EFFECT OF DIFFERENT CONCENTRATIONS OF UREA IN FINAL MOLASSES GIVEN AS A SUPPLEMENT TO CHOPPED SUGARCANE FOR FATTENING CATTLE

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Summary

4 groups of 20 Zebu bulls were used to compare urea concentrations in final molasses of 4, 6, 8 and 10%. These mixtures were offered free choice, the remainder of the ration being chopped whole sugar cane, given in a separate feeder, plus 1 kg/d of rice polishings and minerals. After 70 days, each treatment group was divided into two lots of ten. one continuing on the original treatment while the other received an additional supplement of concentrated urea/molasses (283 g urea/litre) spread on the sugar cane at levels of 40, 35, 30 and 25 ml/kg of fresh cane to compensate for the increasing concentration of urea in the free choice molasses . There were increases in consumption of urea, fresh sugar cane and total DM, and improvements in growth rate and feed conversion with increasing concentration of urea in the molasses; intake of molasses was depressed by increase in concentration. The performance of the subgroups given additional urea/molasses on the sugar cane was inferior to those which did not receive this treatment. Performance of all animals was better in the second than in the first period of the trial.

Key words: Urea, sugarcane, cattle

Introduction

In most experiments on the feeding of sugarcane based rations, urea has been supplied either mixed in the protein supplement (Donefer et al 1975) or dissolved in partially diluted final molasses (Preston et al 1975) which was subsequently spread over the sugar cane at the time of feeding.

The object of the experiment described in this paper was to study the effect of giving the urea/molasses solution on a free choice basis using the urea as a means of regulating the consumption of molasses. Such a system offers several advantages from the point of view of simplicity and reduced labour requirements

Materials and Methods

Treatments and design:
The experiment was carried out in two periods each of 70 days. There were 4 main treatments consisting of urea concentrations of 4, 6, 8 and 10% in molasses and these were given in the first 70 days to four groups of 20 animals. In the second 70 day period each main treatment was divided into two subtreatments. (A) continued to receive the original treatment while (B) received an additional concentrated urea/molasses (283 g urea/kg mixture) solution spread on the cane at the moment of feeding in quantities of 45, 40, 35 and 25 ml/kg of fresh cane.

Procedure:
80 Zebu bulls with an initial weight of 291 kg were housed in 20 X 4 m pens open on all sides with a cement floor and pain roof. The treatments were prepared by first dissolving the urea in water then adding this solution to final molasses so that the content of molasses was fixed at 80% (weight basis). The urea/molasses mixtures were given free choice in open troughs.

The remainder of the ration was chopped sugar cane given twice daily plus 1 kg/d of ice polishings given as a single feed before offering the sugarcane. All the animals had access to a mixture of salt (50%), rock phosphate (47%) and trace minerals (3%).

For treatment B in the second period of the experiment the only modification was the application of more molasses/urea (a solution containing 283 g urea/litre) on the sugarcane at the time of feeding. The levels of application were 45, 40, 35 and 30 ml/kg of fresh cane for the groups which received 4, 6, 8 and 10% of urea/molasses, respectively.

One animal was eliminated from treatment B (8% urea) because of urea toxicity. This was the result of an error, the animal gaining access to a solution of urea in water before this was mixed with the molasses.

Measurements:
The animals were weighed every 14 days and feed consumption recorded daily.

Table 1:
Effect different levels of urea in solutions of final molasses given free choice to fattening cattle (period 1)

	Level of urea in molasses,%			
	4	6	8	10
Numbers of animals	20	20	20	20
Days on trial	70	70	70	56
Live weight, kg				
Initial	269.00	266	227	229
Final	294	294	261	264
Gain/d	.366	.398	.493	.630
Feed intake, kg/d				
Total DM	6.2	6.14	6.25	6.45
Fresh cane	10.6	13.2	13.4	15.3
Molasses	3.03	1.98	1.67	1.54
Urea	.121	.119	.134	.154
Consumption index[1]	2.12	2.12	2.5	2.5
N in DM, %	1.57	1.62	1.67	1.78
N as urea, %	55.46	53.1	57.67	61.1
Conversion [2]	16.8	15.4	12.6	10.2

[1] $\frac{\text{kg DM/d}}{\text{100 kg LW}}$

[2] kg DM/kg gain

Results and Discussion

The basic data for the two experimental periods are given in tables 1 and 2; figure 1 illustrates the more important relationships which were encountered.

It should be noted that as the urea level in molasses was raised' there were corresponding increases in the consumption of urea, of fresh sugar cane and of total DM, and improvements in live weight gain and feed conversion; at the same time consumption of molasses was decreased. It is not possible to decide if the improved, animal performance was attributable to the increased amount of urea ingested, or the change in composition of the basal ration in favour of more sugar cane and less molasses. The results reported by Alvarez and Preston (1975) support the former effect while the preliminary data of Silvestre and Preston (1976) provide confirmatory evidence for the latter.

A beneficial effect in sugar cane rations due to greater intake of urea is to be expected but it is less easy to explain the negative response associated with giving more molasses. It has been shown that when the proportion of molasses in a sugar cane ration is increased this gives rise to a higher digestibility (Montpellier and Preston 1976), and normally this should be reflected in an improvement in animal performance.

The fact that the contrary should occur implies that higher levels of molasses is giving rise to some form of metabolic upset which acts so as to mask the positive effect which would normally occur when digestibility increases.

Conclusions

From the economic point of view, the best treatment was that with 10% urea in molasses, with this mixture and the chopped sugar cane being offered free choice in separate feeders.

All the animals showed better performance in the second 70 day period than in the first. This could be interpreted as an adaptation to the ration. On the other hand, in the second period the size of the groups was reduced from 20 to 10, and perhaps the reduced competition may also have contributed to better performance observed in this period.

No valid conclusions can be drawn concerning the system of giving molasses/urea in one feeder and spraying a concentrated urea/molasses solution (28% urea) on the sugar cane.

Figure 1:
Relationship between urea concentration in molasses and various measures of animal performance

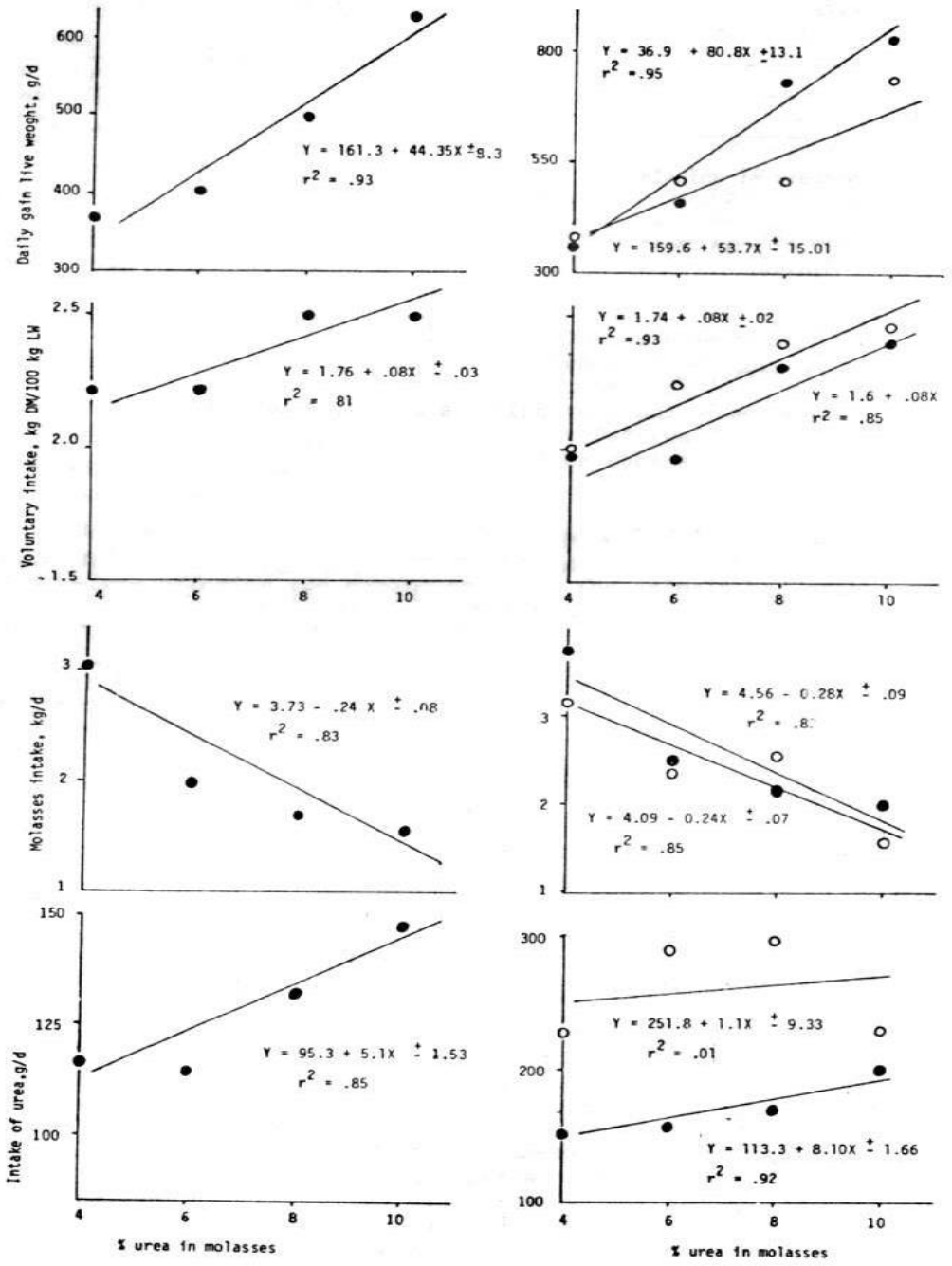

Table 2 :
Animal performance in period 2

	Level of urea in molasses, %							
	4		6		8		10	
	A	B	A	B	A	B	A	B
No. of animals	10	10	10	10	10	10	10	10
Days on trial	70	70	70	70	70	70	84	84
Liveweight, kg								
Initial	287	293	287	294	256	261	260	266
Final	312	319	320	329	307	297	329	328
Gain/d	.363	.382	.463	.510	.735	.510	.830	.740
Feed intake, kg/d								
Total DM	6.06	6.06	6.10	7.17	6.80	6.80	7.26	7.33
Fresh cane	9.30	9.33	13.00	14.50	15.10	13.20	16.33	16.22
Molasses	3.75	3.16	2.50	2.44	2.14	2.53	2.00	1.53
Urea	.150	.227	.158	.287	.171	.290	.200	.232
Consumption index[1]	1.98	2.0	1.96	2.25	2.31	2.40	2.40	2.46
N in DM, %	1.89	2.45	1.84	2.50	1.86	2.62	1.94	2.10
N as urea, %	58.1	67.8	60.1	71.6	60.8	72.8	64.0	67.8
Conversion[2]	16.7	16.0	13.0	14.0	9.2	13.3	8.74	9.90

[1]A= molasses/urea in a separate feeder
B = Same as A but with additional molasses/urea (283 g urea/litre) sprayed over the sugar cane

[2] $\frac{\text{kg DM/d}}{\text{100 kg LW}}$

[3] kg DM/kg gain

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EFFECT OF B COMPLEX VITAMINS ON PERFORMANCE OF STEERS FED SUGAR CANE

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Summary

18 Zebu steers of 300 kg initial weight were allocated to 9 groups of 2 animals and used to compare the following treatments: control; B vitamins injected; B vitamins in the feed. Feeding was based on sugar cane and urea. The average rate of live weight gain during the 70 day trial was 500 g/d and there was no evidence of response to the vitamin treatments.

Key words: Sugarcane, B vitamins, cattle

Introduction

Generally, ruminants do not present problems of B vitamin deficiency since these are synthesised by rumen microorganisms. However , the majority of natural feeds contain important amounts of these vitamins, and it is not known to what extent the animals depend on rumen synthesis on the one hand and dietary supply on the other.

There is some evidence that on purified diets without B vitamins, in which all the nitrogen is in inorganic form, B vitamin deficiency can develop (Naga et al 1975). Sugar cane is not a balanced feed and, in particular has important deficiencies of nitrogen, lipids and phosphorus. Little is known of the vitamin composition of this plant, and it is likely that the content concentration of these nutrients may well be low. In this case, animals fed mainly on sugar cane would have to depend entirely on rumen synthesis for their B vitamin supply.

The objective of the experiment discussed in this paper was to investigate response to B vitamins in cattle fed sugarcane.

Materials and Methods

Treatment and Design:

The treatments were: (A) control, (B) B vitamins injected and (C) B vitamins included in the feed. The design was random block with 3 replications.

Procedure:

18 Zebu steers approximately 300 kg live weight were allocated to 9 groups of 2. During the first 35 days of the trial, 3 of the groups (one replication) were fed fresh chopped whole sugar cane supplemented with a solution of molasses/urea (200 g urea kg/mixture) at the rate of 50 g/kg of fresh cane. The second replication received whole sugar cane ensiled with urea while the third replication received sugar cane ensiled with ammonia. The level of urea and ammonia was adjusted so that these diets were isonitrogenous with the fresh cane ration. During the last 35 days all of the groups received fresh sugar cane. The rations were supplemented with 600 g/d of cotton seed meal, 50 g/d of bone meal and 50/d of salt containing trace minerals. The sugar cane (or silage) was fed on a free choice basis.

