INVESTIGATION OF DIETARY LIMITATIONS ON SUGAR CANE BASED DIETS[1]

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In 4 X 4 Latin square trials, addition of 0, 10, 13 or 16 g urea/kg cane stalk gave DM digestibilities (%) of 66.5[a], 68.9 67.7[ab] and 71.6[b] for diets of chopped cane stalk with mineral supplement addition of propionic acid 0, 10, 20, 30 g/kg cane gave digestibilities of 65.6[a], 67.1[ab], 68.9[ab], and 70.1, for diets of chopped whole cane with urea (10 g urea/kg fresh cane) and mineral supplement.

In random block growth trials (10 animals/treatment 5 animals/replicate) addition of 10 g propionic acid/kg fresh cane increased daily gain from 19 to 180 g/day;$(NH_4)_2SO_4$ at la/kg cane improved daily gains (g/d) from 412 to 584 (P <.06) a diet of cane (75 % stalk: 25% tops), urea (10 g/kg fresh cane) and minerals. Rice polishings (500 g/animal/d) were given in the $(NH_4)_2SO_4$ trial but not in the one with propionic acid.

Key words: Sugar cane, cattle, urea, propionic acid

Satisfactory levels of animal production can be achieved on diets of chopped whole cane supplemented with urea and rice polishings (Preston et al 1976) or a commercial protein source (Silvestre et al 1976). When rice polishings are given as supplement, response to urea can be clearly shown (Ferreiro and Preston 1976a, Alvarez and Preston 1976), but with only cane and urea, without rice polishings, growth is poor (Preston et al 1976).

Leng and Preston (1976) have suggested that "the chief constraint to animal productivity on sugar cape diets is feed intake, which in turn is limited by the supply of amino acids for protein synthesis and gluconeogenesis and of propionic acid for glucose synthesis". Diets based on whole cane (including tops) showed improved performance over diets of cane stalk alone (Ferreiro and Preston 1976b) suggesting greater dietary imbalance in the stalk portion. Literature values for sulphur in cane

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(Anon 1974) suggest that this element could be limiting in unsupplemented diets, the S/N ratio being well below the optimum found by Hume and Bird (1970) of 1/10 for microbial growth.

The present paper examines the effects in sugar cane based diets of (a) increasing levels of urea on intake and digestibility, (b) propionic acid on digestibility, consumption and growth ; and (c) additional sulphate on growth.

Materials and Methods

Dietary Treatments:

Experiment 1: Chopped cane stalk was supplemented with the following levels of urea : none, 10, 13 or 16 g/kg of cane. The cane/urea mixture was fed ad libitum.

Experiment 2: shopped whole sugar cane with 10% urea/kg cane was supplemented with the following levels of propionic acid none, 10, 20 and 30 g/kg cane. The propionic acid was adjusted to pH 4.0 with sodium hydroxide before feeding.

Experiment 3: Whole chopped cane with 10 g urea/kg was given without, or with 10 ml/kg of propionic acid.[1]

Experiment 4: Chopped whole sugar cane was supplemented (Per kg fresh cane) with: 10.4 g urea, or 10 g urea and 1 g ammonium sulphate.

General Procedure:
All the experiments were carried out with Zebu X Criollo steers of approximately 200 kg live weight. In experiments 1 and 2, they were individually housed, in experiments 3 and 4 they were in groups of five.

Sugar cane, supplied twice daily at 8:00 a.m and 2:00 p.m.,was at free access in all experiments as was water and a mineral mixture (NaCl 50%, rock phosphate 47%, and trace minerals 3%). In experiment 1 chopped cane stalk was used; in the remaining experiments whole chopped cane was the basis of the rations.

Digestibility experiments 1 and 2: In each experiment eight animals were used in balanced 4 x 4 latin square designs involving four treatments each of 18 days. Animals were in digestibility crates for the last 9 days and faeces collections made for the last five days. Feed consumption was measured daily by difference and 200 g samples of diet taken daily. Animals were weighed at the beginning and end of each treatment.

Growth experiments 3 and 4: In each of these experiments twenty animals were allocated at random to four pens with two replications of two treatments. Daily

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[1] Refers to equivalent amounts of pure (100%) propionic acid; the acid was actually given as a 50% solution.

consumption per pen was measured and 200 g samples taken for DM analysis Individual animal weights were measured every 14 days.

Results and Discussion

Table 1 shows the effect of addition of urea to the diet of cane stalks on digestibility and consumption. Urea at 16 g/kg cane increased digestibility over the control with no urea but indices of consumption of DM and digestible DM were unchanged. Throughout this experiment, animals had a mean weight loss of 149 g/d, there being no significant differences between treatments. The results indicate that despite the extremely low N intake on stalk alone (2% crude protein in DM) there was no response to additional N and that consumption was strongly limited by some other nutrient.

