EFFECT OF MEAT MEAL, DRIED CASSAVA ROOT AND GROUNDNUT OIL IN DIETS BASED ON SUGAR CANE/UREA, OR MOLASSES/UREA[1]

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48 Zebu steers of approximately 200 kg initial weight were used in a 2 x 2 x 2 factorial design to study the effect of (A) 0 or 600 g/d of meat meal; (B) 0 or 1000 g/d of cassava root meal; (C) 0 or 30 g/d of groundnut oil These treatment combinations were applied to basal diets of chopped sugar cane supplemented with urea and ammonium sulphate or ad libitum liquid molasses/urea plus restricted sugar cane tops and bagasse . The experiment lasted 70 days. On the control diets (unsupplemented) daily weight gain was 54 g/d on sugar cane/urea compared with 351 g/d on molasses/urea. The protein supplement improved animal live weight gain slightly (P< .23)on the sugar cane diet and highly significantly on the molasses diet (P < .02). The effect of cassava root meal was the opposite with significant improvement on the sugar cane diets (P < .02) and a tendency for poorer performance on the molasses diet (P < .23). The ground nut oil had no effect in either diet. Data for feed consumption,. index showed similar responses to live weight gain except on the molasses diet, where cassava meal gave an increase in intake. Feed conversion response was identical to that for LW gain. None of the dietary supplements affected VFA proportions, but there were significant differences between the two diets with higher levels of butyrate, and less propionate and acetate on molasses than on sugar cane. The effect of feeding was also different. After feeding the sugar cane, there were increases in propionate and decreases in acetate with no change in butyrate, while on the molasses diet, feeding (of the forage components) led to increases in acetate and decreases in butyrate with no consistent effect on propionate. It is concluded that the results support the hypothesis that the limiting factors to animal performance on sugar cane based diets are first glucose precursors and then by-pass protein . On molasses diets, it seems that the first limitation is by-pass protein .

Key words: Cattle, sugar cane, molasses, urea, protein, glucose precursors

The experiment to be described in this paper is the third in a series aimed at elucidating the role of by-pass protein and glucose precursors in diets based on sugar cane. In the first trial (Silvestre et al 1976) there was a significant response in animal performance to a mixed concentrate containing starch and protein sources and further improvement when maize grain was also given. When the diet comprised mainly molasses/urea there was a significant response to the concentrate mixture but not to additional maize . The second trial compared three different sources of protein, in the presence or absence of maize grain. In the absence of maize, the best results were obtained with cottonseed cake and the worst with meat meal; fish meal was intermediate in value. When maize grain was added, performance was significantly

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improved on all protein sources, the best combination being maize and fish meal, followed by maize/cotton seed cake and then maize/meat meal (Silvestre et al 1977).

Although maize grain is known to be an effective glucose precursor, since a considerable proportion of the starch in this feed is known to escape rumen fermentation (Thivend and Journet 1970). it is also a source of protein and of unsaturated oil. The aim of the present experiment was to separate the effects of starch, protein and unsaturated oil by studying the effects in a factorial design of meat meal, dried cassava root (67% starch. .57% oil and 2.95% protein in dry matter) and groundnut oil.

Materials and Methods

Treatments and Design: The three nutritional variables in a 2 x 2 x 2 factorial design were 0 and 600 g/d of meat meal; 0 or 1000 g/d of cassava root meal; 0 or 30 g/d of groundnut oil. These treatments were applied to basal diets of chopped whole sugar cane/urea or molasses/urea and restricted forage. There was one replication consisting of a group of three animals on each treatment combination.

Animals: 48 Zebu steers of approximately 200 kg initial weight were used. They were between 2 and 3 years of age at the start and were housed in 3 x 3 m slatted floor pens in an open sided building.

Diets: The sugar cane diet consisted of chopped whole sugar cane to which was added an aqueous solution of urea and ammonium sulphate (180 g urea, 50 g $(NH_4)2SO_4$ 770 g H_2O) at the rate of 50 ml/kg of fresh sugar cane. The molasses diet consisted of final molasses containing 2.5% urea (25 g urea 50 g water 925 g final molasses) which was given free choice. The restricted forage was a mixture of fresh bagasse and chopped sugar cane tops. The cane tops were given at a restricted level of 2% of live weight while the bagasse was given at 0.5% of live weight. On both feeding systems, the animals also received 50 g/d of a mixture of dicalcium phosphate and salt. The appropriate amounts of meat meal, cassava root meal and oil were placed daily on the top of the ration of sugar cane, or the mixture of cane tops and bagasse . On the sugar cane treatment, the cane was chopped (particles of 10 mm) with a Gehl maize harvester (model CB 600), mixed with urea and ammonium sulphate, and left in a loose pile, until it was fed in a single feed in the morning of the following day. On the molasses system, the molasses/urea was available free choice, while the forage allowance was given once daily in the morning. The meat meal was of good quality of US origin and contained 35% protein; the cassava root chips were prepared by passing freshly harvested roots through a stationary forage chopper (model Gehl) and sun-drying the chips. They were fed without further grinding. The groundnut oil was a commercial sample of local extraction.

