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Effect of Level of Urea in the Urea–Molasses–Mineral–Bolus on the Degradation Characteristics of Sugarcane Bagasse

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ABSTRACT. *An experiment was conducted to investigate the effect of level of urea in the urea–molasses–mineral–bolus on the degradation characteristics of sugarcane bagasse and on rumen and blood parameters for evaluating the potential of using urea–molasses–mineral–block to improve bagasse utilization in ruminants. Four castrated male buffaloes (Surti × Local) fitted with ruminal cannulas were used for the experiment. Rice straw was fed ad libitum. Nylon bags containing ground sugarcane bagasse were incubated in the rumen for 0, 8, 16, 24, 48 and 72 h to determine dry matter (DM) and organic matter (OM) degradation. Rumen and blood samples were obtained to examine rumen and blood parameters.*

The readily soluble fraction (a) of sugar cane bagasse was negligible. Dry matter disappearance from the nylon bags was similar (25.1, 26.1, 24.8, 28.0%) among the treatments. Organic matter disappearance was also similar (20.2, 22.7, 21.5, 24.4%) among the different levels of urea in the urea–molasses–mineral–bolus having UMM bolus containing 3, 6, 9 and 12% urea. However, potentially degradable (b) and total degradable fractions (a+b) were increased from 27 to 47% and 32 to 50%, respectively, with the increasing level of urea from 3 to 12%. Increased level of urea in the bolus increased ammonia concentration in the rumen fluid at all time intervals but could not enhance the degradation of bagasse. Rate of degradation or the 'c' fraction, declined (2.79% to 1.56%/h) with the increased level of urea in the bolus. Rumen pH was within the range for optimum rumen environment in all treatments, but blood urea nitrogen (BUN) was higher than normal physiological values when the urea level in the bolus was increased to 12%.

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No specific trend was observed in total volatile fatty acids (TVFA). Organic matter degradability was lower than DM degradability, while potentially degradable and total degradable fractions were higher in all treatments. Although potential degradability of bagasse was increased with the increase in the level of urea in the bolus, it was still low for the bagasse to be utilized as the sole or basal roughage

INTRODUCTION

Fibrous agricultural residues are an integral part of ruminant feeding in rural livestock production systems of many developing countries of the tropical and sub-tropical region. Ruminant livestock in South and South East Asia depend largely on fibrous residues during dry seasons. Such residues contain nearly the same amount of gross energy as any energy concentrates (Ali *et al.*, 1993). Large quantities of these residues are produced at harvest or during processing of the crops as byproducts, but are not utilized maximally and often wasted in the field or in the processing grounds. Proper utilization of these residues could be an economical alternative to meet the increasing demand of animal feed.

Sugarcane bagasse is one such residue with great potential but with low (< 30%) digestibility (Ali, 1991). The low digestibility of bagasse is due to low availability of nutrients and this has become a major problem in using it as a ruminant feed. When bagasse is fed, supplementation with readily available energy and protein sources is necessary to enhance microbial growth and multiplication in the rumen and facilitate efficient degradation. Urea-molasses-mineral-block (UMMB) serves as an ideal alternative for this purpose, because molasses is also another byproduct of the sugar industry and available in abundance in areas where bagasse is available. The UMMB provides the small farmer with an economically viable supplement for his ruminant livestock to improve the efficiency of utilization of fibrous diets at a reasonable cost (Sansoucy *et al.*, 1988). Feeding of UMMB under small farm conditions involves certain practical problems such as excessive intake, rejection and variable hardness of the block. Therefore, this experiment was designed to study the feasibility of using the UMMB in the form of a bolus, and to investigate the effect of level of urea in the bolus on degradation characteristics of sugarcane bagasse and on rumen and blood parameters.

MATERIALS AND METHODS

The experiment was conducted at the SAREC/Buffalo Research Station of the National Livestock Development Board, Narangalle, Sri Lanka. Four castrated male buffaloes (Surti × Local) weighing 160±12 kg and 18±4 months of age, fitted with large ruminal cannulas were used for the experiment. Rice straw was fed *ad libitum* as the sole basal diet during the experiment and no concentrate feed was offered. Water was made available free at all times. All the other management practices adopted were the same for all the animals.

