SUPPLEMENTATION OF SUGAR CANE/UREA FOR GROWING CATTLE: EFFECT OF MAIZE GRAIN AND DIFFERENT LEVELS AND SOURCES OF PROTEIN[1]

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Experiments were carried out to determine the effect on live weight gain, voluntary feed intake and conversion of two levels of ground maize of 0 and 1000 g/d with different levels and sources of protein in a diet based on chopped whole sugar cane supplemented with urea and ammonium sulphate. The design in each experiment was a 2X 4 factorial with one replication and 3 animals per treatment group. The levels of fish meal and cottonseed meal were 0, 75, 150 and 225 g/d in experiments 1 and 2 respectively while the third experiment which was with meat meal had levels of 0, 300, 600 and 900 g/d. In the absence of maize the increase in unit live weight gain per unit of protein n provided by the supplement was 3.09 for cottonseed meal and 2.06 for fish meal and considerably superior to the response in the presence of maize which was.91 for fish meal and.69 for cottonseed. Response to the protein in meat meal was least of all and the same in the presence (.22) as in the absence (.27) of maize. Results for feed conversion were similar to those for live weight gain. Total DM intake increased with protein level on all sources but there were no differences expressing intake as a percent of LW. The response to maize was very marked for all protein sources and was greater on fish meal than on the other proteins. On fish meal, maize increased gain from 174 to 513 and feed conversion from 35.2 to 9.28. DM intake, both in kg/d and as percent LW was increased by maize on fish meal and meat meal but not on cottonseed where only the daily intake was increased. The apparent interaction between maize and protein source (cottonseed was better than fish meal in absence of maize and worse in its presence), and the overall large responses to maize are interpreted as further evidence of the importance of glucose precursors in sugar cane diets. It is also suggested that part of the effect of maize might be related to it being a source of essential long chain unsaturated fatty acids.

Key words: Cattle, sugar cane, protected protein, glucose precursors

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In an earlier experiment in this series (Silvestre et al 1976), supplementation of the basal diet of sugar cane and urea with a mixed protein concentrate led to linear responses in animal performance. The protein concentrate was purchased from a commercial company and had been formulated as a protein balancer for pigs. It contained soya bean meal, meat meal, maize gluten, dehydrated alfalfa and maize grain.

It is important to record that this is only the third report in the literature of positive animal response to increasing amount of protein supplement on sugar cane diets. The other cases of positive response (Preston et al 1976; Lopez et al 1976) both related to the use of rice polishings. No improvement in animal performance was noted with levels from 100 to 900 g/day of meat meal (Preston and Bonaspetti 1974) or blood meal 75 to 330 g/d (Alvarez et al 1974; Lopez and Preston 1977).

The response to rice polishings was interpreted by Leng and Preston (1976) as being due to combined action of both"protected" protein and glucose precursors. The supplement used by Silvestre et al (1976) also provided both these nutrients in that it contained maize grain as well as protein of high biological value.

The objective of the experiments to be described in this paper was to provide more detailed information on the response to protein and to glucose precursors by using a variety of protein sources with and without the presence of supplementary maize. Fish meal was chosen as the best example of a protected protein, in a relative pure form, uncontaminated with starch; meat meal was selected in view of the lack of response to this supplement in earlier work (Preston and Bonaspetti 1974). Cottonseed meal is produced in the Dominican Republic, and although its protein is of only moderate biological value, it is relatively insoluble (expeller process) and also contains starch which might contribute to the glucose supply.

Materials and Methods

Treatments and Design: Three experiments were carried out. The design in each was a 2 X 4 factorial with 1 replication. There was one group of three animals on each treatment and thus a total of 24 on each experiment. The treatments were levels of 0 or 1000 g/d of ground maize grain and 4 levels of protein. In experiment 1, the protein source was fish meal at levels of 0, 75, 150 and 225 g/d; in experiment 2 it was cottonseed meal at the same levels; and in experiment 3 was meat meal at levels of 0, 300, 600 and 900 g/d (the same levels used by Preston and Bonaspetti 1974).

Animals: Zebu bulls were used of approximately 200 kg initial weight and about 2 years of age. They were housed in 3 x 3 m pens with partially slatted floors in a roofed building open at the sides.

Feeding system: The basal diet in all the experiments was whole sugar cane which has been chopped in a Gehl forage harvester to a particle size of between 10 and 20 mm. The chopped cane was mixed with an aqueous solution of urea and ammonium sulphate (180 g urea 50 g ammonium sulphate and 770 g water) at the rate of 50 ml/kg of fresh cane. Generally the cane was chopped and mixed with the NPN solution approximately 16 hr before feeding, allowing it to preferment in this period.

