STUDIES ON UREA UTILIZATION IN SUGAR CANE DIETS: EFFECT OF LEVEL[3]

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50 Zebu bulls of approximately 180 kg live weight and one year of age were used in a production function design to determine the response in live weight, voluntary intake and feed conversion when different levels of urea were incorporated in the standard sugar cane diet supplemented with 1 kg/day of rice polishings. Molasses-based solutions containing 0, 75, 150, 225 and 300 g urea/litre were employed, each added to the sugar cane at the rate of 50 ml/kg of fresh cane. There were highly significant relationships between level of urea and all parameters of animal performance. The regression equations were (X = concentration of urea in dry matter): intake of fresh cane (kg/d) = 9.01 +.37X -.01X^2; voluntary consumption index (kg DM/100 kg LW) = 2.01 +.03X -.001X^2; gain in live weight (g/d)= 212 +18.5X -.22X^2; feed conversion (kg DM/kg gain) = 21.84$X^{-.22}$. The optimum concentration of urea appeared to be 35 g/kg dry matter of the diet.

Key words: Sugarcane, cattle, urea

In an earlier paper (Preston et al 1976), it was shown that a supplement of rice polishings plays a fundamental role in sugar cane diets in stimulating voluntary intake and, as a consequence, live weight gain and feed conversion. In absence of this supplement, when all the nitrogen was provided as urea, the daily gain in live weight was only 200 g, but this increased to 900 g when 1200 g/d of rice polishings was given. On this sugar cane diet, both the proportion of dietary nitrogen as urea (79%) as well as the total level of nitrogen in the diet (21.6 g N/kg DM) are well in an excess of those normally recommended for ruminant feeds (ARC 1965, NRC 1970).

The dietary characteristics of sugar cane feeds, particularly the nitrogeneous components, resemble closely those reported for diets based on final molasses (Preston 1973). So far, there has been no attempt to determine the optimum level of urea either in final molasses or sugar cane based diets. Generally, the levels used have been based on the results of Hume et al (1970) who reported the greatest rate of microbial synthesis (in terms of amounts of microbial protein per unit of fermentable carbohydrate)in diets which contained 24 g N/kg dry matter.

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The objective of the present experiment was to determine the optimum level of urea in a diet of chopped whole sugar cane supplemented with 1 kg daily of rice polishings, the latter representing the most economic level according to the previously cited paper of Preston et al (1976).

Materials and Methods

Treatments and Design: The treatments were five concentrations of urea in whole sugar cane equivalent to 0, 3.75, 7.5, 11.25 and 15 g/kg of fresh cane. These concentrations were obtained by preparing solutions of urea in final molasses containing 0, 75, 150, 225 and 300 g of urea per litre. The final molasses content of these solutions was constant (666 g/litre), varying only the amounts of urea and water (see table 1). The design was a production function with one group of 10 animals on each urea level. The distribution of animals was carried out at random within the two breeds that were used.

Table 1 :
Composition molasses/urea solutions

	Urea concentration, g/litre				
	0	75	150	225	300
Urea, kg	0	12.3	24.5	36.8	49.1
Final molasses	125	125	125	125	125
Water, kg	74.8	62.5	56.4	47.2	38.0
Total volume, litres	164	161	164	164	164

Animals and Diets: 35 Zebu steers and 15 Swiss/Zebu crossbred steers were used. They had previously been on pasture in different parts of the State, and on arrival had a mean live weight of 186 ± 90 kg (x ± SD) and were a little over one year of age. They were adapted to the standard sugar cane rations with normal levels of urea and rice polishings (see Preston et al 1976) and were then given a period of 12 days on the experimental diets before data were recorded.

All the animals had free access to chopped whole sugar cane (particle size ranged from 0.5 to 1 cm) to which had been added the appropriate solution of molasses/urea. Feeding of the sugar cane was twice daily, at 9 a.m. and 2 p.m. The rate of addition of the molasses/urea solution was 50 ml/kg of fresh cane.

A fixed level of rice polishings (1,000 g/head/day) was given as one feed in the morning before offering the sugar cane. All cattle also had access to minerals (salt 500, rock phosphate 470 and trace minerals 30 g/kg) and fresh water.