Nylon bags of 19×13 cm with a porosity of 41 μm containing five (5) g of untreated ground sugarcane bagasse (ground to pass through a 2 mm sieve) were used in duplicate for each incubation period in each animal for each treatment. Four (4) different levels of urea (3, 6, 9 and 12%) in the bolus were used as treatments. Composition of urea–molasses–mineral–boluses used in this study is given in Table 1. Boluses were prepared by mixing the ingredients manually and keeping for a week to harden. Cement was used as a binding agent to enable a slow release of nutrients in the bolus inside rumen. Each

Table 1. Ingredient composition of different urea–molasses–mineral–boluses.

Components (g/kg)	Treatments			
	T1	T2	T3	T4
1. Molasses	450	450	450	450
2. Urea	30	60	90	120
3. Rice bran	340	310	280	250
4. Cement	100	100	100	100
5. Mineral mixture	50	50	50	50
6. Common salt	30	30	30	30

bolus (one formula at a time) was 400 g in weight introduced at 0600 and 1600 h daily into the rumen for 10 consecutive days during the adaptation period prior to the introduction of nylon bags for incubation. The nylon bags were introduced to the rumen for incubation, 2 h after the introduction of the bolus.

Nylon bags were introduced to the rumen through the rumen canula for all treatments at 0800 h and incubated for periods of 0, 8, 16, 24, 48 and 72 h to determine the DM and OM degradation. After each incubation period, respective bags were removed from the rumen, then dipped in ice water to prevent further microbial activity and washed in a washing machine till the water was clear. Washed bags were dried in a forced air oven at 60°C.

Rumen fluid and blood samples were collected during the incubation study to monitor the rumen pH, NH_3-N, TVFA and Blood Urea Nitrogen (BUN) during a 24 h cycle at the time intervals of 0, 2, 4, 8, 16 and 24 h. Rumen fluid drawn through the rumen canula using a large glass syringe was strained through a double layered cheese cloth. The pH was measured immediately after collecting the rumen fluid and a part was stored in pre-acidified culture tubes at -20°C until further analysis. Blood samples were collected from jugular vein, stored at room temperature for 8 h and serum was separated following centrifugation at 2500 rpm for 10 minutes. Serum collected was deep frozen (20°C) in plastic vials until further analysis.

Laboratory analysis for DM and OM (AOAC, 1980) disappearance, rumen pH (electrometrically), NH_3-N, TVFA (AOAC, 1980) and BUN (FAO/IAEA) were determined in the respective samples.

Results obtained for DM and OM disappearance were plotted as per the exponential equation $p = a = b\,(1 - e^{-ct})$ (Mehrez and Orskov, 1977), where,

p = Degradability (%) at time, t,
a = Readily soluble fraction, (%)
b = Insoluble but potentially degradable fraction (%),
e = Base to the natural logarithm,
c = Rate constant (%/h), and
t = time (h)

Rumen pH, NH4-N, BUN and TVFA monitored during the 24 h incubation cycles, were plotted against time of which the sample was drawn.

RESULTS AND DISCUSSION

Disappearance of DM and OM from the nylon bags is given in Tables 2 and 3. The readily soluble fraction (a) of sugarcane bagasse was very low indicating an extremely low availability of soluble nutrients for microbial

Table 2. ***In situ*** **dry matter degradability of sugarcane bagasse as affected by the level of urea in the urea–molasses–mineral–bolus.**