The vitamin solution for injection contained (in 100 ml) B1 2 g, B2 150 mg, B6 250 mg, B12 1 mg, nicotinamide 2.5 g, calcium pantothenate 500 mg; the formula used for adding to the diet contained (in 1 kg): B1 3.85 g, B2 3.22 g, B6 1.92 g, B12 20 mg, nicotinamide 2.58 g, calcium pnatothenate 1.62 g.

The vitamin solution was injected in quantities of 3 ml per animal per week. The dry supplement included in the ration was given at the rate of 5 g/animal/d, spread on the morning feed.

Measurements:

The animals were weighed every 7 days and feed intake recorded daily. The mean rate of live weight gain was calculated by fitting regression lines to the data for live weight and time.

Table 1:
Animal performance on sugar cane diets supplemented with vitamins of the B complex

		B vitamins		
	Control	Injected	Fed.	SE_X
Live weight, kg				
Initial	304	275	291	
Final	338	310	325	
Daily gain	.49	.50	.48	±.070
Feed intake, kg/d				
Fresh sugar cane	18.9	18.5	18.7	±.91
Molasses	.95	.92	.93	
Urea	.19	.18	.19	
Cotton seed meal	.65	.65	.65	
Bone meal	.05	.05	.05	
Salt	.05	.05	.05	
Total DM	6.14	6.50	6.04	±.74
Consumption index[1]	1.92	2.07	1.98	±.051
Conversion [2]	13.2	12.0	11.6	±1.09

[1] $\frac{\text{kg DM/ d}}{\text{100 kg LW}}$

[2] kg DM/kg weight gain

Results and Discussion

Performance data are presented in table 1. There was no evidence of response to the B vitamins independently of the methods of administration.

References

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RUMINAL CONTRACTIONS IN CATTLE FED SUGARCANE

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Summary

Four fistulated swiss/zebu steers were used to measure ruminal contractions. Each day during three consecutive days observations were taken 3 hr before and 2 hr after feeding using a manometer. The diet was sugar cane stalk, chopped and mixed with a solution of molasses/urea (283 g urea/litre) at a rate of 50 ml/kg cane. Two of the animals also received 1 kg of rice polishings 30 minutes before the chopped stalk was fed. The intensity and frequency of the contractions of the ruminal wall were observed in order to relate them with the previously observed pattern of diurnal variation in protozoal biomass. On passing from a period of rest to a period of eating the contractions became more frequent. The maximum frequencies of ruminal contractions were 2.59/minute on the diet without rice polishings and 2.7/min on the diet with the supplement. The highest concentration of rumen biomass was associated with the maximum intensity and frequency of the ruminal contractions and the lowest values in periods of rest probably due to a settling out of the protozoa in the ventral sac of the rumen.

Key words Sugarcane, rumen contractions, cattle

Introduction

It has been observed that the highest readings of protozoal biomass on sugar cane diets occurred in the two hours immediately after feeding, gradually falling to a minimum value during the afternoon and night (Leng and Preston 1976). This experiment was carried out to collect data on the simultaneous. changes occurring in the rate of rumen contractions.

Materials and Methods

Four fistulated steers were used. A cylindrical syringe made of plastic, was fitted to the caps of the rumen cannulas. This was joined to a flexible rubber tube which was in turn connected to a glass tube in the form of a J. This contained a column of water which was displaced on the occurrence of a ruminal contraction. The basic diet was chopped sugar cane stalk fed ad libitum. This was mixed with a solution of molasses/urea (283 g/litre) at a level of 50 ml/kg of sugar cane . 60 g of minerals were also given. Two of the animals were fed 1 kg of rice polishings 30 minutes before the cane was fed. Measurements were taken during a period of 3 days for each animal. Those on the diet without rice polishings were measured 1 hr before feeding and 2 hr after. Observations were made on the animals which received rice polishings 30 minutes before they were fed, 30 minutes after and 2 hr after the cane was fed.

Figure 1: Mean contractions per minute in fistulated steers recieving chopped sugar cane with :: or without □ rice polishings

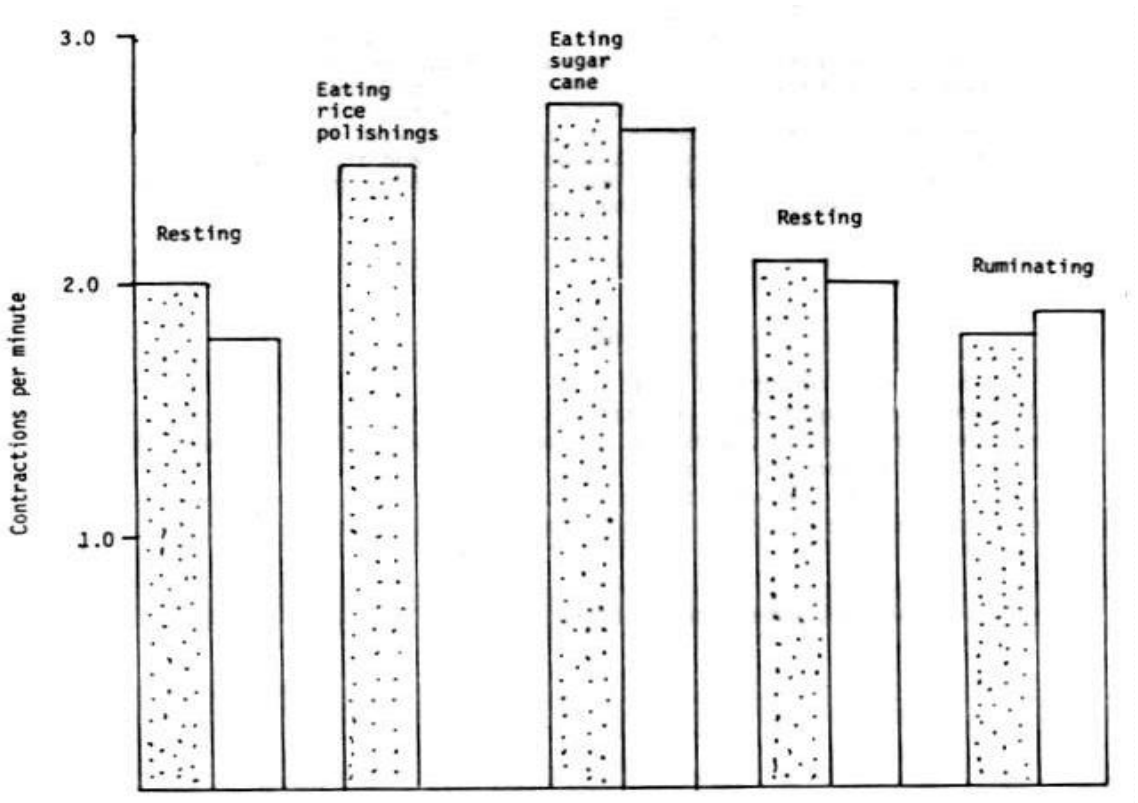

Table 1: Ruminal contractions on sugar cane diets

	Resting	Eating rice polishings	Eating sugar cane	Resting	Ruminating
Time spent on each activity, %					
Rice polishings	22	6.4	41.1	21.4	11.1
None	33	-	34	19	15
Ruminal contractions, No/minute					
Rice polishings	2.00	2.48	2.70	2.07	1.80
None	1.78		2.59	2.01	1.87

Results and Discussion

The relative amounts of time spent in different ruminal activities were expressed as a percentage of the total and are shown in table 1. Taking into consideration only the period after the cane was fed it can be observed that the longer time spent in the act of eating was probably an effect of the rice polishings . There were no apparent differences in the time that the animals spent resting and ruminanting. It appears reasonable to conclude that, principally, the settling of the protozoa to the base of the rumen occurred when the animals were in a state of rest or ruminating. This is the period when the intensity of ruminal contractions in minimal (table 1) it also coincides with the fall in protozoal biomass (Leng and Preston 1976).

In conclusion, it appears that if measurements of protozoa] biomass are to be a useful parameter of the rumen environment some standardisation of technique is necessary with respect to changes in the rate of rumen contractions. It is suggested that the most useful measurements of rumen protozoal biomass are those of maximum and minimum concentrations which occur immediately before, and in the period 2 hr after feeding.

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SPONTANEOUS FERMENTATION OF SUGAR CANE

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Summary

Sugar cane was prefermented either alone, with a solution of urea/molasses (100 g urea/kg) at the level of 100 g mixture/ kg fresh cane or 90 g urea/molasses solution plus 20 g ammonium sulphate/kg fresh cane. Each of these treatments was applied to whole sugar cane which had been chopped finely (less than 5 mm) or coarsely (10 to 20 mm). The mixtures were allowed to ferment in open plastic buckets for 24 hr respectively. Growth of yeast and production of alcohol were accelerated when the sugar cane was chopped finely and in the presence of urea. The initial and final pH was higher in the presence of additives and lower for the fine as opposed to coarse chopping. There was a tendency to a higher concentration of acetic acid in the presence of additives but there was no effect on this parameter attributable to the finess of chopping.

Key words: Sugarcane, fermentation

INTRODUCTION

The procedure usually adopted in the feeding of sugar cane to cattle has been to chop the whole plant to a particle size of about 5 mm and feed this in a fresh form. Supplementation with urea has been carried out by two principal methods: (A) dissolving urea in water, or in a partially diluted solution of final molasses and then adding this to the sugar cane to make a homogeneous mixture; and (B) preparing a solution of sugar in final molasses (usually 10% concentration) and giving this on a free choice basis, with the chopped sugar cane in a separate feeder.

In contrast with almost all other feeds, sugar cane has a high content of soluble

sugars and moisture. As a result, once the cane is chopped, there begins a process of spontaneous fermentation.

The objective of the experiment described here was to characterize certain aspects of this fermentation process using sugar cane alone and mixtures of sugar cane with molasses and urea.

Materials and Methods

Treatments and Design:

The three principal treatments were: (A) chopped whole sugar cane without additives; (B) chopped whole sugar cane mixed with 10% of a solution of molasses/urea (100 g urea/ litre); (C) chopped whole sugar cane mixed with 10% of a solution of molasses/urea/ammonium sulphate (90 g urea and 20 g ammonium sulphate/litre). On each principal treatment there were two subtreatments consisting of coarse (particle size 10 to 20 mm) and fine chopping (5 mm). The design was a 3 X 2 factorial with one replication.

Procedure:

The different mixtures were put in open plastic buckets which were kept under cover at ambient temperature (approximately 30°). Samples were taken at 0, 24, and 48 hr and the following analyses carried out: dry matter (DM), pH, Brix, Alcohol, lactic acid, volatile fatty acids (VFA) and yeast counts.

Analytical Methods

The juice was squeezed from the different mixtures using a screw press and preserved with 5 drops of hydrochloric acid for each 10 ml of juice. Brix was measured directly on the juice with a hand refractometer. DM content was determined by drying in an oven at 90Q for 48 hr . For the determination of alcohol, lactic acid and VFA, a gas cromatograph (Carle Instruments) was used with a column of resoflex Lac-I-R-296.

The temperature was set at 70° for alcohol, 105° for lactic acid, and 120° for the VFA. Hydrogen was used as a carrier gas at a pressure of 2-5 lb/in for alcohol, 8 for lactic acid and 10 for VFA.

The yeasts were isolated on the following media: yeast extract (Difco), glucose,

agar and distilled water (Mossel and Quevedo 1967). A solution of terramycin was added to this mixture at the 1% level (100 ml/litre of media). Dilutions were made directly from the cane juice transferring duplicate 1 ml quantities to petri dishes. The number of colonies was counted 4 days after seeding.

