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Effects of Supplementing a Basal Diet of Treated or Untreated Baggase with Different Levels of *Albizia lebbeck* on Intake, Digestibility and Rumen Fermentation

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Abstract: Four Nubian male goats were used in Latin square design to study the effects of untreated baggase supplemented with 150 g of *Albizia lebbeck* (US), 3% ammonia treated bagasse (T) and the treated bagasse supplemented with 100 g of *Albizia lebbeck* (TS1) or 150 g of *Albizia lebbeck* (TS2). Parameters measured were dry matter and crude protein intake, dry matter, crude protein and neutral detergent fiber digestibility and rumen fermentation. The results showed that the feed intake and dry matter, crude protein and neutral detergent fiber digestibility were significantly ($p<0.05$) higher for TS1 and TS2 than US or T. TS1 and TS2 gave the highest value of VFA, NH_3N concentration and lower pH value than T or US.

Key words: Bagasse, alkali treatment, *Albizia lebbeck*, digestibility, rumen fermentation

INTRODUCTION

Cellulose is the world's most widely available renewable resources, amounting to about 50% of the cell wall material of woody and herbaceous plant. Due to this abundance and renew-ability there has been a great deal of interest in utilizing cellulose as energy source and as feed for livestock. Many fibrous byproducts have a substantial potential value as animal feedstuffs. Ruminants especially have the unique capacity to utilize cellulose, because of their microbes. The shortage and high costs of conventional animal feed during dry season necessitates the use of agricultural byproducts in animal feed. However, the high lignin content, low level of soluble carbohydrate and relative absence of both fermentable and bypass protein are responsible for the low nutritional value of these byproducts (Leng, 1990). It has been recognized that in order to improve the nutritive value of lignocellulosic materials for livestock, some form of pre-treatment is required (Shah *et al*., 1983; Suksombat, 2004; Fadel Elseed *et al*., 2003; Attaelmnan *et al*., 2007). Generally the chemical treatments with alkali are more effective than other treatment. Ammonation improves the nutritive value of crop residues (Aregheore and Perera, 2004) by breaking the lignocellulose bonds and frees some of the cellulose for digestion by rumen microbes. However treatment in itself alone is not sufficient to meet the animal's maintenance requirements.

Supplementation is thus necessary in addition to treatment for meaningful production to be achieved supplement of agricultural byproducts with leave of tree legumes has been reported to increase DMI and DMD and offer an economical alternative to costly conventional protein supplement (Salem *et al*., 2006; Attaelmnan *et al*., 2009). *Albizia lebbeck* is a recognized fodder tree in India and Australia and it is one of a few tree species with record of leaf with a low content of toxin, tannin and phenolic compounds and through its relatively higher content of N, Ca but not P, appears to have potential as supplemented on animal feeding mature pasture grass or crop residues (Kennedy *et al*., 2002; Attaelmnan *et al*., 2009).

The objective of this experiment is to study the effect of supplementing a basal diet of treated or untreated baggase with different levels of *Albizia lebbeck* leaves on intake, digestibility and rumen fermentation.

MATERIALS AND METHODS

Feeds and feed preparation

Bagasse: About 250 kg of bagasse were weighed and filled in airtight container in layers then; 39 liters of ammonia solution were added to insure that all of the quantities were covered. After four weeks the container was opened for a few days to allow all excess ammonia gas to evaporate.

Leaves: Mature leaves were collected from different areas of Khartoum North city by hand picking from randomly selected trees, polled, air dried in a shaded place and stored.

Experimental animals and feed intake: Four male Nubian goats with pre experimental body weight of 11.5 kg were allocated to 4 treatments in a 4 x 4 Latin Square Design. The goats were all treated against ecto and endo parasites and were ear tagged. They have free

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access to water and mineral blocks. The diets used in experiment were: Treated bagasse *ad-libitum* (T); Treated bagasse *ad-libitum* plus 100 g *Alibiza lebbeck* leaves (TS1); Treated bagasse *ad-libitum* plus 150 g *Alibiza lebbeck* leaves (TS2); Untreated bagasse *ad-libitum* plus 150 g *Alibiza lebbeck* leaves (US).