Procedure: The experiment was carried out in the fattening pens of CIEG and began on 20 March 1975 with a duration of 140 days. The description of the site, the climatic data and general procedure have been described by Preston et al (1976).

Measurements: The animals were weighed individually at intervals of 14 days, rate of live weight gain being determined by regression of live weight on time. Intakes were recorded daily, the residues being collected and weighed prior to the morning feed. Twice weekly samples of the chopped cane were taken for determination of Brix (hand refractometer) and dry matter (72 hr in an oven at 70 !). At the end of the experiment samples of rumen fluid were taken with a stomach tube for subsequent analysis for total VFA. These data will be reported in a separate paper.

Results

Health: There were no digestive upsets in any of the animals utilized in the experiment, even at the highest urea levels. One Zebu steer was withdrawn from the experiment after 56 days because of the septicemia. The data from this animal were excluded from the analysis.

Animal Performance: Mean values for live weight gain, feed intake and conversion for each treatment group are given in table 2. All parameters of animal performance were related positively with urea level (figures 1 and 2). In each case, the response follows the law of diminishing returns with the most marked degree of improvement occurring between urea treatments of 0 and 10 g/kg DM. In four of the treatment groups (table 3) crossbred animals had a faster rate of gain than Zebu, the overall difference/over 30%) being in their favour (P <.09).

During the trial there were increases in the percentage of dry matter and in the concentration of sugars (Brix in juice) in the cane, however, when this latter measurement was expressed on the basis of dry matter, there was an opposite tendency for sugar concentration to decrease as the experiment proceeded.

Discussion

The results of this experiment demonstrate very clearly the fundamental role of urea in the efficient utilization of sugar cane by the ruminant. Apparently even at the level of 225 g daily of urea (37 g/kg of diet DM) the optimum point had not been reached in terms of voluntary intake and gain in live weight. This level of urea is equivalent to 40 g of total N per kg of digestible dry matter in the diet and is already higher by almost 30% than that recommended by NRC (1970) and ARC (1965).

It is also above the value of 25.7 g nitrogen/kg of DM reported by 0rskov et at (1974) as the optimum for rumen microbial growth and live weight gain in lambs fed on barley.

Table 2:
Mean values for changes in live weight, feed intake and feed conversion
(10 animals per treatment group: duration of trial 140 days)

	Levels of urea in final molasses (g/litre)				
	0	75	150	225	300
Live weight, kg					
Initial	194.6	188.9	195.0	191.2	188.2
Final	195.9	239.9	262.1	269.3	270.2
Daily gain[1]	.009	.365	.479	.558	.586
Intake, kg/d					
Chopped sugar cane	9.05	11.78	14.47	14.63	15.03
Final Molasses	.35	.46	.55	.56	.58
Urea	0.00	44.76	108.45	164.7	225.6
Rice polishings	1.00	1.0	1.0	1.0	1.0
Minerals	.06	.06	.06	.06	.06
Total DM	3.86	4.78	5.65	5.81	6.01
Voluntary consumption index[2]	2.00	2.27	2.49	2.54	2.67
N, g/kg DM					
Total	8.62	12.1	16.2	20.2	24.3
As vegetable protein	8.62	7.82	7.36	7.18	7.09
As urea	0.0	4.28	8.84	13.0	17.2
Urea, g/kg DM	0.0	9.30	19.2	28.3	37.4
Conversion[3]	429	13.1	11.8	10.4	10.3

[1]Determined by linear regression of live weight on time
[2] Intake daily of DM (kg)/100 kg LW
[3] Intake of DM/gain in LW, kg/kg

These findings suggest that a different point of view may be needed when compounding rations based on raw materials such as sugar cane. The digestibility of whole sugar cane is approximately 61% (Montppellier and Preston 1976). If the sugars represent approximately 48% of the dry matter (figure 3) and are completely fermented in the rumen (Geerken and Sutherland 1969; Kowalczyk et al 1969,1970; Ramirez y Kowalczyk 1971); and that only 20% of the remaining fibre is fermented in this same organ (Valdez and Leng 1976), then it can be calculated that at least 90% of the total digestible material in a sugar cane ration disappears in the rumen. This figure is much higher than that of 74% for diets of barley (0rskov et al 1974) or 50-70% for forages (Philips et al 1960).