Figure 1: Production of alcohol and growth of yeast in sugarcane allowed to ferment spontaneously without additive (▲), with urea(•), or urea and $(NH_4)_2SO_4$ (○)

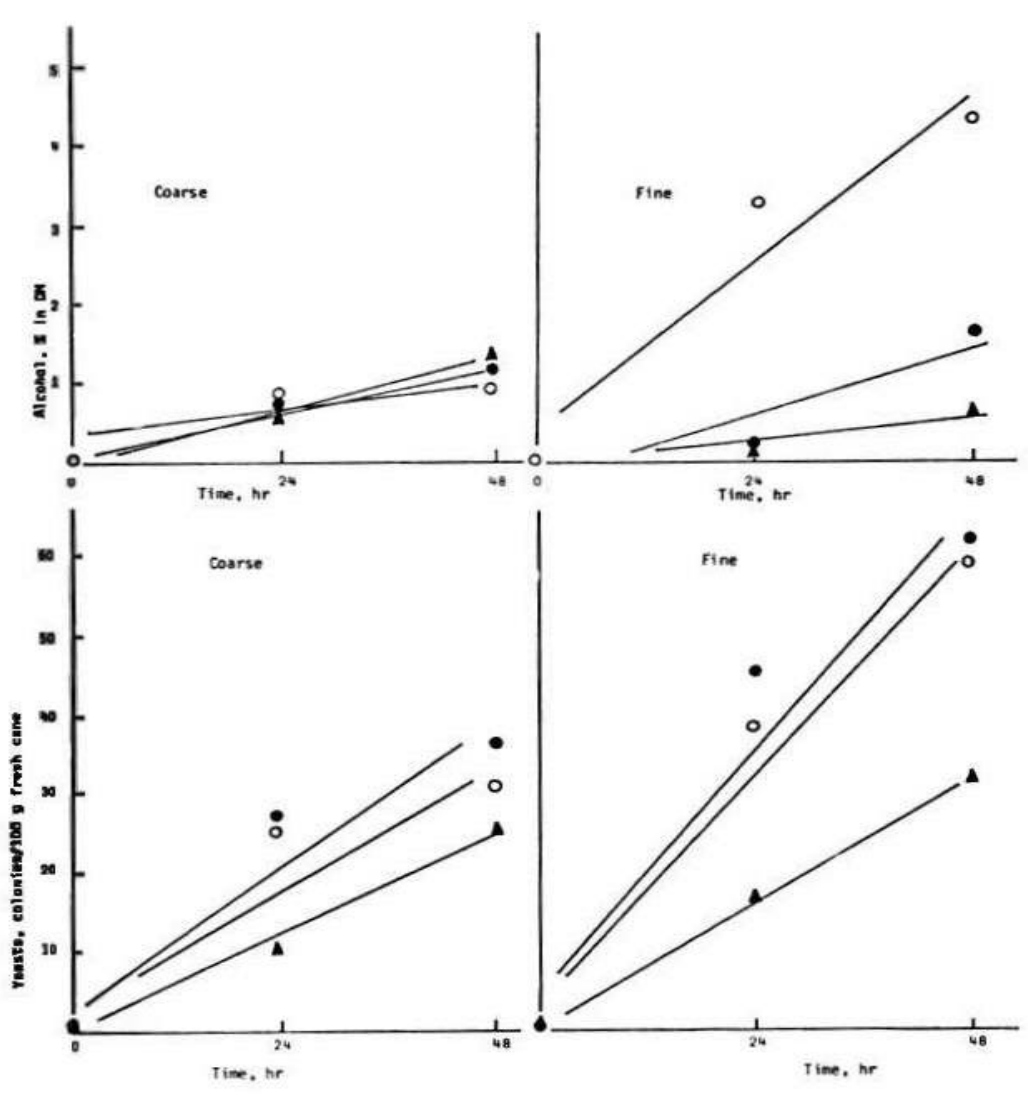

Table 1:
Biochemical parameters in sugarcane fermented for 48 hr

	Coarse			Fine		
	Control	Urea	Urea $(NH_4)_2SO_4$	Control	Urea	Urea $(NH_4)_2SO_4$
pH						
0 hr	4.2	4.9	5.0	5.4	5.2	5.4
24 hr	3.1	4.5	4.1	2.8	4.1	3.8
48 hr	2.9	4.0	3.9	2.4	3.8	3.7
Brix in juice						
0 hr	13.8	21.8	21.8	14	21.5	19
24 hr	12.3	18.0	18.0	13	18.2	16.1
48 hr	9	15.5	17.0	10.5	13	11.0
Yeast Count, colonies/ 100 g fresh cane						
0 hr	0	0	0	0	0	0
24 hr	10	27	25	15	45	38
48 hr	25	36	30	31	61	59
Dry matter, %						
0 hr	23.5	30.0	29.4	26.0	29.1	24.0
24 hr	21.6	25.0	24.2	24.6	25.0	25.1
48 hr	22.5	23.5	22.4	24.8	24.7	23.5
Acetic acid, %in DM						
0 hr	0	.06	.23	0	.16	.02
24 hr	. 86	.77	1.18	.08	.89	.49
48 hr	.96	.81	1.50	.23	1.34	.97
Alcohol, %in DM						
0 hr	0	0	0	0	0	0
24 hr	.55	.75	.86	.11	.17	3.30
48 hr	1.4	1.14	.89	.61	1.63	4.28

Table 2:
Regression coefficients (b) standard errors {Sb) and r² values relating yeast and alcohol concentration with fermentation time (hr)

	Control	Urea	Urea/$(NH_4)_2SO_4$
Yeast count colonies/100 g fresh cane			
Fine			
b	.65	1.27	1.22
Sb	±.012	±.35	±.21
r^2	.99	.43	.97
Coarse			
b	.52	.75	.63
Sb	±.060	±.22	±.24
r^2	.99	.92	.87
Alcohol, %in DM			
Fine			
b	.013	.034	.089
Sb	±.005	±.016	±.028
r^2	.88	.83	.91
Coarse			
b	.029	.024	019
Sb	±.O04	±.004	± .010
r^2	.98	.97	.78

Results and Discussion

The comprehensive analytical data are given in table 1. The most interesting findings were in relation to production of alcohol and yeast growth and the data of these parameters are presented graphically in figure 1 with regression coefficients in table 2. Table 3 gives mean values after 48 hr of fermentation for pH, yeasts and alcohol concentration.

Table 3:
Mean values (±SE_x) and significance levels for pH and yeasts after 48 hr fermentation

	Particle Size		Additive		
	Fine	Coarse	Control	Urea	Urea/ $(NH_4)_2SO_4$
pH					
Mean values	3. 3	3.6	2.05	3.9	3.8
SE_x	±.07			±.09	
Significance level	P< .10			P< .02	
Yeasts, colonies/100 g fresh cane					
Mean values	50.3	30.3	28	48.5	44.5
SE_x	±5.0			±6.1	
Significance level	P< .11			P < .24	
Alcohol, %in DM					
Mean values	2.17	1.14	1.0	1.39	2.59
SE_x	±.87			±1.07	
Significance level	P<.49			P <.63	

The most important findings relate to the growth of yeast and, as a consequence, formation of alcohol as final products of the fermentation. This process was accelerated when the cane was finely chopped and when a source of nitrogen was included (see figure 1). As was to be expected the final pH was lower with finely chopped cane and higher when urea and ammonia sulphate were included (table 3).

There was a suggestion that the presence of sulphur (as ammonia sulphate) stimulated the production of alcohol although this occurred only with finely chopped cane and was not reflected in yeast growth. The production of acetic acid tended to increase when urea or urea and ammonium sulphate were mixed with the cane, but there was no effect of chopping.

The next phase must be to investigate the effect of these biochemical changes in the fermented cane on rumen fermentation in vivo and on animal performance.

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ANIMAL PERFORMANCE AND RUMEN FERMENTATION WITH SUGAR CANE CHOPPED FINELY OR COARSELY

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Summary

The treatments consisted of chopping sugar cane stalk coarsely (10 to 20 mm particle size) or finely (less than 5 mm). The chopped cane stalk was mixed with chopped cane tops (40 to 50 mm particle size) in the ratio 75: 25. A solution of urea/molasses (200 g urea/kg solution) was added to the cane at the rate of 50 g/kg of fresh cane. The animals also received 600 g/d cotton seed meal and 100 g/d minerals. There was one group of 3 crossbred bulls on each treatment. The experiment lasted 138 days and samples of rumen liquor were taken on two occasions during the last month. There were no significant differences in live weight gain or feed conversion due to processing although there was a suggestion that feed intake was higher with the coarse chopping. Molar percent of butyric acid was higher with fine chopping but there were no differences in acetic and propionic acid.

The results support the general finding that particle size has little effect on nutrient value and cattle performance on sugar cane based rations.

Key words: Sugarcane, particle size, cattle

Introduction

The first studies on the use of sugar cane as the basis of a cattle fattening ration stressed the need to eliminate the less digestible rind in order to support adequate animal performance (Donefer et al 1975). However, it was shown subsequently that the advantages of removing the rind were more apparent than real, since in a large scale study with 400 cattle there were no significant differences in any aspect of animal performance on sugar cane which had been derinded or simply chopped (rind included) to a particle size of approximately 5 mm (Preston et al 1975). In this latter experiment (Preston et al 1975), emphasis was on chopping

the whole cane as finely as possible with the objective of producing a particle size similar to that resulting from the derinding technique. This degree of grinding is not easy to achieve under commercial conditions, and obviously results in increased power consumption.

It has since been reported (Montpellier and Preston 19763 that over a wide range of particle sizes ranging from less than 5 mm (in a high speed chopper) to as large as 20 mm (cutting the cane by hand with a machete) there were no apparent differences in either voluntary intake or digestibility.

The objective of the trial reported here was to investigate possible differences in the rumen fermentation pattern as between finely and coarsely chopped sugar cane and also to report preliminary animal performance data.

Material and Methods

Treatments and design:

The treatments were sugar cane stalk chopped (A) coarsely (10 to 20 mm) or (B) finely (2 to 3 mm). There was one group of 3 animals on each treatment. The experiment lasted 138 days.

Animals:

On the coarse sugar cane treatment there were three steers, a Charolais x Zebu, Chianina x Zebu and Angus x Zebu; on the fine cane there were two Charolais x Zebu and one Angus x Zebu. All were castrated males approximately 200 kg LW and 10 months of age at the start of the experiment.

Diets:

The chopped cane stalk was mixed with chopped cane tops (particle size of 40 to 50 mm) in the ratio 75% stalk: 25% tops. The ration was completed by a solution of molasses/urea (200 g urea, 200 g water and 600 g final molasses of 80°Brix) sprayed on the sugar cane at the rate of 50 g/kg of fresh cane; 600 g/d of cotton seed cake and 100 g/d of minerals (a mixture of 50% bone meal and 50% salt with trace elements) was also given . The mixture of cane and molasses/urea was fed free choice while the cotton seed and minerals were given in a separate feeder.

Table 1:
Daily intake of the diffferent components of the ration

	Fine	Coarse
Daily intake, kg		
Fresh cane	18.0	18.5
Molasses	.72	.74
Urea	.18	.18
Cotton seed meal	.57	.57
Salt	.045	.045
Bone meal	.045	.045

Rumen fermentation:

In the last month of the experiment, samples were taken of rumen fluid with a stomach tube. On one sample, measurements were made immediately of protozoal population . Other samples were preserved with concentrated sulphuric acid for subsequent analysis for volatile fatty acids (VFA).

Analytical procedures:

The technique for determining protozoa! biomass was that reported by Leng et al (1976). 10 ml of rumen fluid was incubated with 150 mg glucose in a centrifuge tube at 40° for 20 minutes. The protozoa stored starch and because of the increase in density settled to the bottom, whereas plant materials tended to float helped by gas production by the rumen organisms. The liquid above the protozoa was removed leaving 1 ml of residual material including the protozoa; this was mixed and added to a 1 ml hematocrit tube and incubated for a further 5 minutes at 40° . The protozoa again settled to the bottom and plant material floated. After centrifuging (1500 rpm) for [minute the packed cell volumne was read directly.

Animal measurements:

The cattle were weighed at intervals of 14 days while feed consmuptions were recorded daily. Rate of live weight gain was determined for each treatment group using the regression of live weight on days on trial, subsequently testing the significance of the difference between regression coefficients,by analysis of variance. Feed conversion was determined by regressing cumulative feed intake (DM) on live weight.

Results and Discussion

Animal performance:

There were no significant treatment effects on rate of weight gain or feed conversion (table 2). There was a suggestion that feed intake was higher on the coarse chopping treatment (P <.09).

Rumen fermentation:

Mean values for the molar proportions of the VFA are given in table 3. Molar proportion of butyric acid was significantly higher in animals fed finely chopped sugar cane, but there were no differences in molar proportions of acetic and propionic acid. Although there was a tendency for holotrich packed cell volume to be higher with fine chopping, the variability was extremely high and the difference was not significant.

It has been hypothesised that on most feeds, efficiency of utilization is related to the proportions of VFA produced in the rumen, expressed as the non-glucogenic ratio NGR=(C2 + 2 C4) (0rskov 1975). While specifically on sugar cane-based diets, it has been suggested that animal performance is likely to be limited by availability of glucose precursors (see Leng and Preston 1976).

Regressions were therefore calculated between live weight gain and molar proportions of individual VFA, and also the non-glucogen: ratio (table 4).

All of the relationships were extremely low, and it is interesting to note that the non-glucogenic ratio gave no better prediction of animal performance than propionic acid alone. Although molar proportion of butyric acid was higher for finely chopped sugar cane, and there was a tendency for animal performance to

be poorer on this treatment , the relationship on an individual animal basis was less precise than that with propionic acid.

In terms of interelationships between rumen parameters, these were low between rumen VFA and holotrich packed cell volume Molar proportion of acetic acid was negatively related to both molar butyric acid and molar propionic acid. There was a tendency towards a positive relationship between propionic and butyric acid but the variability was high (see figure 1).