During the experiment, the sugar cane had an average Brix of 12 and a dry matter content of 28%. In addition to the sugar cane, the cattle also received 50 g salt and 50 g of dicalcium phosphate daily. The sugar cane was given once daily in the morning together with the different protein supplements. The animals were weighed individually on a weekly basis and live weight gain was determined by regression of live weight on time on experiment.

Results

Mean values for animal performance and feed intake on the three experiments are given in tables 1, 2 and 3.

Effects of protein: The response to protein was calculated in the presence and absence of maize by the linear regression of live weight gain on level of supplementary protein (figure 1). In the absence of maize, the increase in live weight gain per unit protein provided by the supplement was 3.09 for cottonseed meal and 2.06 for fish meal (r^2=.94 and .90 respectively) and considerably superior to the response in the presence of maize which was 0.91 (r^2=.53) for fish meal and.69 r^2 =.11) for cottonseed. Response to the protein in meat meal was least of all and the same in the presence (0.22:r^2=.21) as in the absence of maize (0.27;r^2 =.66).

Table 1:
Mean values for animal performance on sugar cane diet supplemented with fish meat and maize grain

Maize, g/d	None				1,000			
Fish meal, g/d	0	75	150	225	0	75	150	225
Live weight, kg								
Initial	162	183	183	188	208	203	206	218
Final	165	188	202	209	237	239	248	255
Daily gain, g/d	52	71	267	305	414	512	599	528
Feed intake, kg/d								
Sugar cane	11.0	11.69	12.20	12.83	12.37	12.37	12.62	12.79
Urea	.099	.104	.110	.115	.112	.112	.113	.115
Ammonium sulphate	.028	.029	.031	.032	.031	.031	.032	.032
Minerals	.100	.100	.100	.100	.100	.100	.100	.100
Total DM	3.31	3.57	3.79	4.04	4.51	4.62	4.77	4.88
Consumption index[1]	2.02	1.92	1.97	2.04	2.05	2.09	2.10	2.06
Conversion[2]	63.6	50.3	14.2	13.3	11.0	9.0	7.9	9.2

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

Table 2:
Mean values for animal performance on a sugar cane diet with supplements of cottonseed meal and maize grain

Maize, g/d	None				1,000			
Cottonseed cake, g/d	0	75	150	225	0	75	150	225
Live weight, kg								
Initial	168	177	181	195	202	203	206	220
Final	171	182	198	217	222	236	229	249
Daily gain, g/d	50	77	237	313	292	472	333	409
Feed intake, kg/d								
Sugar cane	12.38	12.13	12.39	13.19	11.81	11.71	12.81	13.0
Urea	.112	.110	.112	.119	.106	.106	.115	.117
Ammonium sulphate	.031	.031	.031	.033	.030	.030	.032	.033
Minerals	.100	.100	.100	.100	.100	.100	.100	.100
Total DM	3.71	3.70	3.85	4.15	4.39	4.43	4.82	4.94
Consumption index[1]	2.19	2.06	2.03	2.01	2.07	2.02	2.22	2.11
Conversion[2]	74.2	48.0	16.2	13.2	15.0	9.4	14.5	12.0

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

Table 3:
Mean values for animal performance on a sugarcane diet supplemented with meat meal and maize grain

Maize, g/d	None				1,000			
Meat meal, g/d	0	300	600	900	0	300	600	900
Live weight, kg								
Initial	183	204	214	231	185	200	209	242
Final	187	217	231	245	209	236	232	279
Daily gain,g/d	54	163	221	185	308	470	299	496
Feed intake, kg/d								
Sugar cane	11.97	13.35	14.50	13.29	11.99	13.0	13.14	13.36
Urea	108	.121	.131	.119	.108	.117	.119	.121
Ammonium sulphate	.030	.034	.037	.033	.030	.033	.033	.034
Minerals	.100	.100	.100	.100	.100	.100	.100	.100
Total DM	3.58	4.27	4.89	4.81	4.45	5.02	5.34	5.66
Consumption index[1]	1.94	2.0	2.20	2.0	2.26	2.30	2.42	2.18
Conversion[2]	66.3	26.2	22.1	26.0	14.4	10.7	17.9	11.7

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

Daily DM intake increased with protein level on all protein sources (table 1, 2 and 3), however when this was expressed as a percent of mean live weight (voluntary consumption index) the regression coefficients were not significantly different from zero in the case of the two animal proteins. On cottonseed there was an apparent interaction, with consumption index increasing according to protein level in the absence of maize, and decreasing when the maize was included. The situation with respect to feed conversion was similar to that reported for live weight gain. There were significant improvements in feed conversion due to protein level in the absence of maize for the fish meal and cotton seed cake supplements and a much diminished response in the presence of maize. The effect of the protein meat meal on conversion was much less marked and did not differ between the treatments with or without maize (figure 3).