Figure 1:
Relation between urea concentration in the diet and live weight gain and feed conversion

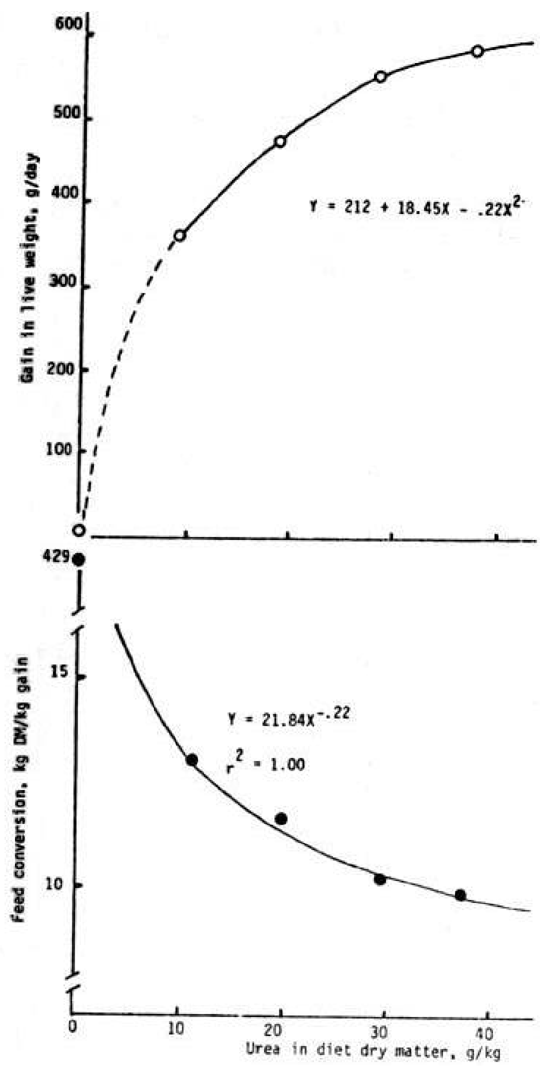
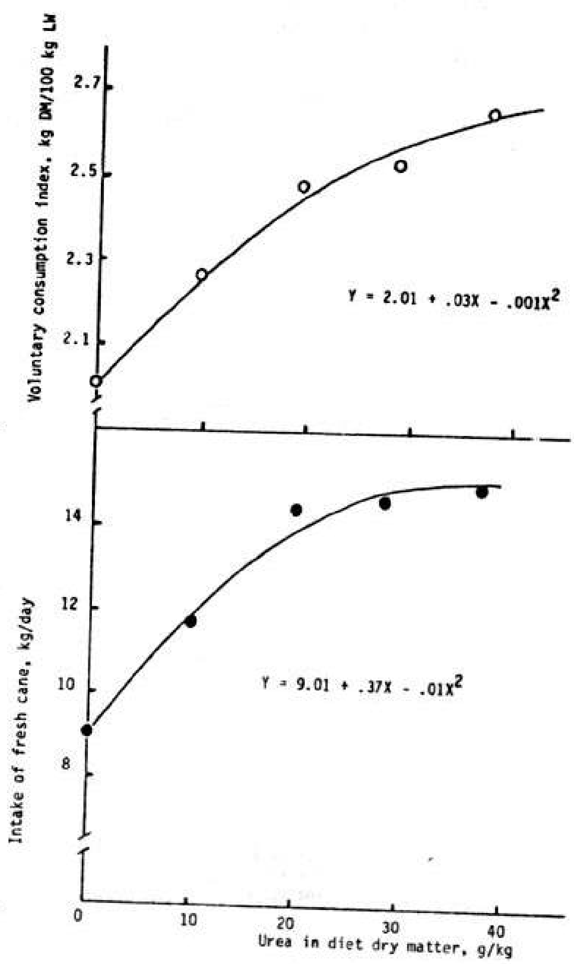


Figure 2 Relation between urea concentration in diet and intake and voluntary consumption index



Thus in sugar cane diets, that are digested almost entirely in the rumen by fermentation, it is logical to expect that the requirement for readily available N will increase. Moreover, sugars ferment much more rapidly than starch or structural carbohydrates and this also can be expected to give rise to a need for a larger intake of nitrogen in the diet.