Table 2:
Mean values changes in live weight feed intake and conversion

	Fine	Coarse	Significance level
Live weight, kg			
Initial	222	204	
Final	320	306	
Daily gain[1]	.590 ±.04	.617±.04	NS
Intake of DM, kg/d	5.43 ±.017	5.57± .021	P<.09
Consumption index[2]	1.99	2.15	
Conversion[3]	8.13 ±.52	7.59 ±.10	NS

[1] Calculated by regression

[2] $\frac{\text{kg DM/d}}{\text{l00 kg LW}}$

[3] DM intake/gain LW

Figure 1:
Relationships between rumen VFA on finely (○) and coarsely (•) chopped sugarcane

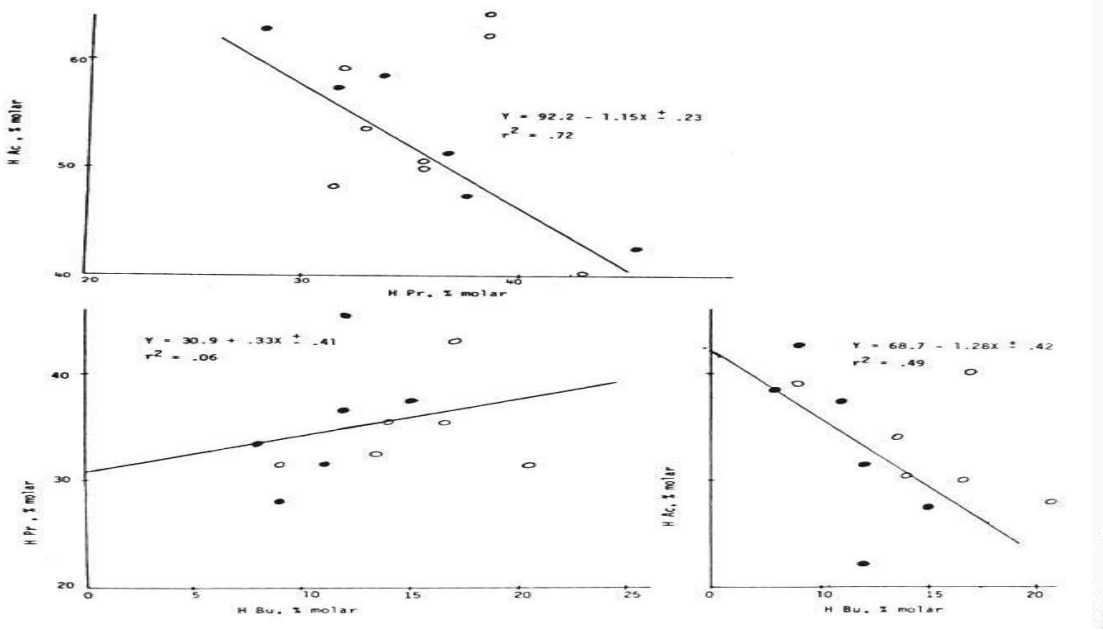

Table 3:
Mean values (x± Sx) for rumen fermentation parameters

	Fine	Coarse	SE_x	Significance level
Volatile fatty acids, %molar				
Acetic	50.3±2.6	53.4±3.1	±3.0	NS
Propionic	34.9±1.8	35.5±2.5	±2.1	NS
Butyric	15.1±1.6	11.2±1.1	±.52	P<.01
Holotrich packed cell volume, % rumen fluid	1.45	1.05	±.96	NS

Table 4:
Relationships between animal performance and rumen fermentation parameters

Y	X	b ± SEb	r^2	Syx
Gain in LW, g/d	Hac	- .092±1.34	.0005	30.6
Gain in LW, g/d	Hpr	- .310±1.82	.0030	50.5
Gain in LW, g/d	Hbu	- .270±2.46	.0012	30.6
Gain in LW, g/d	$\frac{C_2+2C_4}{C_3}$	- 3.38±21.1	.0024	30.4
HBu, % molar	PCV[1]	- .11±.81	.8019	3.93
HPr, % molar	PCV	- .023±1.10	.000045	5.31

[1] Packed cell volume as holotrich protozoa, % in rumen fluid

Conclusion

In view of the numbers of animals involved it is best not to put too much emphasis on the absence of relationship between rumen fermentation pattern and animal performance. Both small numbers, and the fact that samples were taken by stomach tube, 'could be expected to increase variability. In general, the results support other findings that degree of processing, in terms of final particle size, does not seem to be an important factor determining animal performance on sugar cane based rations.

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EFFECT OF STAGE OF MATURITY ON NUTRITIVE VALUE OF SUGAR CANE

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Summary

Determinations were made of nutritive value according to the method of Van Soest on sugar cane harvested at 8 and 16 months of age. The range of Brix in the juice was 11.4 to 17 for the 8 months cane and 15.2 to 18.0 for 16 months cane. All indices of energetic value were higher in 16 months than in 8 months cane, the respective values for in vitro digestibility being 70.5 and 57.5%. There were negative relationships between in vitro digestibility and most cell wall fractions. The only analyses in favour of the younger cane were nitrogen and ether extract. The results suggest that, contrary to the situation with most grasses, the nutritive value of sugar cane increases with maturity.

Key words: Sugarcane, maturity. nutritive value

Introduction

There are few reported analyses for the composition of sugar cane from the point of view of animal feeding, and none of these refers to the effect of increase in age/maturity (Anon 1974).

The object of the experiment reported here was to obtain preliminary data on certain parameters of nutritive value in sugar cane stalk of different ages,

Materials and Methods

Treatments and design:

The treatments consisted of the same variety of sugar cane harvested at 8 on 16 months after planting.

Procedure:

Selections were made of sugar cane variety H 37 grown on experimental plots at Platon Sanchez, Veracruz. Five canes representing different degrees of Brix were selected for each age of maturity. After removing the tops, the cane stalks were ground in a high speed chopper and samples taken of juice and of fresh ground cane for analysis. Brix was measured on the fresh juice with a hand refractometer, while other samples were taken for dry matter estimation (drying at 60° for 48 hr). These were used subsequently for a proximal analysis (AOAC 1970), and in vitro digestibility and cell wall components according to the method outlined by Van Soest (1967).

Table 1:
Chemical analysis off sugarcane harvested at 8 and 16 months (means and SE)

	Age at harvest		Significance level
	8 mth	16 mth	(P<)
Digestibility in vitro,%	57.5±3.4	70.5±4.73	.07
Brix of juice, o	14.5± .77	16.3± .87	.21
% in dry matter			
Acid detergent fibre	37.7±1.02	33.4±1.48	.05
Lignin	6.24± .13	5.43± .13	.01
Cellulose	28.6± :91	26.2± .91	.21
Cell wall	61.1±1.70	54.1±2.65	.06
Silica	2.04±.28	1.06± .28.	.06

Table 2:
Proximal of sugarcane harvested at 8 and 16 months of age (mean values and SE)

	Age at harvest		Significance level
	8 mth	16 mth	(P<)
Dry matter, %	20.5±.67	22.2±1.76	.28
% in dry matter			
N x 6.25	4.19 ±.28	2.89±.35	.02
Ether extract	1.10± .08	.81±.22	.14
Fibre	27.7±1.12	25.0±1.66	.21
Nitrogen free extract	61.4±1.56	67.8±1.40	.03

Results and Discussion

The data for in vitro digestibility, Brix in juice and some cell wall components are set out in table 1. The conventional proximal analysis is given in table 2 and relationships between in vitro digestibility and cell wall parameters in table 3.

The most important findings are the higher in vitro digestibility and lower content of structural cell wall components in 16 months cane as compared with the younger 8 months cane. The only criteria in favour of the younger cane were protein (N X 6.25) and ether extract. However, the differences in these components in favour of the young cane were small and would not appear to compensate for the quite considerable differences in in vitro digestibility.

Table 3: Relationship between in vitro digestibility and various analytical measurements

Y	X	Equation	r^2	SE_b
Digestibility	°Brix	Y=26.8 + 2.3X	.20	±1.66
Digestibility	Acid detergent fibre	Y=137.2-2.08X	.42	±0.87
Digestibility	Lignin	Y=123.8-10.4X	.24	±6 40
Digestibility	Cellulose	Y=114.2-1.89X	.24	±1.17
Digestibility	Cell wall	Y=120.4-1.0X	.26	±0.58

As was to be expected, there were significant relationships between in vitro digestibility and most cell wall components (table 3). The positive correlation between digestibility and Brix in juice indicates that the improved nutritive value with increasing maturity in sugar cane is a function of the storage of sugar. As the cane matures the increase in sugar content has the effect of diluting the structural cell wall components, thus leading to an increase on overall feeding value . These analytical data support the results of feeding trials (Alvarez and Preston 1976) in which cattle growth rate and feed conversion were significantly better on mature than on young sugar cane.

Sugar cane therefore possesses a distinct advantage over most other tropical grasses in that its feeding value increases with maturity . Since maturity of sugar cane coincides generally with the dry season, when most conventional grasses present both qualitative and quantitative deficiencies, one obvious role of sugarcane is as a dry season feed supplement.

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AMMONIA/MOLASSES AND UREA/MOLASSES AS ADDITIVES FOR ENSILED SUGAR CANE

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Summary

Chopped sugar cane stalk was ensiled in four litre sealed jars with solutions containing either 34% aqueous ammonia (28% NH_3) and 66% molasses or 17% urea, 17% water and 66% molasses, at levels of 0, 20, 40, 60 or 80 ml/kg of fresh cane. Six jars were prepared on each subtreatment one of them being opened on days 0, 2, 5, 10, 20 and 40. Ammonia had a marked effect on the pH pattern during ensiling, with initial values of 10 falling to between 3.5 and 4.5, the rate of fall being inversely related to the concentration of ammonia; pH with urea was only slightly higher that in the control silage with no additives. Ammonia was much more effective in reducing the loss of sugars during the ensiling process. The most effective ammonia level appeared to be the equivalent of 1.6 g N/kg of cane, assessed in terms of minimum loss of sugar and maximum lactic acid concentration. At hither levels of ammonia inclusion, lactic acid content decreased. In contrast, the most advantageous level of urea was the highest one (equivalent to 30.6 g urea/kg of fresh cane). Acetic acid decreased with addition of ammonia but was little affected by urea. Butyric acid was found in only a few of the samples.

Key words: Sugarcane, ammonia urea, ensiling

Introduction

The justification for ensiling sugar cane relates in part to the problems associated with harvesting of sugar cane in the wet season and the fact that its nutritive value is higher when it reaches maturity (Banda and Valdez 1976) which usually coincides with the dry season. Thus, in a situation where year round dry lot feeding was practised, there could be a reason for harvesting sugar cane in the dry season, at its optimum nutritive value, and conserving it for use in the wet season.

The other argument in favour of ensiling sugar cane is that a controlled fermentation under anaerobic conditions may be a means of improving nutritive values by increasing the content of true protein (by microbial sinthesys) and of lactic acid. Both of these factors have led to improvements in feeding value of whole crop maize ensiled with additives (Henderson and Geasler 1970).

Results reported by James (1973) on the use of ensiled derinded sugar cane were discouraging in that voluntary feed intake and animal performance were very considerably reduced in comparison with fresh sugar cane.

It has been postulated that these negative effects were associated with the production of alcohol and, to some extent acetic acid, and that the former, at least, could be avoided by adding a solution containing ammonia to the sugar cane at the time of ensiling (Preston et al 1976).

The objective of the experiment described here was to examine the effect of different concentrations of both ammonia and on the ensiling of sugar cane, under laboratory conditions.

Table 1: Composition off additives (%)

	Ammonia/molasses	Urea/molasses
Final molasses, (80° Brix)	66.7	66.7
Aqueous ammonia [1]	33.3	
Urea		16.7
Water		16.6

[1]Contains 28.3% NH_3

Materials and Methods

Treatments and design:

The principal treatments were urea and ammonia each given at 5 different levels according to a 2 x 5 factorial design with one replication. The two additives were included at levels equivalent to 0, 1.6, 3.1, 4.7 and 6.2 g N per kg of chopped sugar cane stalk (fresh basis).

Glass jars of 4 litres capacity with a sealed top were used as experimental silos. Mature sugar cane stalk (Brix 17.5) was chopped finely in a high speed chopper and mixed with 0, 2, 4, 6 and 8% (weight/weight) of each of the solution, the compositions of which are given in table 1. Six different jars were prepared for each treatment combination, the objective being to open these on days 0, 2, 5, 10, 20 and 40. The experiment was started on 3 January 1975.