The feeds were offered once a day at 8:30 a.m. First, the leaves supplement was provided and then treated bagasse was offered when the supplement is consumed. Feeds were weighed in a top loading balance. After each 2 weeks (adaptation period) faeces and urine were collected daily for 7 days. The experiment lasted for 84 days. During experimental period, animals were weighed weekly.

Rumen environment study: Rumen liquor was collected by stomach tube and sampled every 2 h up to 6 h post the morning meal. Immediately the pH was measured using standard pH meter. Then the fluid strained through two layers of cheese cloth, acidified with three drops of H_2SO_4 and stored at -20°C for further analysis. Rumen ammonia nitrogen (NH_3-N) and Volatile Fatty Acid (VFA) were determined according to Abdulrazak and Fujihara (1999).

Chemical analysis: Samples of feed examined and residues were analyzed for their proximate components, DM, ash and CP according to AOAC (1990). NDF, ADF were determined according to Goering and Van Soest (1970).

Statistical analysis: Data were analyzed by analysis of variance for a Latin squire design (Steel and Torrie, 1980), where the F test was significant; the treatment means were compared using Least Significant Difference (LSD).

RESULTS

Chemical composition: The chemical composition of treated, untreated bagasse and *Albizia lebbeck* was summarized in Table 1.

Feed intake: The effect of treated bagasse (T) or treated baggase supplemented with (100 g) of *Albizia lebbeck* (TS1) and (150 g) of *Albizia lebbeck* (TS2) or untreated bagasse supplemented with (150 g) of *Albizia lebbeck* (US) on feed intake, DM and CP was summarized on Table 2. The results showed that there was significant difference ($p<0.05$) in Bagasse Intake (BI), Dry Matter Intake (DMI) Crude Protein Intake (CPI) N Intake (NI) among treatments as shown in Table 3. The use of (TS1) or (TS2) had obtained the higher value of (CPI) 47.49 g/d, 44.75 g/d and (NI) 7.25 g/d 7.22 g/d respectively than animal fed on (US) or (T). There was a significant difference ($p<0.05$) in bagasse intake between (TS1) 240.46 g/d and (US) 108.36 g/d, however there was no significant difference ($p<0.05$) between (TS1), (TS2) and (T). Total Dry Matter Intake (TDMI) was significantly different ($p<0.05$) between (TS1) which gave the highest intake 335.5 g/d and (T) that gave the lowest intake 173.75 g/d, hence there was no significant difference ($p<0.05$) between (TS1), (TS2) and (US).

At equal levels of offered *Albizia lebbeck* (150 gm) but different in basal diet, treated or untreated bagasse daily intake of nutrient was higher to animal fed on treated bagasse than animal fed on untreated bagasse. Graded level of *Albizia lebbeck* (100, 150 g) supplement to treated bagasse did not show significant difference ($p<0.05$) in daily nutrient intake.

Digestibility and N retention: As shown in Table 2 there was a significant ($p<0.05$) difference among treatments on Digestibility of Dry Matter (DMD), Crude Protein (CPD) and Neutral Detergent Fiber (NDFD). Animal fed on (TS1) and (TS2) had a higher DMD and CPD and than (US) and (T). Animal fed on (TS1) had higher NDFD than animal fed on (US), (T+S2) and (T). Hence there was no significant difference ($p<0.05$) between (TS2), (US) and (T). It is clear from Table 3 that the urine nitrogen increased and N retention decreased significantly for (T) and (US) and higher N intake and N retention were observed for (TS1) and (TS2).

