.6-69.3 mM L^{-1}) of all diets obtained could be due to the low NDF digestibility (54.5-55.2%).

The averaged ruminal NH_3-N value for goats in the different treatment groups was 12.2-19.2 mg dL^{-1} and was within the range of 10-20 mg dL^{-1} required for optimum digestion (Krebs and Leng, 1984; Leng, 1990). This study indicates that Neem and Leucaena fodders could substitute grain protein (SBM) up to 50% of total protein without affecting productive performances of goats.

The results are in agreement with resaerch of Saha and Muinga (2008), who reported that substitution >42% of concentrate with Leucaena foliage did not affect milk yield of cattle. Neem and Leucaena fodders also has been successfully used as a protein supplement for ruminants (Arunachal *et al*., 2002; Kahindi *et al*., 2007).

CONCLUSION

The results revealed that Neen and Leucaena fodders could substitute 45-50% of CP from SBM without affecting productive performances, ruminal fermentation and N balance. Neen and Leucaena fodders could be used for goats in the tropics as high protein.

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