Table 2:
Organic acids (% inDM) in sugarcane ensiled with ammonia/molasses on urea/molasses

Amount of solution added[1]	Lactic acid		Acetic acid		Butyric acid	
	NH_3[1]	Urea[1]	NH_3	Urea	NH_3	Urea
0	4.67	4.67	1.5	1.5	-	-
2	12.50	4.80	1.3	1.6	-	1.3
4	7.53	4.80	.87	1.7	-	-
6	6.23	8,83	.63	1.8	.89	-
8	5.97	9.63	.60	1.6	1.	-

[1] Contains 7.85% N as NH_3 or urea

Measurements:

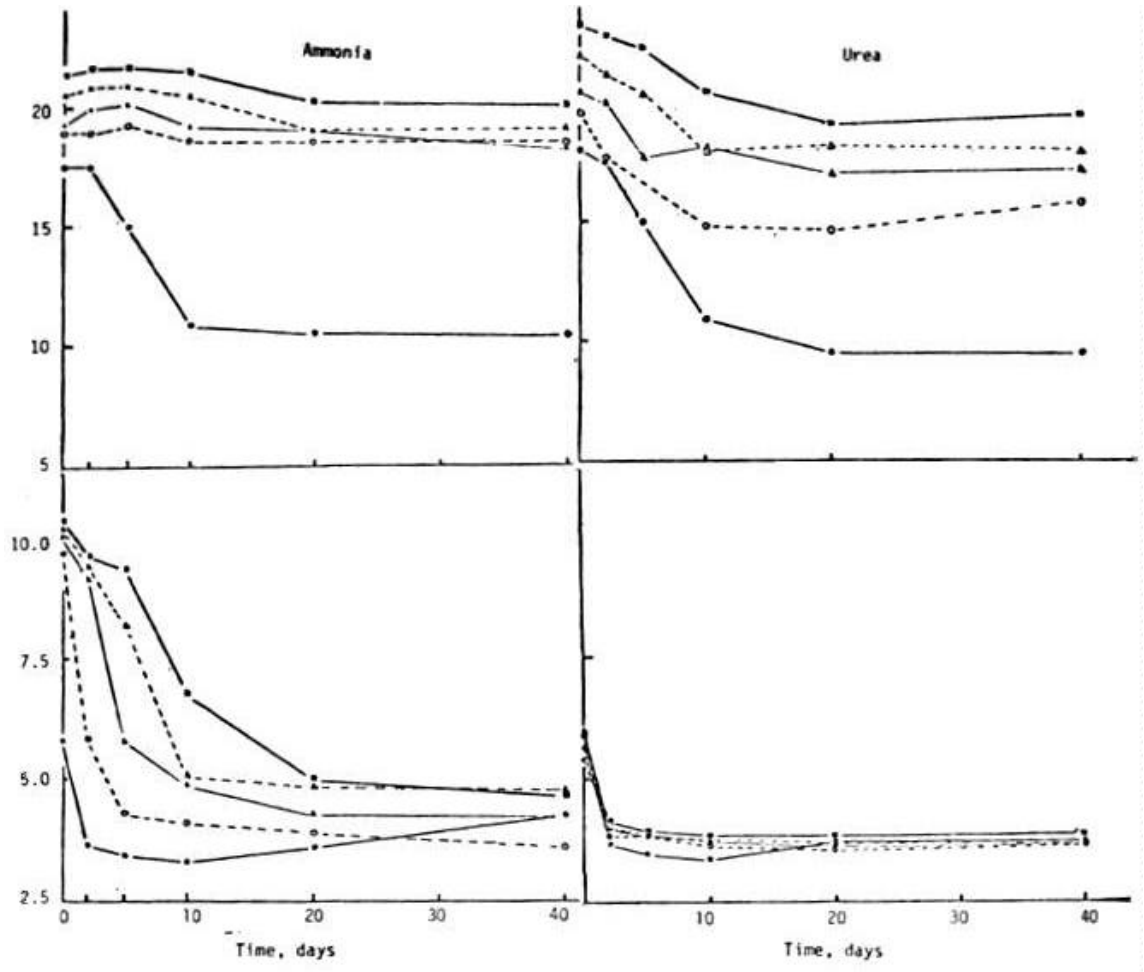
Samples were taken of the freshly prepared mixtures and from the silos when these were opened. They were mixed thoroughly after discarding the top 100 mm, and juice extracted with a hand press. Brix and pH were determined immediately on fresh juice. Other samples were preserved for subsequent analysis for lactic acid and volatile fatty acids by gas chromatography The methods were those described by González and MacLeod (1976)

Results and Discussion

The fermentation pattern, in terms of Brix and pH, during the process is set out in figure 1. Figure 2 shows the effect of the additives on the relative loss of sugars (Brix) while table 1 gives values for lactic, acetic and butyric acids.

The relationship between lactic acid and amounts added of urea and ammonia is presented in figure 2.

Figure 1:
Fermentation pattern in chopped cane stalk ensiled with a solution of molasses/ ammonia (66 kg molasses, 34 kg aqueous ammonia (28% NH_3) or molasses/urea (66 kg molasses, 17 kg urea, 17 kg water) concentrations of 0 (•), 20 (○), 40 (▲), 60 (△) and 80 (■) ml/kg of cane



There were very obvious differences between ammonia and urea in terms of their effects on the fermentation patterns. All levels of ammonia equally effective in preventing the reduction in Brix value observed with untreated cane. In contrast, the beneficial effect of urea appears to improve with increasing concentration.

Ammonia had a much more marked effect on the pH pattern. All the levels used raised the initial pH to about 10, while during the first 20 days of ensiling pH decreased according to the concentration of ammonia. Final values reached were, on the whole, similar to those recorded for the untreated cane. In contrast, urea had only a slight tendency to modify the pH pattern. The superiority of ammonia over urea in terms of preserving the original sugars in the cane , is very apparent from figure 2.

Figure 2:
Loss of sugars (Brix) in juice from sugar cane ensiled with solutions of molasses/ ammonia (•) or molasses/urea (◦)

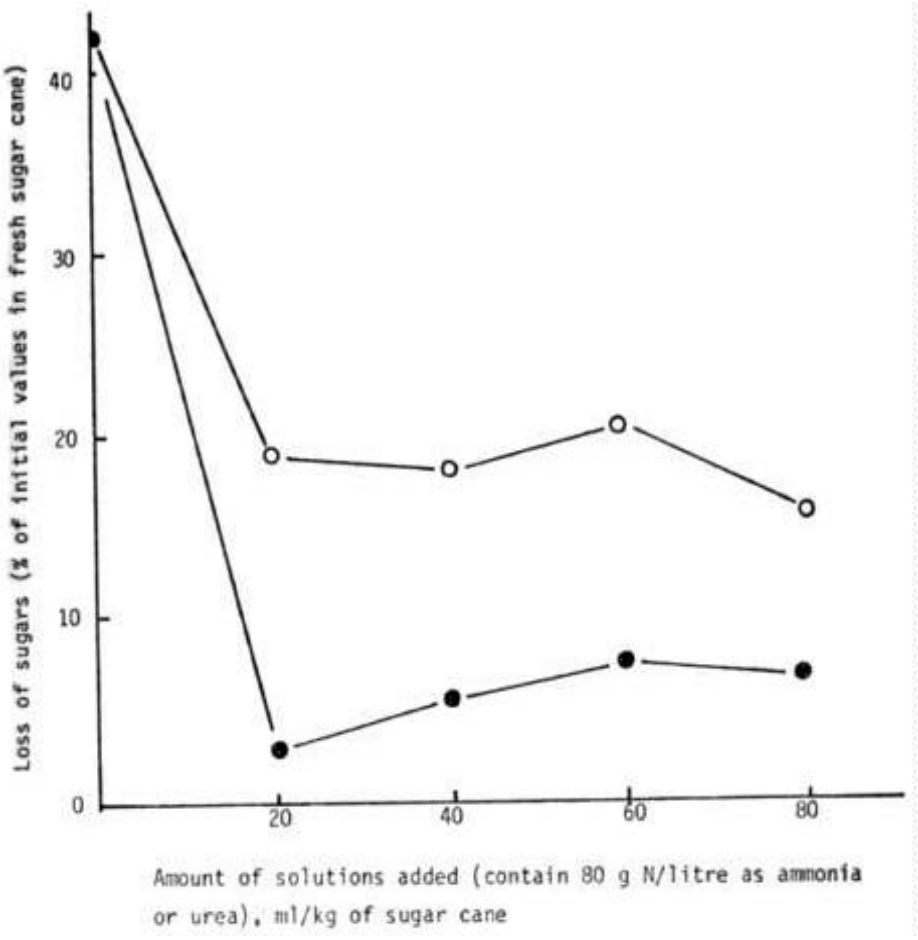


Figure 3:
Effect on lactic acid concentration in ensiled sugar cane of varying levels of ammonia (◦) or urea(•)

The data on contents of organic acids suggest that the use of both ammonia and urea gave rise to increases in lactic acid concentrations and a reduction in acetic acid. However. in the case of ammonia the optimum concentration appears to be the lowest one used (equivalent to 1.6 g added N per kg of silage), the values for lactic acid subsequently falling as more ammonia was added. The contrary was observed with urea, ie lactic acid increased with amount of urea added. The content of acetic acid decreased linearly according to the amount of ammonia added (r = -.97) hut there was a tendency towards an increase with urea level (r = .55). Butyric acid was only found in three of the samples and appeared to be unrelated to treatment.

In general terms, all the treated silages had an acceptable texture and smell; while the untreated silage was obviously inferior.

Conclusions

It would appear that the ensiling of sugar cane presents specific problems, not normally encountered with other forages. These appear to be related to its high content of soluble sugars and the fact that the conversion of these into alcohol

and , to lesser extent, acetic acid, proceeds normally under anaerobic conditions due to fermentation by yeast. In most cases it will be necessary to include some form of additive to control this process, if maximum feeding value is to be retained in the ensiled material.

In this respect, ammonia appears to be more effective than urea Moreover, on world markets the unit price of nitrogen in ammonia is only half that in urea so there are therefore economical advantages from use of the former. The disadvantage is that ammonia is obnoxious to handle and ways must be found therefore to stabilize it as much as possible, if it is to be used under commercial conditions.

Dissolving ammonia gas in molasses, as proposed by Michigan workers (Henderson & Geasler 1970), is effective in general terms, but the fact that solubility of the ammonia in this mixture decreases with increase in ambient temperature, makes the process a little less suitable for use under tropical conditions (Preston et al 1976).

It also seems that the optimum levels of ammonia for use with sugar cane might well be lower than that found to be most effective with whole crop maize (Henderson and Geasler 1970).

Acknowledgements

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PERFORMANCE OF FATTENING CATTLE ON IMMATURE OR MATURE SUGAR CANE

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Summary

Cane stalk from mature (14 months, 16.8 Brix, 28.3% DM) or immature cane (8 months, 9.7 Brix and 20.5% DM) was mixed with tops from the immature cane in the ratio 70:3C. The mixture was supplemented with urea/molasses (283 g urea/kg solution) sprayed over the cane at the rate of 50 ml/kg fresh cane. Rice polishings (1 kg/d) and free choice minerals were also given . There were 4 Zebu steers in individual pens in a completely roofed building on each treatment. The trial lasted 112 days and was carried out from May to August 1975 in what turned out to be a prolongation of the dry season. Rate of live weight gain and feed conversion were improved by almost 100% on mature as supposed to immature cane. There was a tendency for DM intake to be higher on the mature cane but the major difference in animal performance could be ascribed to improved feed utilization efficiency on the mature cane. Analysis of rumen fluid showed significantly higher proportions of butyric acid and less acetic acid in animals receiving the immature sugar cane. It is suggested that the superior performance of mature sugar cane is probably due to a higher content of soluble sugars in the dry matter.

Key words: Sugarcane, maturity, cattle

Introduction

The first large scale trial at this Centre on the utilization of sugar cane for fattening cattle (Preston et al 1975) was carried out between January and April 1974, a period which coincided with the normal dry season in that part of Mexico. Performance on the best treatment (896 g/d) was close to the genetic potential for the commercial Zebu cattle which were used (see Preston and Willis 1974). Results in the following 6 months wet season were quite the contrary, with animal performance little above maintenance (CIEG 1974).

Two factors were thought to have contributed to this poor animal response. One was the difficult environmental conditions in the fattening pens, which were almost continuously wet and deep in mud; the second was the fact that the sugar cane being used at that | time was mostly in the early stages of growth (between 6 and 8 months following the previous harvest).

The objective of the trial described here was to evaluate stage of maturity of sugar cane as a factor determining animal performance.

Materials and Methods

Treatments and Design:

The two treatments were immature cane stalk (8 months of age, average Brix 9.7 and average dry matter content 20.5) and mature cane stalk (14 months of age, Brix 16.8 and dry matter content 28.3). 4 animals in individual pens were allocated to each treatment according to a random block design with 4 replications.

Procedure:

The experiment began on 9 May 1975 and ended on 29 August. It was planned to have coincided with the wet season, but in fact 1975 was an extremely abnormal year and little or no rain fell during the whole of this period.

The animals were Zebu steers approximately one year of age weighing 200 kg and had been adapted to sugar cane rations for the previous 3 months. They were housed in individual 2 X 3 m pens with a cement floor and palm roof.

The variety of sugar cane was poj 2878. The mature cane was on average 14 months of age while the immature cane was only 8 months. The latter was maintained in active growth by application of irrigation.

For each type of cane, the tops were separated from the stalk and the final rations prepared by combining chopped tops from the immature cane with the stalk from the respective types of sugar cane in the ratio 30:70.

The sugar cane stalk and tops were processed in a high speed forage chopper to give a particle size between 5 and 10 mm for stalk, and 40 to 50 mm for tops. The sugar cane was supplemented with a solution of urea/molasses(283 g

urea, 208 g water and 817 g final molasses/litre of solution) which was sprayed over the sugar cane at the rate of 50 ml/kg of fresh cane. In addition, each animal received 1 kg/d of rice polishings and had free access to a mixture of rock phosphate, salt and trace minerals. The sugar cane was chopped and fed twice daily . The rice polishings were given in the morning as the first feed before the sugar cane was offered.

Table 1:
Mean values for feed intake, weight gain and conversion for bulls fed rations based on immature and mature sugarcane

	Immature	Mature	SE_x
No of animals	4	4	
Length of trial, d	112	112	
Live weight, kg			
Initial	214	210	
Final	244	268	
Daily gain	.27[a]	.525[b]	±.026
Intake, kg/d			
Fresh cane	13.8	12.4	
Rice polishings	1.0	1.0	
Final molasses	.56	.51	
Urea	.198	.178	
Minerals[1]	.056	.058	
Total DM	4.25	4.78	
Consumption index[2]	1.87	2.03	±.060
Conversion[3]	l9.4[a]	9.48[b]	±2.70
N in diet, g/kg DM	29.2	25.0	

[1] 50% rock phosphate, 35% salt 15% trace minerals

[2] $\frac{\text{100 kg DM/d}}{\text{kg LW}}$

[3] DM intake/gain in LW

ab Means (P<.05)

These tendencies in animal performance were reflected in the changes in Brix of the cane juice and in DM content of the cane stalk, both of which increased during the experiment for the young cane but fell for the mature cane (figure 1).