Rumen VFA: At the end of the trial, rumen samples were taken by stomach tube from each of the animals. Preservation of the samples and the procedure for measuring the volatile fatty acid (VFA) proportions were described by Minor et al (1977).

Measurements: Intakes of sugar cane, bagasse and sugar cane tops were determined at intervals of 14 days; rate of live weight gain was determined by regression of live weight on time in the experiment.

Results

Performance traits:

Mean values for performance and feed intake parameters for individual treatment combinations are given in table 1. Mean values for the main treatment effects on performance traits for the two feeding systems are summarised in table 2.

Table 1:
Mean values for performance traits and feed intake on the different treatment combinations

Meat meal, g/d	0				600			
Cassava chips, g/d	0		1000		0		1000	
GN oil, g/d	0	30	0	30	0	30	0	30
Sugar cane/urea								
Live weight								
Initial	243	271	233	269	237	246	255	235
Daily gain	.054	.110	.405	.292	.227	.233	.403	.292
Intake, kg/d								
Sugar cane	8.7	13.6	12.1	13.9	14.0	14.0	13.0	13.5
Urea	.077	.122	.109	.125	.126	.126	.117	.122
$(NH_4)2SO_4$	.021	.034	.030	.035	.035	.035	.033	.034
Total DM	3.6	3.9	4.1	4.6	4.3	4.7	4.6	4.9
Consumption index[1]	1.46	1.42	1.66	1.66	1.73	1.66	1.70	2.01
Feed conversion[2]	66.30	35.36	10.20	15.86	18.77	18.24	11.41	16.88
Molasses/urea								
Live weight kg								
Initial	216	227	233	203	206	216	214	215
Daily gain	.351	.363	.244	.133	.482	.567	.594	.440
Feed intake, kg/d								
Cane tops	4.8	4.0	4.6	4.1	4.1	4.70	4.47	4.0
Bagasse	.84	.26	.83	.72	.81	.78	.79	.77
Molasses/urea	3.0	3.6	2.9	3.1	3.7	3.3	3.8	3.1
Total DM	3.55	3.74	4.29	4.28	4.43	4.25	5.35	4.78
Consumption index[1]	1.57	1.56	1.80	2.10	2.0	1.82	2.36	2.07
Feed conversion	10.1	10.3	17.6	32.2	9.2	7.5	9.0	10.85

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

Table 2:
Mean values for main treatment effects for performance traits

	Meat meal			Cassava root			Groundnut oil		
	Without	With	Sign	Without	With	Sign	Without	With	Sign
Sugar cane/urea									
Gain in live weight, g/d	215	269	(P<.23)	156	348	(P<.02)	273	232	(P<.48)
Consumption index[1]	1.55	1.78	(P<.04)	1.57	1.75	(P<.07)	1.67	1.69	(P<.55)
Feed conversion[2]	32	16	(P<.24)	35	13.6	(P<.14)	27	22	(P<.58)
Molasses/urea									
Gain in live weight, g/d	273	521	(P<.02)	441	253	(P<.23)	418	376	(P<.54)
Consumption index[1]	1.79	2.04	(P<.05)	1.74	2.06	(P<.04)	1.31	1.29	(P<.84)
Feed conversion[2]	17.6	9.2	(P<.14)	9.3	17.4	(P<.15)	17.4	11.5	(P<.46)

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

Effect of meat meal: There was an indication of improved rate of live weight gain on the sugar cane diet due to addition of meat meal (P <.23); however, the effect was highly significant on the molasses/ urea system (P <.02). For each g of meat meal protein added to the sugar cane ration the improvement in gain was 1.2 g, whereas on molasses the improvement was 2.17 g. Voluntary Feed intake was increased on both feeding programmes by the meat meal. There was a tendency for feed conversion to be better on the cane diet (P <.24) due to the addition of meat meal the effect being more significant (P < .14) on the molasses/urea ration.

Effect of cassava root chips: Completely opposite effects resulted from the addition of cassava root chips. On sugar cane there was a highly significant increase in live weight gain (P< .02), while on the molasses/Urea diet there was a tendency for gain to decrease with the cassava chips (P <.23). On both feeding systems/voluntary consumption index was improved by the starch source. The data for feed conversion :reflected the effects on live weight gain.

Effect of groundnut oil: Addition of oil had no significant effect on any of the performance traits. This was true equally on the sugar cane and the molasses diets.

Table 3:
Mean values for molar VFA proportions in rumen fluid (3 hr after feeding)

	Meat meal		Cassava root		GN Oil	
	Without	With	Without	With	Without	With
Sugar cane/urea						
Acetic	64	83	63	64	64	63
Propionic	23	24	23	23	24	23
Butyric	13	13	13	13	13	14
Molasses/urea						
Acetic	52	55	58	49	57	50
Propionic	18	15	18	15	17	16
Butyric	29	30	23	36	26	33

Rumen VFA:

Molar proportions of the VFA in rumen fluid taken 3 hr after feeding are set out in table 3. There were no effects of any of the dietary supplements on these parameters. The results for the samples taken before feeding were different from those obtained 3 hr after feeding, but there were no significant effects due to dietary supplements.