Time (h)	Treatments			
	T1	T2	T3	T4
0	5.0	4.7	2.6	3.6
8	9.2	6.9	7.7	6.8
16	14.5	17.0	12.4	12.3
24	17.7	19.7	15.5	18.3
48	25.1	26.1	24.8	28.0
72	27.6	33.0	31.5	34.1
a	4.58	3.80	2.70	6.58
b	27.03	34.94	44.01	47.26
a+b	31.16	38.74	46.77	49.84
c	0.0279	0.0237	0.0146	0.0156
RSD	0.65	2.41	0.34	1.27
ERD	14.3	15.0	12.7	13.8

a = Readily soluble fraction (%)
b = Insoluble but potentially degradable fraction (%)
c = Rate constant (%/h)
a + b = Total degradable fraction (%)
RSD = Residual standard deviation
ERD = Effective rate of degradation

utilization as suggested by Ali (1991). Therefore, an external source of readily available nutrients is essential to maximize the efficiency of the microbes for better utilization of bagasse based diets. Dry matter disappearance of untreated sugarcane bagasse from nylon bags after 48 h was low amounting to 25 to 28%, which was not significantly different among the different levels of urea in the urea–molasses–mineral–bolus. Increased level of urea in the bolus and thereby

Table 3. ***In situ*** **organic matter degradability of sugarcane bagasse as affected by the level of urea in the urea-molasses-mineral bolus.**

Time (h)	Treatments			
	T1	T2	T3	T4
0	0.70	0.42	0.80	0.60
8	4.24	2.19	2.88	2.40
16	10.10	12.74	8.32	8.41
24	10.59	15.37	10.26	11.17
48	20.25	22.72	21.54	24.39
72	26.85	31.82	29.43	30.66
a	0.80	0.00	0.26	0.00
b	48.60	44.50	55.30	72.20
a+b	49.40	44.50	55.60	72.20
c	0.0106	0.0168	0.0103	0.0080
RSD	1.23	2.63	1.42	1.65
ERD	9.30	10.90	9.70	9.50

a = Readily soluble fraction (%)
b = Insoluble but potentially degradable fraction (%)
c = Rate constant (%/h)
a + b = Total degradable fraction (%)
RSD = Residual standard deviation
ERD = Effective rate of degradation

ammonia in the rumen fluid (Figure 1) did not increase the DM disappearance from the nylon bags as was anticipated. This could be due to the fact that cellulolytic bacteria require small amounts of amino acids and peptides as well as branched chain fatty acids, which are growth factors and can be synthesized from amino acids (Givens and Moss, 1995). This is in contrast with the reports

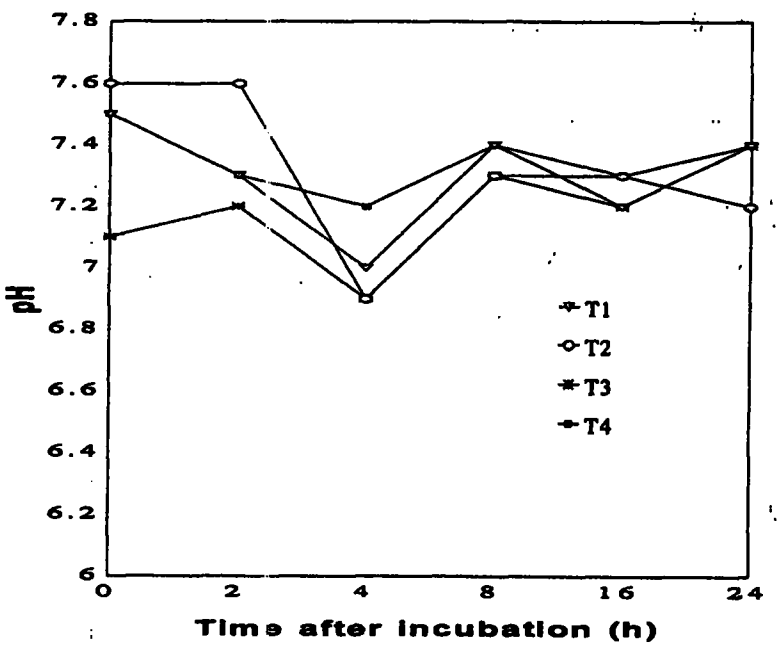

Figure 1. Effect of level of urea in the urea–molasses–mineral–bolus on rumen pH during 24 h cycle.

