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Effect of Ammonia and Urea Treatments on the Chemical Composition and Rumen Degradability of Bagasse

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Abstract: The objective of the experiment was to investigate the effects of different alkali treatments on chemical composition and rumen degradability of bagasse. This experiment contained four treatments which included: untreated bagasse (Ba) served as a control, 3% urea (BaU3) 5% urea (BaU5) and 3% ammonia solution (BaA). Crude protein content of the treated bagasse was enhanced (P<0.05) over the untreated control and ranked as follows 10.5, 9.0, and 7.3 % for BaA, BaU5 and BaU3 respectively. NDF content was decreased (P< 0.05) from 87.9% for Ba to 84.2, 80.8 and 70.5% for BaU3, BaU5 and BaA respectively. Hemicellulose content was significantly (P< 0.05) decreased for BaA from 25.7 to 17.3%. ADL and ADF contents were decreased (P< 0.05) for BaA and BaU5 compared to BaU3 and Ba. Degradability of NDF was increased (P< 0.05) by alkali treatments from 12.3 to 52.7, 58.1 and 68.8% for BaU3, BaU5 and BaA, respectively.

Keywords: bagasse, ammonia, urea, NDF degradability

INTRODUCTION

Agricultural byproducts such as bagasse have enough potential to be used as non conventional roughage for animal feed in Sudan, particularly when forages are in short supply. Although these agricultural byproducts are low in protein, palatability and digestibility and thus their nutritive values, the value of exploring increased use of bagasse is of considerable importance. Like other agricultural byproducts bagasse contains lignocellulosic materials. The lignifications degree represents a steric barrier that prevents the enzymatic attach of ruminal microorganism on cellulose and hemicelluloses. Bagasse like other byproducts containing high fiber, responds to various treatments, chemical treatment[8,10,15] and biochemical treatment[2,7,11]. Chemical treatment has been reported, the most promising treatment to breakdown or disrupt the amount of lignin present in various byproducts thus increasing their digestibility[4].

The aim of the present study is to determine the effects of various alkali treatments on chemical composition and degradability of bagasse.

MATERIAL AND METHODS

Sample Preparation and Treatment: Two hundred g of sugar cane bagasse were weighed and placed in glass jars, and then the treated substrates were added. Three replicates were used per treatment. The treatments were: (1) Untreated bagasse served as a control (Ba); (2) bagasse treated with 3% urea (BaU3); (3) bagasse treated with 5% urea (BaU5) [kg urea/L water] and (4) bagasse treated with 3% ammonia solution (BaA).

The jars were tightly secured and incubated for seven weeks enclosed in the shaded places with an average temperature of 40°C. After seven weeks the samples were air dried, thoroughly mixed and ground in hammer mill to pass a 1 mm screen for chemical analysis and 2.5 mm screen for *in-situ* degradability.

Degradability Study: Degradability study of bagasse was carried out in a cannulated steer according to the nylon bag technique described by Ørskov *et al*[14]. Steer was fed at maintenance level on a balanced roughage concentrate diet with free access to water and mineral blocks.

About 3 g of treated and untreated bagasse were weighed into nylon bags (80 x 140 mm; pore size 45µ), and introduced inside the rumen. The bags were incubated for 4, 8, 16, 24, 48, 72 and 96 h for three consecutive periods. At the end of each period of time the bags were immediately removed and put it in a cold water to stop the rumen microorganism activity then washed under tap water. The dry matter disappearance at zero time (soluble fraction) was estimated as washing loss of sample weighed into the nylon bag and rinsed through running tap water. The residues in the bags were oven dried at 105°C. Residual samples after incubation were mixed, pooled and made ready for analysis. The degradation kinetics

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of the incubated experimental diet may described by curve linear-regression of NDF or CP loss from the bag with time.

$$P = a + b\ (1-e^{-ct}) \quad (1)$$

Where P=Potential degradability

a = Axis intercept at time zero represent soluble and completely degraded substrate that is rapidly washed out of the bag.
b = the difference between the intercept (a) and the asymptote, represent insoluble but potentiality degradable substrate which is degraded by microorganisms according first order kinetic
t = Incubation time.
c = Constant rate.