There were differences in the rumen fermentation pattern. Molar proportion of butyric acid was higher on young cane than with mature cane, acetic acid was less, but there were no differences in propionic acid.

Rumen fermentation:

At the end of the experiment, samples of rumen fluid were taken from each animal with a stomach tube before and approximately 3 hr after the first feed. These samples were preserved with concentrated sulphuric acid for subsequent analysis for molar proportions of volatile fatty acids (VFA).

Measurements :

The animals were weighed at intervals of 14 days and feed consumption recorded daily. The molar proportions of VFA were determined according to the method described by Gonzalez and MacLeod (1976). Periodical analyses were made of the Brix in the juice of the cane stalk and also the dry matter (DM) content of the combined stalk and tops given in each ration.

Results and Discussion

Mean values for feed intake and animal performance are given in table 1. The data for molar proportions of VFA are given in table 2. Changes in the Brix of the juice and in stalk DM content of the two types of cane are set out in figure 1 while figure 2 shows changes in the voluntary intake of fresh cane and in cumulative live weight gain during the experiment.

Over the trial as a whole there was a significant difference ($P < .03$) in daily live weight gain in favour of the cattle fed stalk from mature cane. The data for feed conversion were particularly striking, with values (DM basis) of',l9.4 and 9.48 for young an] mature cane respectively. The cumulative weight gain during the progress of the trial showed little variation in the case of the mature cane while on the young cane there was a tendency ($r2 = .29$) to increase as the trial progressed (figure 2).

Table 2:
Rumen fermentations based on mature and immature sugarcane stalk

	Before feeding		After feeding	
	Immature	Mature	Immature	Mature
pH	6.8	7.25	6.9	6.6
Molar % VFA				
			a	b
Acetic	70.5 ± 2.25	72.3± .65	57.8±.40	62.6±.35
Propionic	17.1 ± .85	19.1±1.6	25.4±1.7	24.1±.80
			c	d
Butyric	12.5 ±1.7	10.7±.90	16.9 ±1.4	13.4± 1.2

ab Differ at P <.01

cd Differ at P < .18

Conclusions

Despite the limited number of animals used in the trial, caused by the difficulty in maintaining adequate quantities of actively growing young cane in the abnormal dry season conditions, there can be no question about the superiority of mature as compared with immature cane stalk in terms of feeding value for cattle. These data support the observations made under practical conditions the previous year, and are further confirmed by the analytical data reported by Banda and Valdez (1976), which indicated superior in vitro digestibility and reduced concentration of cell wall components in 16 months as opposed to 8 months old sugar cane.

Figure 1:
Changes in dry matter and Brix in mature (•) and immature (◦) sugar cane stalk during the trial (9 May-29 August)

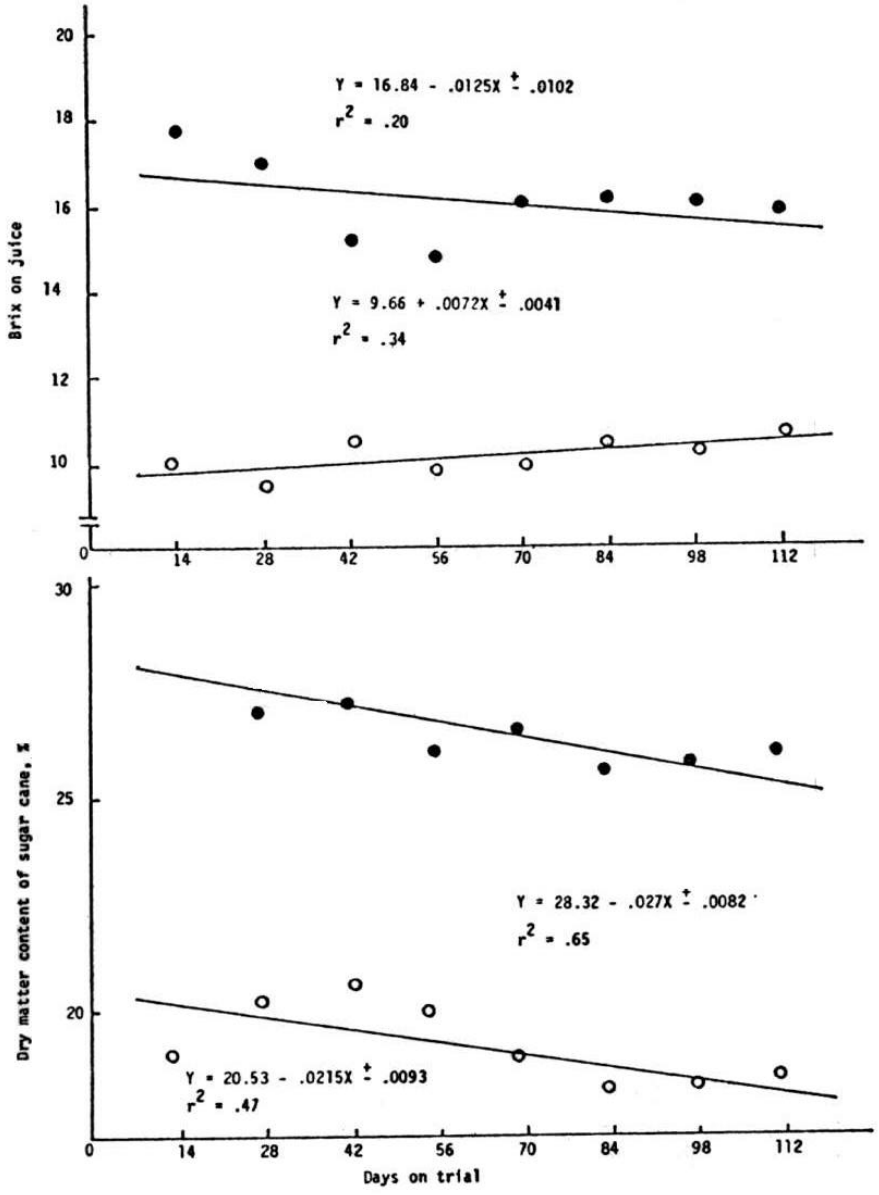
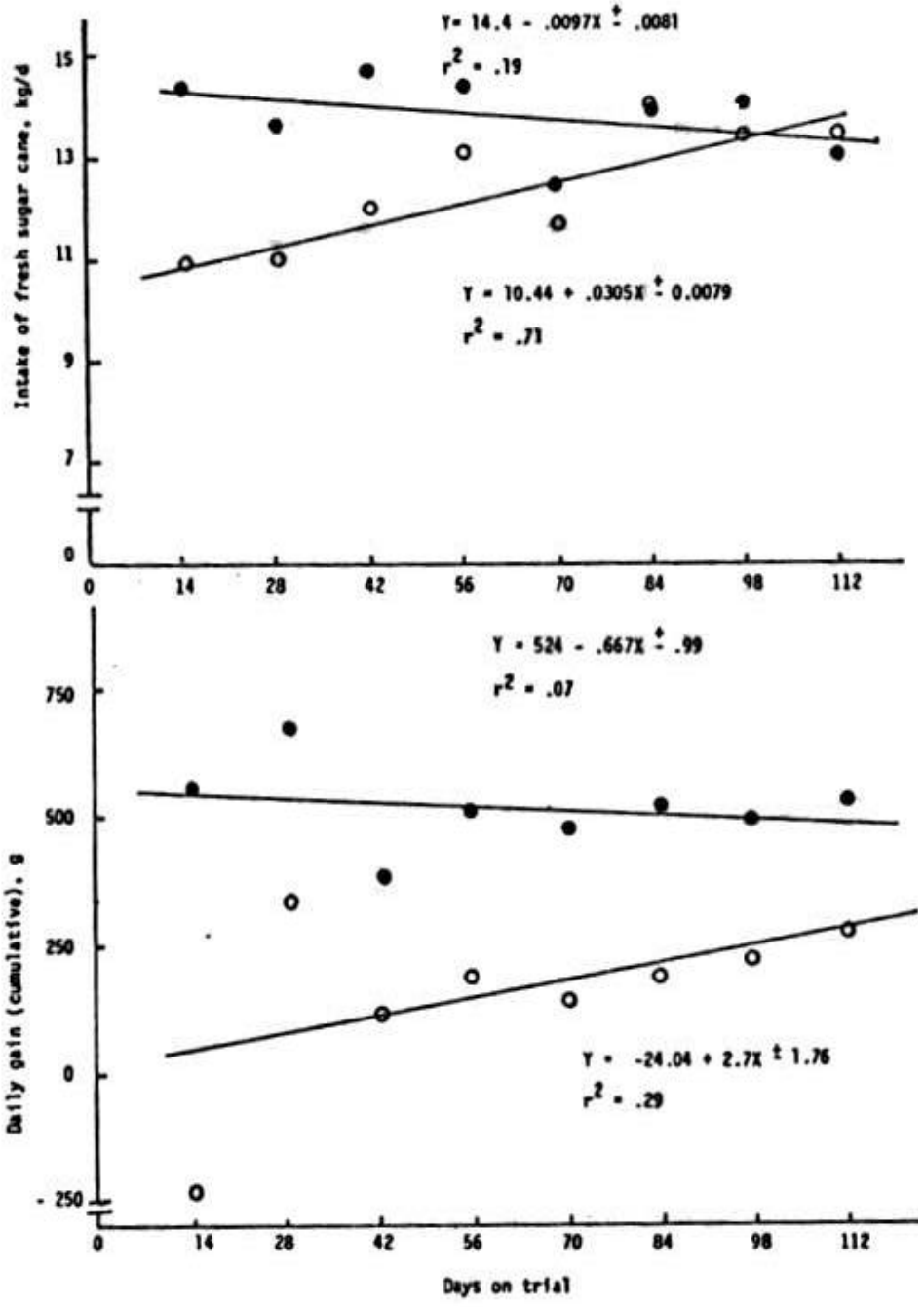


Figure 2:
Cumulative daily weight gain and intake of fresh cane for mature (•) and immature (○) cane stalk treatments.



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LEUCAENA LEUCOCEPHALA AS PROTEIN SUPPLEMENT FOR DUAL PURPOSE MILK AND WEANED CALF PRODUCTION ON SUGAR CANE BASED RATIONS

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Summary

18 crossbred Swiss/Zebu cows (60 to 80% Zebu breeding) between 4 and 6 months of lactation were fed a basal ration of chopped whole sugar cane, molasses/urea (100 g urea/kg) and minerals. The treatments were supplements of : (A) 2 kg/d rice polishings (control) ; (B) 1 kg/d rice polishings and restricting grazing for 3 hr on Leucaena leucocephala; (C) only restricting grazing on Leucaena. The cows were machine milked, the calf being allowed to suck for a few seconds prior to milking to stimulate let down and then for 30 minutes after the machine was removed. The rest of the day, the calves were separated in a pen where they received chopped whole sugar cane, molasses with 10% urea, rice polishings and minerals all on a free choice basis. Milk production was 4 kg/d for treatments A and B and was significantly less (3.2 kg/d) on the group C receiving Leucaena. Calf growth rate averaged 600 g/d and milk consumed by the calf was in the range of 1.4 to 1.9 kg/d with a tendency to be less for the group C calves. Consumption of sugar cane (14.5% DM and 9.4° Brix) was highest for the control;least for group which did not receive rice polishings. Estimated intakes of Leucaena were 9 kg/d equivalent to a protein consumption of about 400 g/d. The poor results on the use of Leucaena as the only supplement attributed to a depressing effect on total DM intake.

Key words: Sugarcane, leucaena, milk production

Introduction

The justification for developing integrated milk/beef production systems with dual purpose cattle for tropical conditions has been discussed by Preston (1976). While details of the general procedure to be adopted, and some preliminary findings under tropical conditions in the Dominican Republic, have been described by MacLeod et al (1976)

The objectives of the experiment described here were to obtain preliminary information on cow and calf performance in such a dual purpose production system, and more specifically to investigate the use of restricted grazing of the woody legume Leucaena leucocephala as a protein source to supplement the basis ration of sugar cane and urea.

Materials and Methods

Treatments and Design:

The three treatments consisted of variations in the protein component of the ration namely: (A) 2 kg/d of rice polishings, (B) 1 kg/d of rice polishings and restricted grazing for 3 hr on a pure stand of Leucaena leucocephala, and (C) only restricted grazing on Leucaena leucocephala. There were 3 groups each of 6 cows and their calves on the respective treatments. The data were analysed as a random block with three treatments and six replications.