of Soetanto *et al.* (1988), Kunju (1986) and Sansoucy *et al.* (1988), but is in agreement with the findings of Schiere *et al.* (1988) who used other fibrous byproducts of sugarcane. Information on bagasse degradation in the presence of urea–molasses–mineral–bolus is scanty. In this study, the potentially degradable (b) and total degradable fractions (a+b) increased from 27 to 47% when level of urea in the bolus was increased from 3 to 12%, respectively. But the rate of degradation (c), decreased with increased level of urea in the bolus. A reduction in the rate of degradation and lack of positive effect on the DM disappearance from nylon bags might be due to fewer number of bacteria in the

rumen to saturate adhesion sites and less than optimal rate of colonization by the microbes (Orskov, 1986). This condition is a common characteristic when low quality highly fibrous feeds are used as the sole feed for a long duration. Organic matter degradability was lower than DM degradability (except potentially degradable and total degradable fractions which were much higher in all treatments) but both DM and OM degradability had similar trends (Tables 2 and 3). This implies a higher degradability of inorganic material in the bagasse than DM. Trends of other fractions were similar to that of DM.

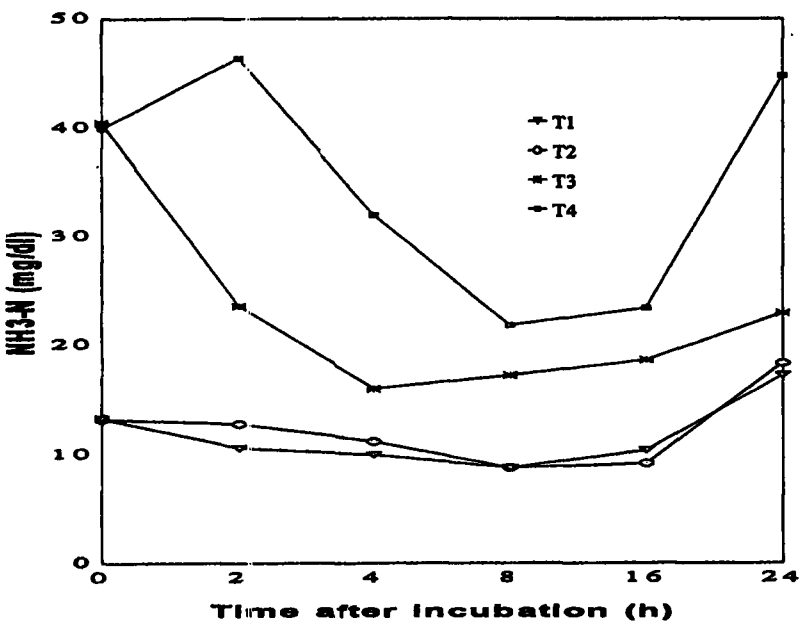

Figure 2. Effect of level of urea in the urea–molasses–mineral– bolus on rumen NH_3-N during 24 h.

Supplementation with UMMB would tend to rectify the nutrient imbalances in poor quality roughages by enhancing the microbial activity, resulting in high dry matter digestibility in the rumen and voluntary intake. However, in this study, the dry matter and organic matter digestibility and voluntary intake was not much affected. This may due to either the high undegradability of the baggase or unfavourable ratio of nitrogen to readily fermentable energy.