Equation (1) provides curve constants that can be used in conjunction with other predicted rates for specified diet to estimate the effective degradability of the sample.

$$\text{Effective degradability} = a\ \frac{bc}{c + k}$$

Where
a, b and c are constants as defined in equation (I)

k = Rumen small particles outflow rate.

Then a graph was plotted by the fitted values of NDF dis-appearance % against time of incubation in hours to form a curve.

Chemical Analysis: Samples of feed examined and residues were analyzed for their proximate components, DM, ash and CP according to methods of AOAC[1]. NDF, ADF and ADL were determined according to Georing and Van Soest[5]. All the analysis was run in triplicate

Calculation and Statistical Analysis: The result from in-situ study fitted to model $p= a+b(1-e^{-ct})$ of **Ø**rskov and McDonald [13] to determine the degradation characteristics of the incubated samples.

Data were analyzed by analysis of variance for a completely randomized design[17]. Where the F test was significant, the treatment means were compared using least significant difference (LSD).

RESULTS AND DISCUSSIONS

Results:

Chemical Change: Table (1) showed the chemical composition of treated and untreated bagasse.

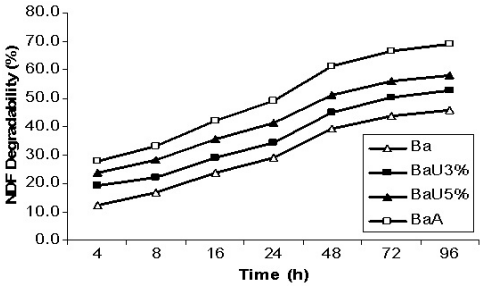

Fig. 1: Rumen degradation of NDF% of treated or untreated bagasse (Ba) untreated bagasse, (BaU3) Bagasse treated with 3% urea, (BaU5) bagasse treated with 5% urea (BaA) bagasse treated with3% ammonia solution.

All treatments significantly (P< 0.05) increased crude protein (CP) content from 2.11% for Ba to 10.5, 9.0 and 7.3% for BaA, BaU5 and BaU3 respectively. The cell wall fractions changed as follows: NDF content was significantly (P< 0.05) decreased for BaU3, BaU5 and BaA compared to Ba. The decrease in content of NDF for BaA was greater than BaU5 and BaU3. ADL and cellulose content were decreased significantly (P< 0.05) in BaA and BaU5 compared to BaU3 and Ba. A significant (P< 0.05) decrease in ADF and hemicellulose contents was observed in BaA compared to BaU5, BaU3 and Ba.

Nylon Bag Degradability: *In-situ* degradability for NDF increased among all treatments compared to untreated bagasse as shown in Figure (1). The soluble fraction (a) as shown in Table (2) increased significantly for BaA, BaU5 and BaU3 compared to Ba, while insoluble faction but degradable in the rumen constant (b), lag time (LT) and rate (c) of degradability showed no significant difference among all treatments (P< 0.05) as shown in Table (2), while potential degradability was increased significantly (P< 0.05) for BaA than BaU5, BaU3 and Ba. The effective degradability increased significantly among all treatments and in different rate of outflow.

Discussions: The urea and ammonia solution treatments of bagasse in the present study enhanced its nitrogen content, which contributed by the addition of nitrogenous substrate and the highest content was obtained by ammonia solution. This increase in CP was similar to that reported by Wanapat *et al*[20], Nguyen *et al*[12], Granzin and Dryden[6] and Fadel Elseed *et al*[3].