Figure 1:
Relationship between live weight gain and protein level for different protein sources in the presence or absence of maize

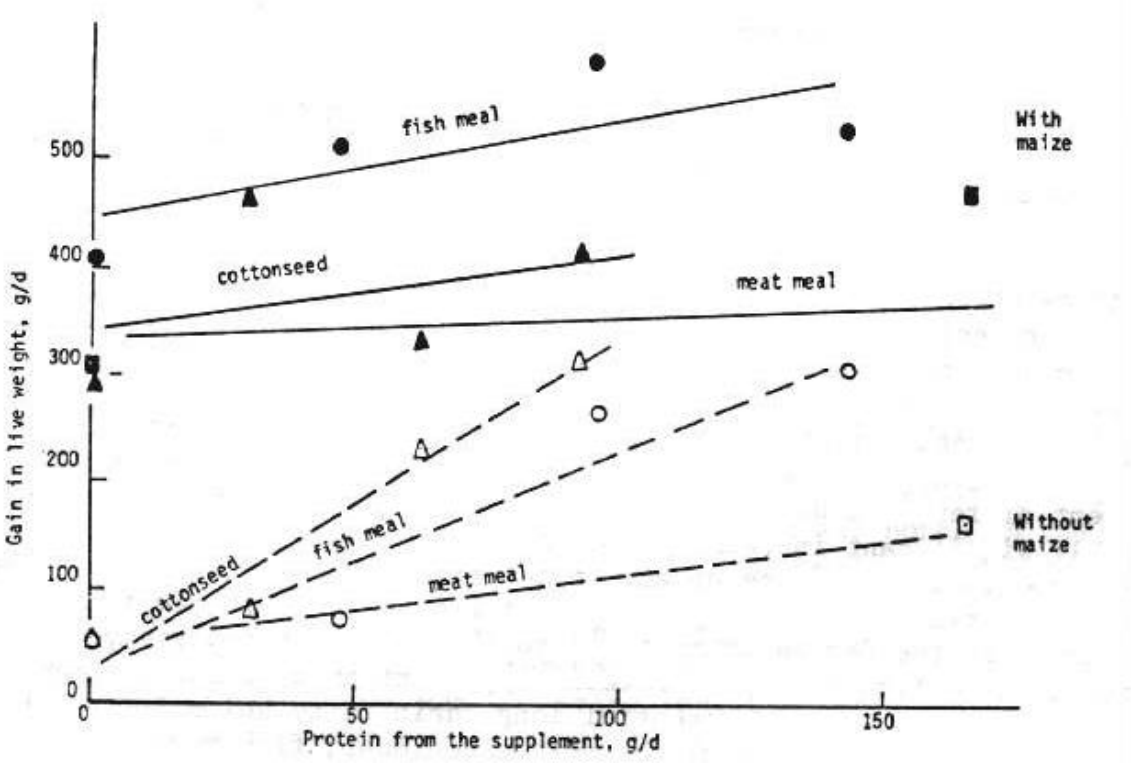
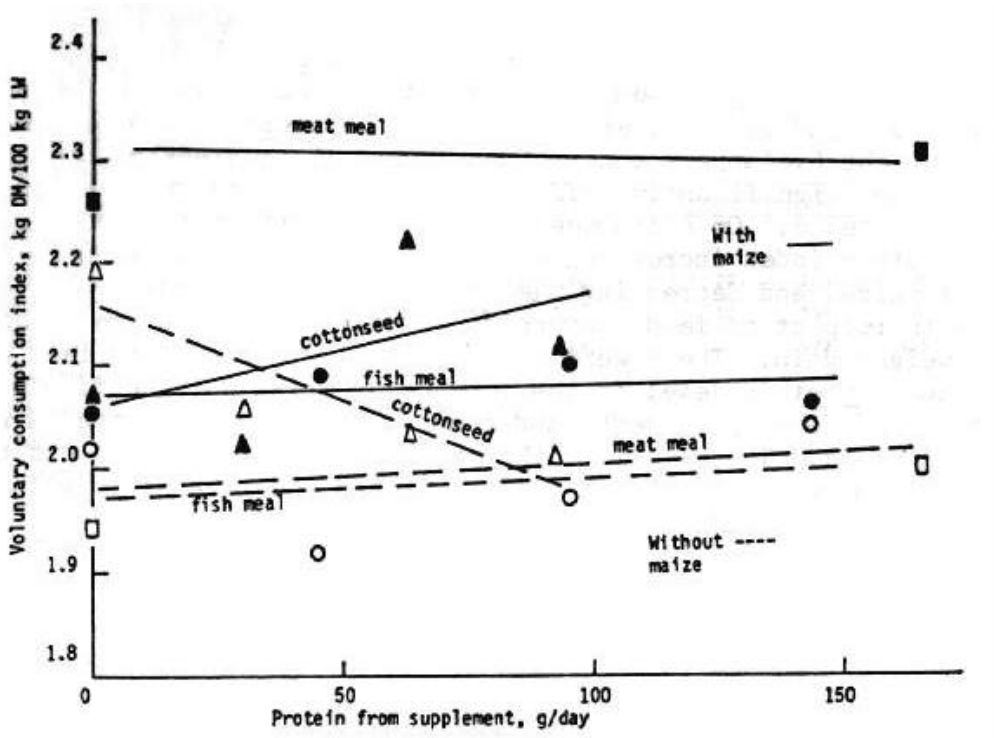
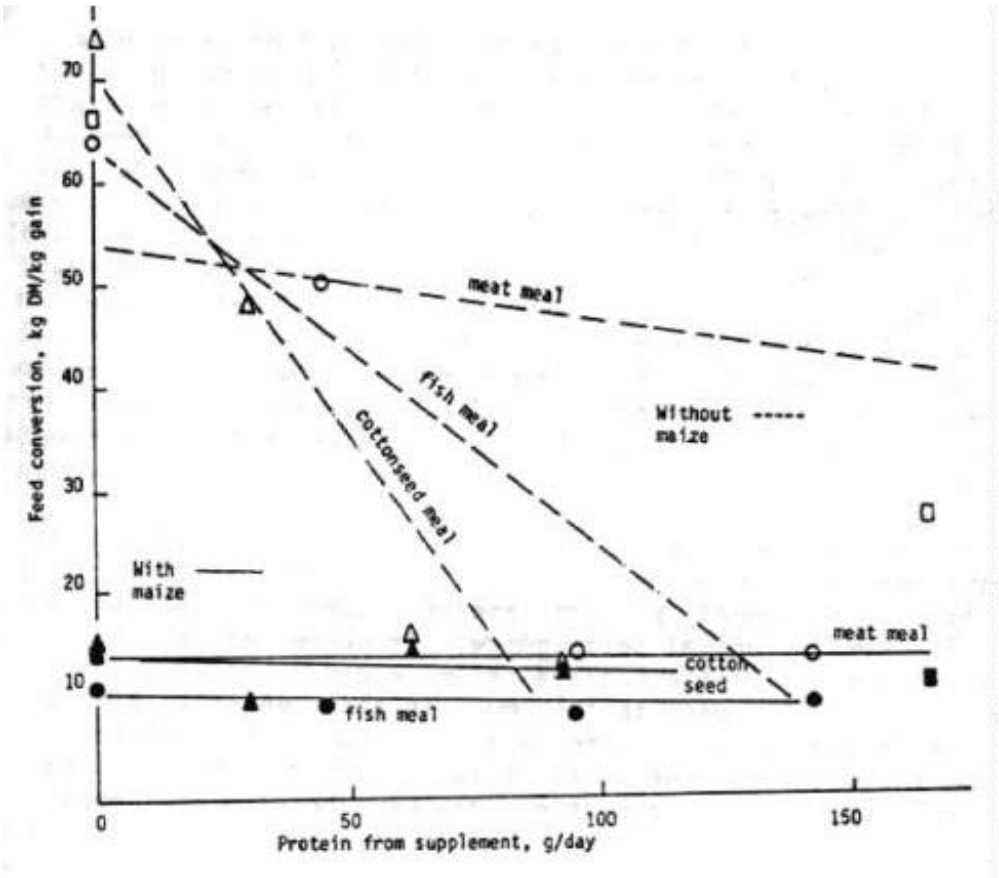