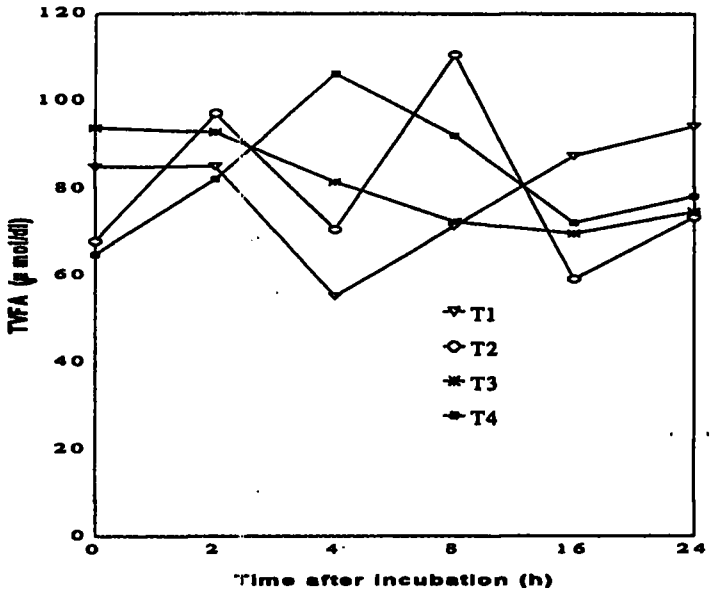

Figure 3. Effect of level of urea in the urea–molasses–mineral– bolus on rumen total volatile fatty acids during 24 h.

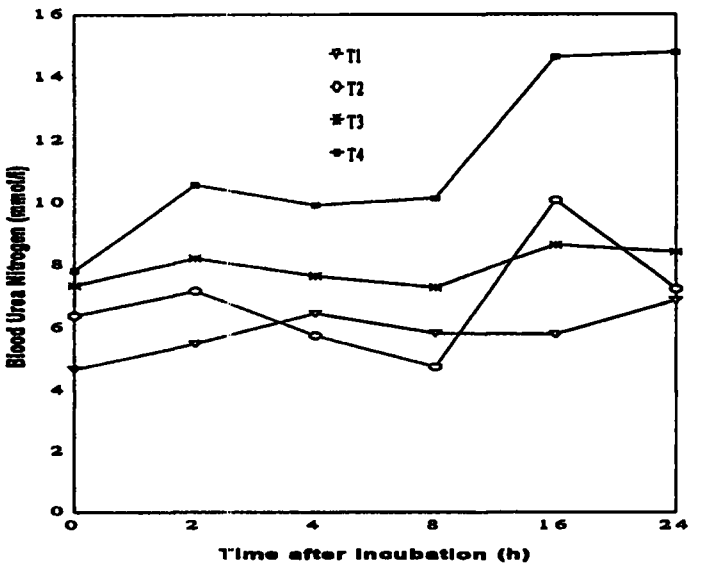

Figure 4. Effect of level of urea in the urea–molasses–mineral–bolus on blood urea nitrogen during 24 h cycle.

The effects of level of urea in the bolus on rumen parameters and blood urea nitrogen are shown in Figures 1–4. The pH of the rumen fluid was uniform at all times during 24 h cycle among the different levels of urea in the bolus. Increasing level of urea in the bolus increased ammonia concentration in the rumen fluid above 400 mg/l, but did not increase the DM or OM disappearance from nylon bags as evidenced from Tables 2 and 3. Increased concentration of ammonia in the rumen fluid was also reflected in BUN levels. Blood urea nitrogen levels increased with the increase of urea level in the bolus but were within the normal physiological levels except when the urea level was 12% in the bolus. These levels were within the recommended range for cattle (Whitaker and Kelly, 1990). This must be due to the loss of ammonia from the rumen indicating the inability of animals to utilize such a high level of urea in the bolus which could even lead to urea toxicity. Rumen pH was uniform and alkaline among all treatments and tended to fluctuate diurnally. No specific trend was observed in total VFAs.

The low response to urea–molasses–mineral–bolus suggests that supplementation of soluble nitrogen or readily available energy sources alone, is not sufficient to improve the utilization of sugarcane bagasse. This may be due to the presence of a physical barrier in the form of strong ligno–cellulose bondage. Therefore, in addition to supplementation to improve the nutritional status of the feed and to improve the availability of nutrients for microbial activity, chemical pre–treatment may be necessary.

CONCLUSIONS

Urea–molasses–mineral–bolus did not increase DM or OM degradation irrespective of the level of urea in the bolus. Therefore, it is unlikely that urea–molasses–mineral–block alone will increase *in vivo* utilization of bagasse. However, potential and total degradable fractions improved considerably except DM at 3% level of urea in the bolus, indicating that these fractions have the potential to be utilized. Although potential degradability of bagasse was increased considerably with increasing levels of urea in the bolus, the levels were still low for the bagasse to be utilized as the sole or basal roughage.

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