Table 1: Chemical composition (%) of *Albizia lebbeck,* treated and untreated baggase

	DM	CP	NDF	ADF
Albizia lebbeck	95.2	17.50	48.54	36.87
Treated bagasse	90.5	11.90	69.40	50.17
Untreated bagasse	92.5	2.11	88.70	61.67

Table 2: Effect of supplementing treated, untreated bagasse with two levels of *Albizia lebbeck* on feed intake and digestibility

		T	US	TS2	TS1	SEM
Feed intake (g DM)	Treated bagasse	173.75^{ab}	-	191.75^{ab}	240.46^{a}	30.54
	Untreated bagasse	-	108.36^{b}	-	-	
	Total DM	173.75^{b}	243.66^{ab}	334.55^{a}	335.49^{a}	29.46
	Total CP	20.68^{b}	27.28^{b}	44.78^{a}	47.49^{a}	2.85
Digestibility (%)	DM	53.10^{c}	62.70^{b}	68.64^{ab}	72.22^{a}	2.13
	NDF	56.33^{b}	60.10^{b}	61.68^{b}	70.19^{a}	2.11
	CP	55.01^{c}	58.17^{b}	66.84^{a}	68.10^{a}	1.74

(T) Treated bagasse with no supplement; (T+100) Treated bagasse supplement with 100 g *Albizia lebbeck*; (T+150) Treated bagasse supplement with 150 g *Albizia lebbeck*; (U+150) Untreated bagasse supplement with 150 g *Albizia lebbeck*; (DM) Dry Matter; (CP) Crude Protein; (NDF) Nutrient Detergent Fiber; (SEM) Standard Error of Means.

$^{a-c}$Means with different superscripts in the same raw were significantly different ($p<0.05$)

Table 3: Effect of *Albizia lebbeck* supplementation bagasse on N-retention

	T	US	TS2	TS1	SEM
N intake (g/d)	3.31^{b}	4.36^{b}	7.22^{a}	7.25^{a}	0.72
Faeces-N	1.72^{a}	1.92^{b}	2.47^{b}	2.28^{b}	0.72
Urine-N	1.30^{b}	2.04^{a}	1.68^{ab}	1.67^{ab}	0.15
N-retention	0.29^{b}	0.41^{b}	3.28^{a}	3.36^{a}	0.32

(T) Treated bagasse; (TS1) Treated bagasse supplement with 100 g *Albizia lebbeck*; (TS2) Treated bagasse supplement with 150 g *Albizia lebbeck*; (US) Untreated bagasse supplement with 150 g *Albizia lebbeck*; (SEM) Standard Error of Means.

$^{a-b}$Means with different superscripts in the same raw were significantly different ($p<0.05$)

Table 4: Effect of *Albizia lebbeck* supplementation bagasse on Rumen fermentation

	T	US	TS2	TS1	SEM
pH	7.40^{a}	6.48^{c}	6.82^{b}	6.79^{b}	0.02
VFA (mmol/dl)	5.34^{d}	8.20^{c}	10.20^{b}	10.51^{a}	0.01
NH_3-N (mg/dl)	10.41^{c}	9.35^{d}	14.75^{a}	13.21^{b}	0.26

(T) Treated bagasse with no supplement; (T+100) Treated bagasse supplement with 100 g *Albizia lebbeck*; (T+150) Treated bagasse supplement with 150 g *Albizia lebbeck*; (U+150) Untreated bagasse supplement with 150 g *Albizia lebbeck*; (VFA) Volatile Fatty Acid; (SEM) Standard Error of Means.

$^{a-d}$Means with different superscripts in the same raw were significantly different ($p<0.05$)

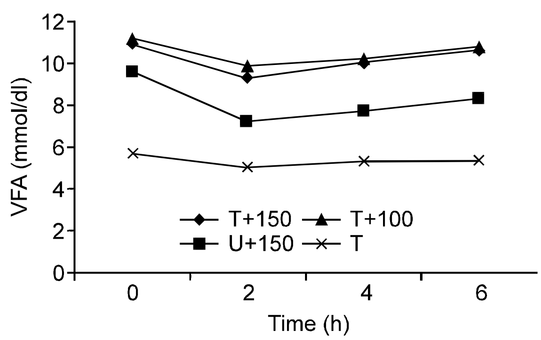

Fig. 1: Diurnal change in rumen total VFA of goat offered (T) Treated bagasse with no supplement; (T+100) Treated bagasse supplemented with 100 g *Albizia lebbeck*; (T+150) Treated bagasse supplemented with 150 g *Albizia lebbeck*; (U+150) Untreated bagasse supplemented with 150 g *Albizia lebbeck*