Table 1:
Mean values for digestibility and voluntary consumption index
for cattle fed chopped cane stalk with different levels of urea (experiment 1)

	Levels of urea in cane, g/kg			
	0	10	13	16
Digestibility of DM, %	66. 56[a]	68. 97 [ab]	67. 74 [ab]	71. 61[b]
Voluntary consumption index[1]				
DM	1.00	1.13	1.00	1.04
Digestible DM	.66	.78	.70	.72

[1] Feed intake (kg/d)/100 kg live weight
[ab] Means without superscript in common differ at $P < .05$

When propionate was present in the diet there were increases in overall digestibility of DM (significant at the highest level of propionate addition). Propionate can be considered 100% digestible and this is the reason for the differences observed; digestibility of the basic diet remained unchanged (table 2). Consumption index was unchanged by propionate addition but consumption of sugar cane was diminished. In this trial, consumption was close to maintenance there being a mean loss of 30 g/animal/day during the trial with no difference between treatments.

In growth experiment 3 (table 3), using chopped whole cane with urea without propionate, there was a negligible weight gain (19 g/animal/day) which rose to 180 g day, when propionate was included in the diet.

Table 2 :
Digestibility and voluntary consumption index for a sugar cane (stalk and tops)/urea diet with different levels of propionic acid (experiment 2)

	Propionic acid	ml/kg cane		
	0	10	20	30
Total diet				
Digestibility of DM,%	65.67[b]	67.15[ab]	68.99[ab]	70.10[a]
Voluntary consumption index[1]	1.30	1.30	1.20	1.27
Excluding the propionic acid				
Digestibility of DM, %	65.67	65.87	66.55	66.64
Voluntary consumption index[1]	1.30	1.25	1.11	1.27

[1] DM intake (kg/d)/100 kg LW
[ab] Means without common superscript differ at P <.05

Table 4 shows the effects of sulphate addition on a basic diet of cane (75% stalks: 25% tops)/urea with 500 g daily of rice polishings. Daily weight gains in this experiment were over 400 g/d for the control treatment, and over 500 g/d when sulphate was a4Je4. Feed conversion was specially good on this latter treatment

Table 3:
Change in live weight, feed intake and conversion for a sugar cane (stalk and tops)/urea diet with or without addition of propionic acid (experiment3; two groups of 5 animals per treatment for 42 days)

	Propionic acid, ml/kg cane		Significance level
	None	10	
Live weight, kg			
Initial	220.6	210.9	
Final	221.6	218.4	
Daily gain	.019	.180	P < .09
Total DM intake, kg/d	2.18	2.11	
Percent diet N as urea	78.7	78.6	
Total N in DM, g/kg	18.8	18.7	
Voluntary consumption index[1]	1.93	1.93	

[1]Daily intake of DM)/100 kg live weight

The change front weight loss to maintenance between experiment 1 and 2 is in agreement with previous observations of Ferreiro and Preston (1976a) that inclusion of tops improves performance. In experiments 3 and 4, positive effects on growth were obtained for sulphate and propionate. Sulphate effects are most likely to be exerted at the level of rumen microbial synthesis (Hume and Bird 1970) with an increase of ruminal protein outflow.

Unitary hypotheses can be put forward for effects of both sulphate and propionate on growth being mediated through effects on amino acid metabolism. Propionate could act by either sparing amino acid from gluconeogenesis, or by correcting an absolute deficiency of gluconeogenic precursors (Leng and Preston 1976). Published and unpublished values from this Centre for volatile fatty acid proportions in the rumen contents of animals fed cane diets, give a range for propionate of 20 to 25%. Diets giving this proportion of propionate normally support adequate growth and performance, in fact this is the range recommended by Blaxter (1966) for milk production. On these grounds, the action of additional propionate on amino acid usage seems the more probable explanation.

As only 80 g of propionate are required per 100 g of glucose synthesised in gluconeogenesis compared with 172 g protein, a small increase in propionate sparing action would lead to appreciable amino acid saving.

Table 4:
Effect of sulphate on animal performance on sugar cane diets (Experiment 4: two groups of 5 animals per treatment for 10 days)

	Ammonium sulphate, g/kg cane		Significance level
	None	1.00	
Live weight, kg			
Initial	194.2	201	
Final	223.0	239.4	
Daily gain	.412	.548	P <.06
Intake of DM, kg/d	4.7	4.21	
Feed conversion[1]	10.12	7.68	P <.05
Voluntary consumption index[2]	2.03	2.03	
Total N in diet DM, g/kg	21.7	21.7	
Diet N as urea, %	69.6	69.7	

[1] Feed DM/gain in LW, kg/kg
[2] Daily DM intake (kg)/100 kg LW

Theoretical calculations from the data of Purser and Beuchler (1976) (Sutherland TM, unpublished) suggest that cane-based diets are amino acid limited in the order methionine, histidine and threonine. This would make such diets particularly susceptible to sulphate shortage and particularly responsive to supplements such as rice polishings in which the protein is rich in these amino acids.

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