The most interesting comparison relates to the effect of sampling time and of the overall feeding system. With respect to the feeding system, acetic acid was lower as was propionic acid, particularly after feeding, while butyrate was much higher on molasses compared with sugar cane. These effects are similar to those reported by Ravelo et al (1976). The two diets also behaved differently with respect to the effect of feeding. On sugar cane there was a fall in acetate and an increase in propionate after feeding and no change in butyrate. Results were exactly opposite for molasses, where the effect of feeding was to increase acetate and decrease butyrate with no effect on propionate. It should be clarified here that feeding on the molasses diet refers to the forage component only; while on cane it is the whole diet.

Discussion

The most interesting finding in this experiment was the apparent interaction between the basal diets and the dietary supplements providing protein and starch. The results indicate that the order of limiting nutrients appears to be different on molasses than on sugar cane diets. On cane the greatest response was on the cassava root supplement while on molasses it was on meat meal. Since none of the supplements changed the pattern of rumen VFA, it must be assumed that the supplements were acting as sources of by-pass nutrients: cassava root supplying starch, and meat meal, protein. The further implication from this is that on sugar cane the first limiting nutrients are glucose precursors, but that on molasses, amino acids take priority.

Table 4:
Comparisons between systems and sampling time for molar VFA proportions (%)

	Sampling	System		Level of significance (P<)		
VFA	time[1]	Cane/urea	Molasses/urea	System	Time	Interaction
C_2	0 hr	71	47	.001	NS	.002
	3 hr	64	54			
C_3	0 hr	16	17	.004	.001	.01
	3 hr	23	17			
C_4	0 hr	13	36	.0001	.13	.06
	3 hr	13	76			

[1] Time relative to feeding the complete ration on the cane system; and the foray component on the molasses system (molasses/urea always available)

This juxtaposition of nutrient priorities, as between molasses and sugar cane, is interesting. At the level of the rumen, the opposite effect would be expected since the gluconeogenic balance of the VFA produced on molasses is lower (for the sample 3hr after feeding $C_3/(C_2+2.C_4)$ =.15) than on cane (0.26), indicating a greater likelihood of response to glucose precursors on the former. One possible explanation (Leng 1977 personal communication) is that there may be direct absorption of some of the glucose (and fructose) which constitutes approximately 17% of the fresh weight of molasses; by comparison in mature sugar cane as used in this experiment, almost all the sugars are present as sucrose. Moreover, it is reasonable to presume that absorption through the rumen wall would be more likely in the case of molasses where the sugars are present in high concentration in aqueous solution, and unlikely on the sugar cane where the sugars are still within the plant cells.

Conclusions

It is proposed that the rate limiting nutrients to animal performance on sugar cane diets are glucose precursors, and that these are most efficiently provided by starch containing supplements of which a part can be expected to pass directly to the duodenum. On molasses, however, bypass protein seems to be the first limiting nutrient, suggesting that the gluconeogenic status of a molasses diet is superior to that of a sugar cane based diet.

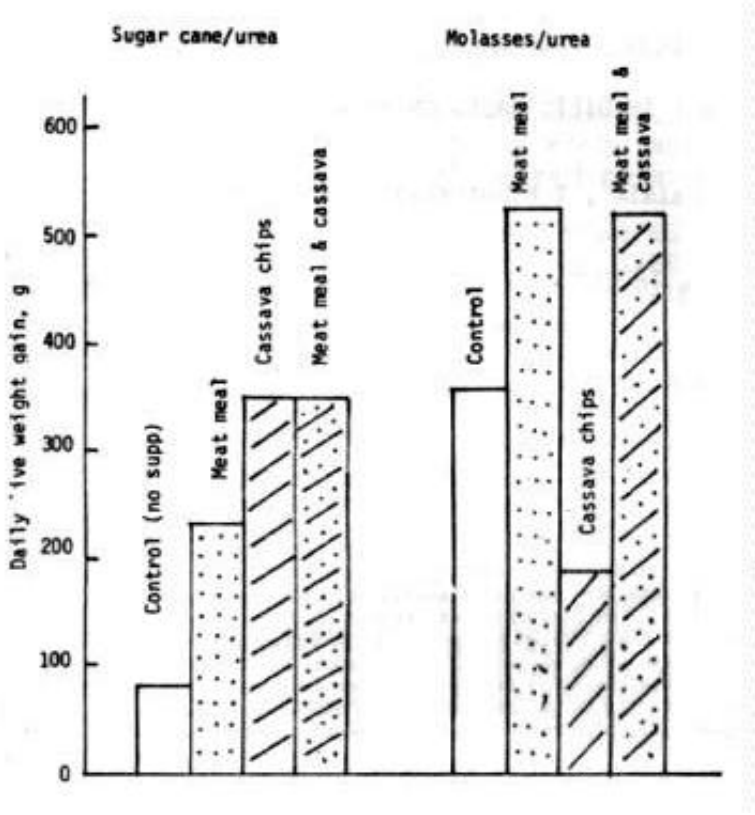

Figure 1:
Growth rates on individual treatments (values with and without oil combined)

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