It is therefore considered that the best reference points on which to base the composition of sugar cane diets, are those associated with the feeding of purified diets (e.g. Hume et al 1970) or with in vitro fermentations (Satter and Slyter 1974).

The optimum levels of N found by these two groups of workers were 32 and 35 g/kg digestible dry matter, respectively, which are only slightly lower than the value obtained in the present experiment of 40 g/kg digestible dry matter.

A notable tendency in this experiment was a reduction in live weight gain as the experiment progressed. This can perhaps be related to the season. The experiment coincided with the last 4 months of the dry season, one of the most severe recorded in the State. As a result, the leaves of the sugar cane tops were almost completely dry, to the point of presenting a yellowish-brown rather than the normal green colon At the same time, the proportion of top in the entire cane plant was reduced.

Figure 3:
Relation between Brix value in cane (dry matter basis) and stage of the experiment

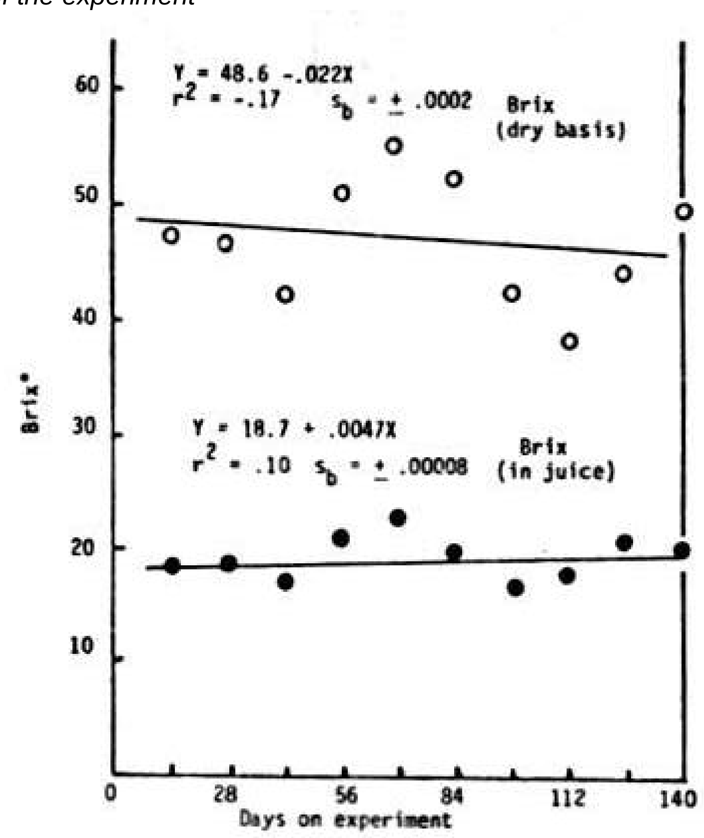


Table 3 :
Breed comparison for daily gain in live weight

	Urea concentration, g/litre					
	0	75	1500	225	300	X ± SEx
No. of animals						
Zebu	7	7	6	7	7	7
Crosses	3	3	3	3	3	3
Live weight gain, g/d						
Zebu	-25	358	450	520	489	358.4 ± 100
Crosses	87	336	537	632	812	480.8 ± 125
Difference[1]	112	-22	87	112	323	122 ± 63

[1] The significance of the difference between breeds, determined by the " t " test was P <.09

The deterioration in animal performance as the experiment progressed, can perhaps be attributed to these changes. It has been shown that although the sugar cane stalk is of higher digestibility than the tops, nevertheless performance is better when some tops are included rather than only stalk (James 1973; Ferreiro and Preston 1976). The fact that there was an improvement both in feed consumption and in daily gain, coinciding with the beginning of the rains when the cane tops again began to grow, tends to support these arguments.

The further demonstration (see Preston et al 1976) of better performance in crossbred steers (Brown Swiss or Holstein X Zebu) than in commercial Zebu, strengthens the argument for combined milk and beef production as a system for the tropics (Preston 1977).

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