Animals:

The cows were commercial crossbreds with different proportions of Brown Swiss or Holstein, and Zebu. It was estimated that the Zebu component was between 60 and 80% on average. Most of the European "blood" was Brown Swiss which is the predominant crossing breed used in the tropical regions in southern Mexico . The calves were by a variety of sires, of the three breeds already mentioned. The cows were arranged in the treatment groups according to their previous production, genetic makeup and stage of lactation. Almost all the cows had lactated from 4 to 6 months before the experiment began. All had received a sugar cane based ration for at least the previous three months. They were housed in open sided pens with a cement floor and a palm roof for shade. The area per cow was 11.5 m^2. Milking was once daily at 6 a.m. by machine (Alfa Laval) in an abreast pipeline parlour. The calf was allowed to suck each teat for a few seconds to stimulate letdown, and was then tied at the head of the cow, When machine milking was completed (no stripping was practised), the calves were suckled for a 30 minute period. At this point, cows and calves were separated to their respective pens until milking the following morning.

Diets:

The basic ration was chopped whole sugar cane given ad libitum in one feed trough, and a solution of urea/molasses (100 g urea/kg of mixture) in another,

also provided on a free choice basis. All animals received a mixture of salt, rock phosphate and trace minerals. The rice polishings were given as the first feed in the morning before offering the sugar cane. The cows on the grazing treatments were on the pasture from 8 to 11 a.m. each day, immediately following milking. The calves were managed as one group and had free access to chopped whole sugar cane, molasses with 10% urea, rice polishings and minerals.

Approximately 1 hectare of Leucaena leucocephala was available. It had been sown 8 months previously at row spacings of 1.6 m . It was fertilized at sowing with 250 kg triple super phosphate/ha. The area was divided into 4 paddocks so as to enable a form of rotational grazing to be practised. The first rotation lasted 55 days 23, 10, 7 and 15 days respectively in the four paddocks. The area in each was not the same, nor was the stand of the legume, which explains the different times spent in each. In the second rotation, there was insufficient regrowth, and after a further 15 days grazing the trial had to be suspended. It lasted in total for 70 days.

Measurements

Milk production by the machine was recorded daily while on one day of each week milk consumed by the calves was determined by weighing before and after suckling. Feed intakes were recorded daily. Estimations were made at 14 days intervals of the amount of Leucaena consumed. The cows in each group were weighed before and after grazing and the increase in live weight assumed to represent total intake of fresh forage as Leucaena.

In addition, determinations were made at intervals of the Brix of the sugar cane juice, and the dry matter content of both the sugar cane and the Leucaena leucocephala.

Results and Discussion

Mean intakes of the different ration components during the 70 day trial are set out in table 1, including the estimate of Leucaena leucocephala consumption. Table 2 gives the production data for both the cows and calves, while in table 3 the relationships within these parameters are presented in the form of linear regression equations. Changes in live weight of the cows during the 70 day trial are show in figure 1.

An outstanding feature of the results was the very high intake of sugar cane particularly by the control group receiving 2 kg/d of rice polishings. This could be explained in part by the very low dry matter content of the sugar cane (14.5%) and the low Brix value (9.36), both factors indicating that the sugar cane was very immature, and therefore of low feeding value according to the findings of Alvarez and Preston (1976) . The lowest intake of dry matter was by the group which received no rice polishings, while the highest was on the combined treatment.

Table 1:
Mean values for feed intake of cows, kg/d

	Rice polishings	Leucaena R. polishings	Leucaena
Sugarcane	40.9	33.8	27.2
Molasses	2.45	3.17	2.39
Urea	306	.396	.299
Rice polishings	2.0	1.0	-
Leucaena	-	9.6 ±1.5	8.6 ±.5
Minerals	.08	.076	.084
Total DR	10.1	11.4	8.70

The production data, showing saleable milk yields ranging from 3 to 4 kg/d is reasonable, in view of the type of animal used, and their being in the middle to end of lactation phase. The average calf growth rate of 600 g/d is extremely satisfactory and more than comparable with what can be expected from calves in single suckling management systems in the tropics.

When saleable milk yield was expressed in terms of persistency (yield during the experimental period as a function of yield prior to experiment), there was a significant difference in favour of the groups receiving rice polishings alone, or rice polishings plus Leucaena. However, there were no differences in growth rate between groups of calves on these treatments, despite the fact that the calves on the cows which did not receive rice polishings consumed less milk than the other two groups ($P < .22$). Total milk yield at 6 kg/d for the two best groups is very acceptable under the particular conditions of the experiment.

Table 2:
Milk production and live weight changes in cows and calves d uring:ng 70 day trial period

	Rice polishings	Leucaena R.polishings	Leucaena	SE_x	Level of significance (P<)
Saleable milk, kg/d					
Pre-experimental (p)[1]	4.14	4.02	4.08	±.53	.99
Experimental (e) [2]	3.97	4.16	3.20	±.46	.34
Persistency (e/p)	.96[a]	1.06[a]	.80[b]	±.069	.05
Milk intake by calf, kg/d	1.95	2.02	1.43	± .25	.22
Total milk (Saleable + calf)kg/d	5.92	6.19	4.63	± .56	.15
Calf growth					
rate, g/d	599	576	634	± 84	.99
Live weight change					
in cows, kg/d	.34[a]	.32[a]	-.23[b]	±.13	.01
Live weight persistency[3]	l.05	1.09	.97	±.30	.03

[1] During 7 days prior to start of trial
[2] During 70 day trial
[3] Final Lw/initial LW
ab Means without common superscipt differ at P<.05

There were significant differences in weight change of the cows. Both groups receiving rice polishings gained in live weight at approximately 300 g/d , however the group which only received Leucaena as supplement had an overall loss of weight of 230 g/d, significantly different from the other two groups

Table 3:
Relationship betweeen production parameters

Y	X	Equation	r^2	Sb	Syx
Milk intake by calf, kg/d	Milk sold, kg/d	1.37 + 17X	.10	± .14	.62
Calf growth rate, g/d	Milk intake by calf, kg/d	881 - 155X	.26	±68	173
Calf growth rate, g/d	Milk sold, kg/d	775 - 45.7X	.07	±42	193
Calf growth rate, g/d	Total milk, kg/d	917 - 56,5X	.18	±31	181
Milk persistency[1], %	LW persistency[2], %	-45.1 + 1.34X	.37	±.46	16.1

[1] Saleable daily milk for 7 day pre-experimental period
Saleable daily milk during 70 day experimental period

[2] Final LW/initial LW

In fact that calf growth rate was similar on all treatments, despite the significantly lower milk yield of the cows supplemented with only Leucaena grazing, indicate that the contribution of milk to the overall diet of the calf was not a critical factor in determining its growth rate . It is probable that the supplementation, which was common to all calves, helped to compensate for the differences in milk intake. This suggestion is supported by examination of the relationships between the different production parameters (table 3). As would be expected, the best relationship was between calf growth rate and milk consumed, but even here the milk intake only explained 26% of the total variability in live weight gain.

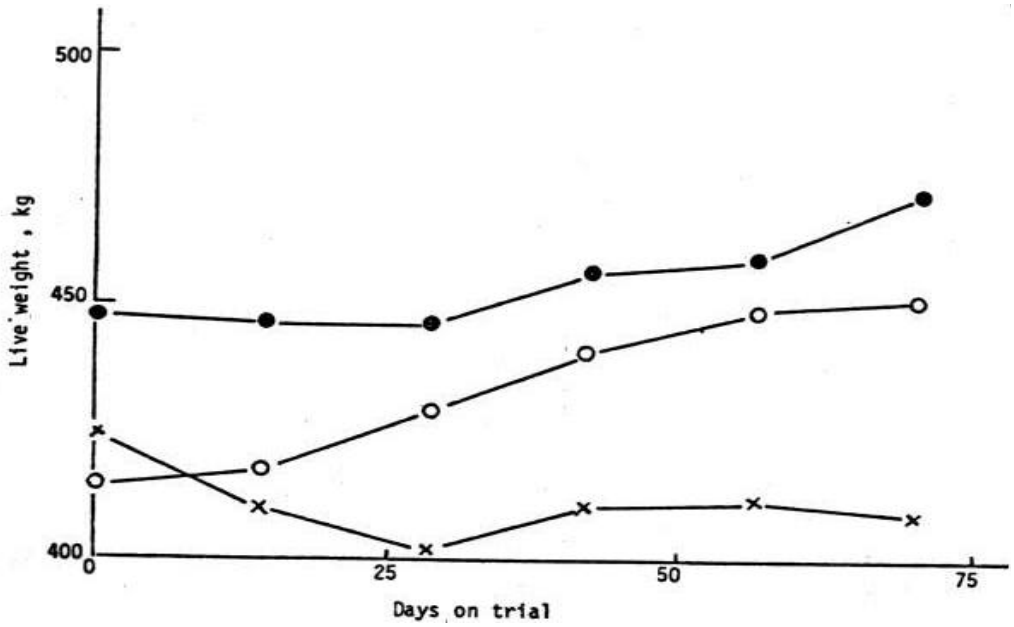
Yield persistency and live weight persistency were also positively related, supporting the belief that in dual purpose cows the partition of nutrients above maintenance, is divided) fairly equally between milk production and body weight gain.

Examination of figure 1 which gives live weight changes of cows during the experiment shows that those which were deprived of the rice polishings supplements and had to rely only on Leucaena as the protein supplement

showed a loss in live weight during the first 30 days of the experiment during which time the ether two groups continued to maintain or even to gain live weight, Subsequently, there was some recovery on the Leucaena group, but even after 70 days on experiment they weighed some 50 kg less than the others. Moreover, they seemed to be able only to maintain their weight at this point, while the other treatment groups showed steady increases.

The poorer performance on the Leucaena only group is probably due mainly to their lower overall intake of DM, since this parameter was highly correlated with total milk yield (r = .94). In contrast, supplementary true protein was not related to yield (r = .06), protein intake being lowest on the 2 kg/d rice polishings group (240 g/d) and twice as high as this for the Leucaena1 only treatment (480 g/d), which nevertheless gave least milk.

Figure 1:
Changes in live weight of milking cows fed sugar cane, molasses/urea and either 2 kg/d rice polishings (•), 1 kg/d rice polishings and 3 hr/d grazing on Leucaena leucocephala (◦) or only 3 hr/d grazing Leucaena (x)



[1] The samples of Leucaena, approximating to what the cattle were observed to consume, were found to contain 27.3% DM with 20% protein in the DM.

In other experiments with weaned calves (Alvarez F J 1976, unpublished data), there is evidence that Leucaena given as the sole protein supplement depressed intakes, while the addition of small amounts of rice polishings helped to alleviate this effect. The possibility that this intake depressing factor in Leucaena is related to its mimosine content merits investigation.

Conclusions

Bearing in mind the preliminary nature of the observations, it nevertheless appears that a mean production of approximately 4 ta/d of saleable milk can be obtained by once daily milking of dual purpose crossbred Zebu cows and that, providing there is adequate supplementation, calf growth rate will be at;least; comparable with that expected normally on a single suckling system where the cows are not milked. Assuming that sugar cane/urea is to be the basic feed, i.e. in the dry season when pasture supplies are scarce,then it should be supplemented with either 2 kg/d daily of rice polishings or comparable protein source or a combination of this and restricted grazing on Leucaena leucocephala. The use of Leucaena alone, as the only supplement is not recommended at this stage

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ENSILING OF SUGAR CANE WITH AMMONIA MOLASSES AND MINERAL ACIDS

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Summary

Chopped sugar cane stalk was ensiled for 49 days in 15 litre bins: alone, with additional bagasse, ammonia, ammonia and molasses or ammonia, molasses and mineral acids. In the untreated sugar cane, and the treatment containing bagasse, there was a considerable loss of sugars, converted in part into alcohol (5.5% in DM on the untreated sugar cane) and organic acids. In the silos containing added ammonia there was negligible loss of total sugars, although a high proportion of the sucrose was hydrolysed to reducing sugars. In the ammonia treated silages there was no alcohol, however lactic acid was relatively low (less than 1%). Final pH was high on the sugar cane ensiled with ammonia and ammonia/molasses, and there appeared to be some advantages from inclusion of mineral. acids which led to a final pH of 4.6. Addition of ammonia increased by a factor of 2 to 3 the amount of non ammonia nitrogen in the final ensiled product.

Key words: Sugarcane, ensiling, ammonia

Introduction

The justification for ensiling sugar cane relates in part to the problems associated with harvesting this crop in the wet season, and the fact that its nutritive value is higher when it reaches maturity (Banda and Alvarez 1976, Alvarez and Preston 1976), which usually coincides with the dry season. Thus in a situation where year round drylot feeding was practised, there would appear to be advantages from harvesting sugar cane at its optimum nutritive value in the dry season and conserving it for use in the wet season.

An additional reason for examining the possibility of ensiling sugar cane is that a controlled fermentation under anaerobic conditions might be a means of improving nutritive value through an increase in true protein content (by microbial growth) and lactic acid concentration. Increased concentrations of both these nutrients have been reported in whole crop maize, as a result of using additives and were associated with an improvement in feed utilization efficiency when such treated silage was fed to cattle (Henderson and Geasler 1970).

Work carried out so far on the ensiling of sugar cane has been discouraging . James (1973) compared fresh and ensiled derinded sugar cane and reported that voluntary intake was reduced by one third with a corresponding deterioration in live weight gain and feed conversion in the cattle fed the ensiled material. He attributed the poorer performance to production of acetic acid in the ensiled sugar cane having a negative effect on voluntary intake.