Rumen fermentation study: The mean values of pH, concentration of VFA and ammonia-N in the rumen liquor were shown in Table 4 and Fig. 1, 2. Rumen pH tended to decline for (TS1), (TS2) and (US) than (T). The lowest concentration of VFA recorded by (T) was 5.34 mmol/dl while the highest value recorded by (TS1) was 10.51 mmol/dl.

There was a significant difference in the concentration of NH_3-N in the rumen liquor among treatments with a higher value for (TS2) and (TS1) than (T) or (US).

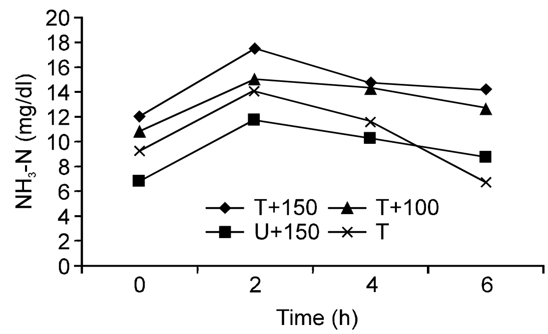

Fig. 2: Diurnal change in rumen ammonia-N of goat offered (T) Treated bagasse with no supplement; (T+100) Treated bagasse supplemented with 100 g *Albizia lebbeck*; (T+150) Treated bagasse supplemented with 150 g *Albizia lebbeck*; (U+150) Untreated bagasse supplemented with 150 g *Albizia lebbeck*

DISCUSSION

Chemical composition: DM content of treated bagasse and untreated bagasse were different, treated bagasse has lower DM, NDF, ADF and higher CP than untreated bagasse as a result of ammoniation of bagasse. This result agrees with other researches (Ngyuen *et al.*, 2001; Fadel Elseed *et al.*, 2003; Aregheore and Perera, 2004; Suksombat 2004; Attaelmnan *et al.*, 2007) who reported that ammoniation improves the nutrient values of agricultural byproducts. In the present study *Albizia lebbeck* has a high CP of 17.5 and low ADF, NDF compared to basal diet.

Feed intake: Nutrient intake from agricultural byproducts like bagasse which are characteristic by high lignocellulose and low nitrogen content are generally insufficient for maintenance requirement for goats if fed alone (Aregheore and Perera, 2004). Treatment of such material is advocated for breaking the lignocellulosic bond and freeing some of the cellulose (Suksombat, 2004). For digestion and increase CP content, however, treatment in itself alone is not sufficient to meet the animal maintenance and production requirements. Nitrogen has been identified to be the important factor limiting the utilization of nutrient of fibrous materials. Supplementation with low degradable protein is thus necessary in addition to treatment for meaningful production to be achieved (Attaelmnan *et al.*, 2009). Supplement with foliage legumes generally increase the total DM intake (Salem *et al.*, 2006). This may be attributed to the ability of foliage legumes to provide nitrogen, energy and vitamins which are limited in fibrous materials for rumen microbes resulting in an increase of microbial population leading to an increase in the degradation rate of poor quality roughages and to a higher digest passage rate. Lower intake of DM, CP and bagasse in animal fed on (US) or (T) was mainly reflection of the lower CP and higher NDF and ADF content in their diet.