Figure 2:
Relationships between voluntary consumption index and protein level for different protein sources in the presence or absence of maize



Effect of maize: Overall mean values for live weight gain, voluntary intake and feed conversion according to levels of maize are summarised in table 4. There were highly significant effects due to the maize. on live weight gain which was increased more than two fold on all protein sources. Dry matter intake was increased by maize on all protein sources; however, correcting this for mean live weight showed apparent differences between the three proteins. Thus, maize invoked a highly significant increase in voluntary consumption index on meat meal ($P < .005$), and none at all on cotton seed meal ($P < .68$). The effect with fish meal was significant at $P < .10$. It is tempting to conclude that the degree of response to the maize was inversely related to the efficacy of the protein supplement as a combined source of glucose precursors and essential long chain fatty acids for which the order of superiority would be cottonseed meal, fish meal and meat meal. The data for feed conversion were similar to those for live weight gain, with a very considerable improvement on all protein sources resulting from the addition of supplementary maize. The levels of significance were lower because of increased variability between observations and the fact that the data were analysed on a group basis. compared with individual animals in the case of live weight gain, In the presence of maize, feed conversion was best with fish meal (9.28) with poorer results, with little difference between them, for cotton: seed meal and meat meal.

Figure 3:
Relationships between feed conversion and protein level for different protein sources in the presence or absence of maize



Discussion

The interesting feature of the results for live weight gain in the interaction between the effect of maize and protein source; i.e. response to protein was greater for cottonseed than for fish meal in the absence of maize, while the opposite effect was noted in the presence of maize. In view of the fact that fish meal has both a better balance of amino acids and a greater degree of protection of the protein, than is the case for cottonseed meal, it would appear that some other nutrient in the latter was contributing to the better animal response, when maize was not being fed. It is suggested that the advantage of the cottonseed cake was associated with its content of starch acting as a glucose precursor. Such a conclusion is compatible with the fact that when fish meal was fed with maize, it gave better results than cottonseed meal.

In examining the overall effect of added maize, the logical conclusion is that this also reflects its role as a glucose precursor. An effect due to the protein in the maize, as a major factor, can be discounted for the following reasons. If the effect of maize was to be attributed entirely to the protein content, then in the fish meal experiment, the

increase in live weight gain per unit of protein in the maize would be 3.39 g compared with only 2.06 g gain per g of protein from fish meal in the absence of maize. As the protein in maize is of considerably poorer biological value and probably less well protected, than that in fish meal, it is more reasonable to conclude that the effect of maize is as a glucose precursor.

The much greater effect on feed conversion brought about by maize as compared with fish meal, provides further evidence that the supply of glucose precursors is an important characteristic of any supplement used in rations based on sugar cane and urea.

The fact that response to added protein was lower in the presence of maize than in its absence, would also indicate that when only protein is given as a supplement to diets of sugar cane and urea, then it functions partially as a precursor of glucose, as was proposed by Leng and Preston (1976).

The poor results recorded for the meat meal is in agreement with the earlier report of Preston and Bonaspetti (1974) who used a similar range of levels of meat meal in sugar cane/urea diets and also found no response in terms of animal performance. It seems unlikely that the cause of this would be the balance of amino acids, since meat meal is only slightly inferior to fish meal in this respect. Processing can be an important factor with meal, but here again the meat meal was of North American manufacture and could be expected to be of high quality.

Table 4:
Effect of added maize grain on animal performance on sugar cane diets with different protein sources

	Level of maize grain, kg/day		Probability level
	0	1.0	
Gain in LW, g/day			
Fish meal	174	513	.05
Cottonseed meal	169	376	.06
Meat meal	156	391	.02
Consumption index[1]			
Fish meal	1.99	2.08	.10
Cottonseed meal	2.07	2.11	.68
Meat meal	2.04	2.29	.005
Feed conversion[2]			
Fish meal	35.3	9.28	.12
Cottonseed meal	37.9	12.7	.18
Meat meal	35.1	13.7	.13

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

The only possible difference between meat meal and fish meal would be with respect to the composition of the fatty acids. Meat meal made from by-products mainly of pigs, sheep and cattle, particularly under conditions of feeding in North America, would be expected to have all of its fatty acids in a saturated form, while all the other supplements used, i.e. fish meal, cotton seed cake and maize meal have a high proportion of unsaturated fatty acids. It is known that mature sugar cane is low in total lipid material (less than 1% ; Banda and Valdez 1976) and that the greater part of this is present as saturated waxes. Thus sugar cane might be deficient in essential fatty acids (linoleic, linolenic and arichodonic acids) and therefore part of the response to fish meal, cottonseed cake and maize could be accounted for by their being sources of these essential nutrients.

Conclusions

The results of the three experiments reported here provide further evidence for the hypothesis that the production rate of cattle fed on sugar cane and urea depends on the supply of both protected protein and glucose precursors. There is indirect evidence that there is also a need for essential long fatty acids and that the content of unsaturated oil in the supplement may be an important factor. Further work is required to separate more precisely the individual effects of protected protein, glucose precursors and essential fatty acids before the true economic significance of these different nutrients can be elucidated in sugar cane diets.

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