The NDF fraction for BaA, BaU5 and BaU3 was significantly lower than Ba. These declines in concentration of NDF among treatments may be enhanced with generic action of alkali on feedstuffs

Table 1: Chemical composition (%) of treated and untreated bagasse

	CP	NDF	ADF	ADL	HC	Cellulose
Ba	2.11[c]	87.90[d]	62.20[b]	10.3[b]	25.7[b]	51.9[b]
BaU3	7.30[b]	84.20[c]	59.90 [b]	9.66[b]	24.3[b]	50.24[b]
BaU5	9.00[ab]	80.80[b]	57.20[b]	8.33[a]	23.6[b]	48.87[a]
BaA	10.50[a]	70.50[a]	53.0[a]	6.6[a]	17.5[a]	46.4[a]
SEM	0.6	0.89	2.17	0.33	1.74	0.8

(Ba) bagasse, (BaU3) Bagasse treated with 3% urea, (BaU5) bagasse treated with 5% urea (BaA) bagasse treated with3% ammonia solution.(CP) crude protein (NDF) neutral detergent fiber (ADF) acid detergent fiber (ADL) acid detergent lignin (HC) hemicellulose.
(SEM) standard error of means: [a-d] means with different superscripts in the same column were significantly different (P< 0.05).

Table 2: Rumen degradation kinetics of NDF for treated or untreated bagasse fractions (% DM)

	Ba	BaU3	BaU5	BaA	SEM
A	11.07[d]	17.37[c]	20.83[b]	24.60[a]	0. 58
B	36.70	39.23	39.93	46.00	3.25
c	0.03	0.02	0.03	0.03	0.004
PD	47.7[c]	56.6[bc]	60.8[ab]	70.6[a]	3.48
LT (h)	2.97	2.77	1.67	2.13	0.62
ED2%	19.33[d]	25.23[c]	30.80[b]	36.37[a]	1.66
ED 5%	23.40[d]	29.23[c]	35.07[b]	41.50[a]	1.26
ED8%	32.30[d]	38.43[c]	44.33[b]	52.53[a]	1.09

a= readly degradable fraction; b= slow degradable fraction; c= rat of degradation; PD= potential degradability; LT= lag time; Ba= untreated bagasse; BaU3, BaU5= bagasse treated with3% and 5% urea respectively; BaA= ammonia solution treated bagasse; SEM= Standard error of means: [a-d] means with different superscripts in the same row were significantly different (P< 0.05).

that disturb the cell wall components resulting in increasing the soluble fraction. This result was obtained by Fiordos *et al*[4]. and Fadel Elseed *et al*[3].

Hemicellulose content for BaA was significantly lower than BaU5, BaU3 and Ba. This result is in agreement with result obtained by Lufadeju *et al*[9] who reported that the ADF and hemicelluloses content of gamba hay were not affected significantly when treated with 3% urea. Also Suksombat[18] indicated that the hemicellulose content of bagasse was reduced by NaOH treatment but not by urea treatment. Tengyun[19] indicated that the nutritional value and feeding benefit of using ammonia solution to treat wheat straw were obviously higher than urea.

Degradability of NDF fraction was increased significantly for BaA, BaU5 and BaU3 compared to Ba. This result may have been partially caused by alkali treatment which convert insoluble fraction to the soluble fraction. This effect may be due to alkali treatment to cell wall of fibrous materials are modified the bonds between lignin and structural carbohydrate are partially cleared, making it easier for rumen cellullytic bacteria to colonize and degrade ingested fibrous materials[12]. This is also may be due to the fact that more readily available fibrous are liberated and consequently rumen microbes can multiply faster and this degrades fibrous material faster[16]. The rate of NDF degradation tend to be greater in the first 48 hrs than is the latter period of incubation which may have resulted from high amount of nitrogen supply immediately after incubation. A greater nitrogen supply at the initial stage of incubation is also supported by an increase in the readily degradable fraction of CP.

Result of this experiment indicate that treatment of bagasse with 3% urea, 5% urea and 3% ammonia solution improve the nutritive value of fibrous materials in terms of increasing digestibility, however, the increment by ammonia solution was higher than urea. The advantage may give additional value for ammonia because of its availability in Sudan as a by-product from petroleum industry.

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