Higher intake of DM, CP and bagasse in animal fed on (TS1) or (TS2) obtained in this study due to both ammoniation of bagasse with 3% ammonia solution results in an increased CP content from 2.11% to 11.9% and increased level of soluble fraction of cell walls of bagasse to be easily attached by microbes and thus increase in outflow of cell walls into lower digestion track and thus intake enhanced. This result supports earlier studies (Boodo, 1988), Stuart and Funora (1994). Hassoun *et al.* (2002) indicated that higher feed intake was observed when sugarcane residues were treated with urea from 57.5-72.8 g/kg. Also nutrient intake was enhanced in animal fed (TS1) or (TS2) could have been brought about by the positive effect of leaves of *Albizia lebbeck* supplementation which have alleviated nitrogen deficiency in the rumen thereby improving the rate of degradation of bagasse and the fraction outflow of liquid from the rumen and hence intake was enhanced. This result is in agreement with the result obtained by O'rden *et al.* (2000) who reported that Dry Matter Intake (DMI) was increased when low quality roughages were supplemented with leaves of tree legumes. Also Aregheore and Perera (2004) stated that leaves of *Gliricid sepium* and *Leuceana leucocephala* can be used as protein supplements to improve the nutritive value of maize stover in the diet of goats. Hindrichsen *et al.* (2002) concluded that supplementation of basal diet of maize stover with *Leuceana diversifolia* results in an increase in total feed intake.

At equal level of offer from *Albizia lebbeck* (150 g) to treated or untreated bagasse, treated bagasse supplemented with (150 g) of *Albizia lebbeck* promote a higher intake of nutrient than untreated supplemented with equal amount, this may be attributed to the fact that ammoniation treatment of bagasse resulted in an increase in CP and soluble fraction in treated bagasse.

Digestibility N-retention: The present study shows that the animals fed on (TS1) and (TS2) had a higher digestibility of DM, CP and NDF than animals fed on (US) or (T). In general, both ammonia treatment and supplementation with leaves of *Albizia lebbeck* to bagasse resulted in an increased nitrogen supply and delignification of bagasse. Since the rumen is the primary site for fiber digestion, the increase in apparent digestibility was presumably due to increased rumen degradability resulting from increased susceptibility of structural carbohydrates of bagasse cell walls to rumen fermentation as well as more energy and nitrogen being made available for better growth of rumen microbes which degraded bagasse. The increase in degradation rates as a result of increased bagasse degradability and better microbial activity as a result of supplying N, would cause substantial improvement in digestibility and feed intake.

The increase of digestibility obtained in this study due to supplementation with foliage legumes to treated agricultural byproduct agrees with the findings of Wambui *et al.* (2006) who stated that use of browse foliages greatly improves the intake and digestibility of treated maize stover.

It is clear from Table 3 the urine nitrogen increased and N-retention decreased in animal fed on (T) or (US) and higher N intake and N- retention were observed in animal fed on (TS1), (TS2). Faecal N is an important aspect in ruminant nutrition as it indicates the degree of protein degradability in the rumen. Animal fed on (TS1) or (TS2) relatively retained more N compared to animal fed on (US) and (T) and this is possibly due to positive associative effects of nitrogen intake. Positive N balance in this study is in agreement with the result obtained by Patra *et al.* (2003) who stated that animal received MPT leaves had positive N-retention.

Rumen fermentation: The general decrease in rumen liquor pH and increase in VFA (TS1) and (TS2) due to the supplement of MPT leaves and ammoniation were probably a reflection of the improvements in the ruminal fermentation rate as previously found by (Ngyuen *et al.*, 2001), which resulted in increased DMD and NDFD. These groups with higher digestibility showed higher values of VFA and lower value of pH. This is presumably because VFA is the end product of rumen microbial degradation and the more of VFA produced resulted in the lower rumen pH. The increase in the level of NH_3N in rumen liquor of animal fed on (TS1) or (TS2) diet may be due to high digestible crude protein of these diets resulting in an increase in NH_3-N concentration. This result is in agreement with (Ngyuen *et al.*, 2001).

Conclusion: Supplementation of treated bagasse with leaves of *Albizia lebbeck* had positive effects on intake of basal diet (bagasse), DMI, CPI, DMD, CPD and NDFD. High level of *Albizia lebbeck* did not give any increase in feed intake and digestibility coffcient compared to low level, therefore, *Albizia lebbeck* is consequently a species that may be used with good results in the feeding system for goats in small holder farm.

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