Unlike in conventional forages, which have only low concentrations of soluble,sugars, the microflora found on sugar cane appears to be predominated by yeasts which under anaerobic conditions at low pH have the capacity to metabolize sugars to alcohol. It is therefore possible that the poorer results associated with the ensiling of sugar cane might be attributed, not so much to acetic acid but more probably to formation of alcohol . This is not, a problem on other forages, e.g. maize, which has only 3 to 4% of sugars on a dry matter basis, so that substrate limitation helps to prevent,alcohol formation,

It is widely known that if sugars are fermented in the presence of adequate amounts of nitrogen, then less alcohol is' formed since the environment is then more favourable to the growth of the yeast itself. Addition of a nitrogen source is one possibility therefore to reduce alcohol production; it was also thought that if the initial pH in the ensiled material was higher, this also would favour bacteria rather than yeast organisms .

The objective of the experiment described here was to examine some of the end products of the ensiling,bf sugar cane amd to attempt to modify these,by incorporation of nitrogen in the form of ammonia. The solubility of ammonia in diluted molasses was also determined.

Materials and Methods

Trial 1:

Treatments:

The treatments are described in table 1. The additives were dry bagasse (with the aim of reducing the moisture content of the ensiled material), aqueous ammonia, ammonia mixed with molasses and ammonia mixed with molasses and mineral acids. Ammonia was chosen as a nitrogen source which would also raise pH in the initial stages of fermentation; the mineral acids were included in an attempt to improve the stability of the ammonia/ molasses mixture.

Procedure:

Sugar cane stalk was ground finely (particles of less than 5 mm) and mixed with the various additives. The mixed material was packed in 15 litre plastic containers which were sealed tight in order to ensure anaerobic conditions. The experimental silages were kept at ambient temperature (approximately 25°) for 49 days. Samples were taken of the fresh cane and the different mixtures before ensiling and after the 49 day conservation period.

Measurements:

Analyses were made of pH, total and reducing sugars; lactic acid, alcohol, total nitrogen and ammonia nitrogen. The methods were those AOAC (1970).

Table 1: Composition of experimental silos

	Fresh cane	No additive	Bagasse	Aqueous ammonia	Ammonia molasses	ammonia molasses mineral acids
Chopped stalk	100	100	84.4	97.92	96.06	96.30
Bagasse (day)			15.6			
Molasses					1.90	1.57
NH_4OH[1]				2.08	2.04	1.94
H_2SO_4						.11
H_3PO_4						.85

[1] Contains 28% NH_3

Trial 2:

The objective was to determine the saturation point of gaseous ammonia in diluted solutions of molasses, with and without mineral acids. The basic solutions contained (by weight): (A) 61% molasses , 39% water, and (B) 57% molasses, 30% water, 4% H_3PO_4 , 2% H_2SO_4. Anhydrous ammonia was then bubbled through two tanks of each of these solutions, one held at 20° and the other at 30°, until the saturation points were reached. The amount of ammonia remaining in solution was then determined.

Table 2:
Analysis of chopped sugarcane after ensiling with ammonia alone or plus molasses and mineral acids

		Ensiled cane with				
	Fresh cane	No additives	Bagasse	Aqueous ammonia[1]	Ammonia and molasses[2]	Ammonia, molasses mineral acids[3]
pH	5.4	3.4	3.65	7.70	6.17	4.65
Total sugars	44.4	31.1	28.4	41.3	42.2	43.2
Reducing sugars	4.08	3.58	1 .14	12.7	20.9	29.2
Sucrose	40.7	27.5	27.3	28.6	21.3	14.0
Alcohol	0	5.49	3.22	0	0	0.8
Lactic acid	0	1.34	.67	.95	.64	.74
Total N	.107	.187	.216	1.44	1.31	1.29
Protein N	.093	.183	.213	.393	.497	.477
Ammonia N	.024	.004	.003	1.05	.812	.816

Contained

[1] 2.08% aqueous NH4PH (28 a NH3)

[2] 1.94% NH_4OH, 1.57% molasses, .11% H_2SO_4 and .085% H_3PO_4

[3] 2.04%NH_4OH and 1.90% final molasses

Results and Discussion

Trail 1:

The analyses on the different silages are given in table 2 while the makeup of the N fraction is illustrated in figure 1.

The principal change occurring in the sugar cane ensiled without additives was the conversion of sucrose into alcohol and organic acids (only lactic acid was measured in this experiment). This process was not affected materially by inclusion of bagasse.

The incorporation of ammonia resulted in the conservation of almost all the sugars, eliminating completely the formation of alcohol. Addition of ammonia also led to increases in non-ammonia nitrogen (presumably amino nitrogen), indicating considerable microbial growth. There was a suggestion that this process was improved by the simultaneous inclusion of molasses. Addition of ammonia led to hydrolysis of some of the sucrose to reducing in sugars, this was enhanced by addition of molasses and still further when additional mineral acids were included. However, there was no effect on the concentration of total sugars which remained almost the same on all the different treatments containing ammonia.

In general, lactic acid levels were lower than are found normally in most ensiled forages, particularly maize, where values as high as 8 to 12% have been found with use of ammonia and molasses (Henderson and Geasler 1970).

The final pH of 7.7 in the sugar cane ensiled with aqueous ammonia would appear to be undesirably high, as was that for the addition of ammonia plus molasses. In this respect, the combined additives of molasses, ammonia and mineral acids appear to give the best combination of end products.

Trial 2:

Table 3 shows the composition of the solutions, saturated with ammonia, with and without mineral acids and at temperatures of 20° and 30°.

Solubility of ammonia was higher at the lower temperature, and not affected significantly by inclusion of mineral acids.

Table 3:
Solubility of anhydrous ammonia with or without mineral acids in diluted molasses at 20° or 30°

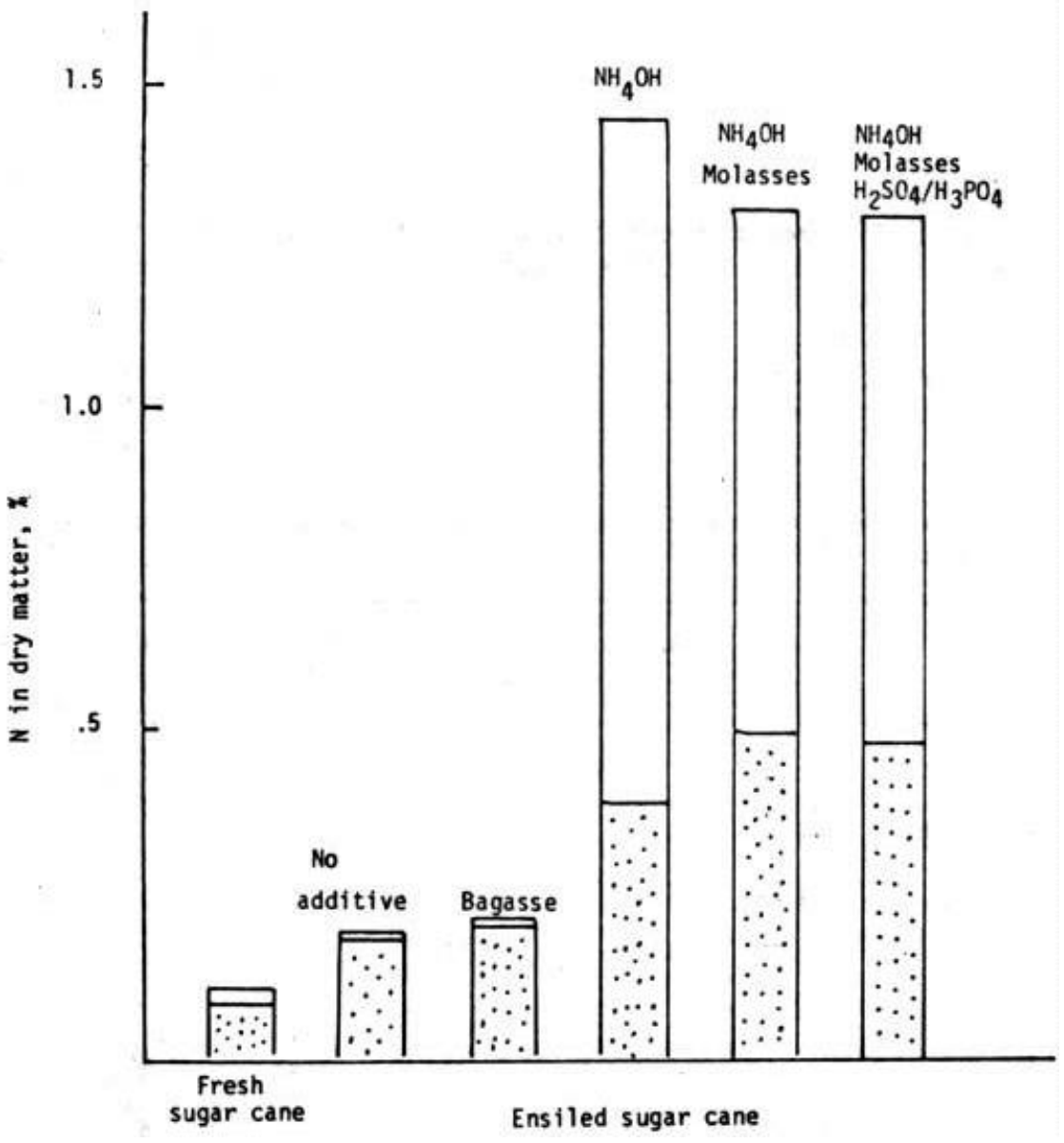
	Molasses	Water	Anhydrous Ammonia	H_3PO_4 (85 %)	H_2SO_4 (98.1%)
			% by weight		
Without acids					
20° C	53.03	33.90	13.07	-	-
30° C	55.75	35.85	8.60	-	-
With acids					
20° C	49.22	31.15	13.95	3.61	2.09
30° C	51.66	32.70	9.68	3.79	2.19

Conclusions

The results of this experiment show the advantages to be gained from adding ammonia to sugar cane at the time of ensiling, as a mean of maintaining the original sugars present in the cane and preventing their conversion to alcohol which occurs to a considerable degree when sugar cane is ensiled alone. There were also important increases in content of amino nitrogen which was increased by a factor of two to three compared with the untreated sugar cane.

For use in tropical conditions, a suitable ammonia/molasses mixture would contain: molasses 53, water 34 and anhydrous ammonia 13 (parts by weight).

Figure 1 :
Effect of ensiling chopped sugar cane stalk with various additives on ammonia N (□), non-ammonia N (∷) and total N (total column weight)



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MILK PRODUCTION BY DUAL PURPOSE COWS GRAZING UNSUPPLEMENTED PANGOLA OR FED IN DRYLOT ON SUGARCANE AND MOLASSES/UREA BASED DIETS

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Summary

A crossbred Holstein/Zebu herd was used to compare: (A) unsupplemented grazing on pangola pasture: (B) drylot feeding with chopped sugar cane and liquid molasses/urea (50 g urea/kg) both available free choice in separate feeders, and 600 g/d cotton seed cake and minerals; and (C) the same as in (B) but with restricted grazing from 8 to 11 a.m. Cows were milked twice daily by hand, allowing the calf to be suckled before,for a few seconds to stimulate letdown and for 30 minutes after milking was finished. The trial began on 5 August 1975. Results from the drylot treatment (B) were inferior to the other two, mainly due to extremely bad conditions in the corrals caused by accumulation of mud and inadequate feed trough facilities. There were no important differences between the unsupplemented grazing and the restricted grazing plus sugar cane, molasses/urea treatment. Levels of production for these latter systems were of the order of 9 kg milk daily (including milk consumed by the calf) while body weight was maintained or increased slightly.

All of the dietary treatments were associated with moderately high levels of butyric acid production (16 to 20% molar) while samples taken from the cows immediately after they had been in drylot for 4 hr show molar butyric as high as 32%. There were no holotrich protozoa in the sugar cane group and relatively small numbers of entodinea. Both of these organisms were present in much larger numbers in the animals on unrestricted grazing.

Key words: Sugarcane, milk production, system

Introduction

It has been argued that technologies for production of beef and milk as independent specialised systems, as have been developed almost exclusively in temperate regions of North America and Europe, are perhaps not so appropriate to the needs of developing countries situated in the tropics (Preston 1976).

Specialised milk production is almost invariably associated with the use of the Holstein breed because of its high genetic capacity to convert food into milk. However, the use of this breed in the tropics presents two major problems The first relates to difficulties of adaptation, in terms of the climatic and parasitic elements in a humid tropical region: while the second is based on the fact that most feeds that can be grown in these regions are relatively low in nutritive value, specifically protein. As a result, in order to feed the Holstein sufficiently well for it to express its genetic capacity requires the use of large quantities of cereal based concentrates which usually have to be imported.

The alternative approach which has been proposed (Preston 1976) for milk production in the tropics envisages the use of adapted native cattle partially upgraded with European dairy breeds such as Holstein, Brown Swiss or Simmental, to produce dual purpose animals with a moderate milk production combined with the capacity to raise a calf of excellent attributes for beef production. By set-ting the production ceiling at a moderate level it is easier to adjust the system to the available resources in tropical regions, taking account of their limitations in nutritional, climactical and human terms.

The theoretical production targets are that each breeding cow should yield about 1,500 kg of milk for sale, while suckling her calf on a restricted system to a weaning weight of some 200 kg at 300 days. After weaning, the calf is expected to fatten at an average live weight gain of 850 g/d to reach a slaughter weight of 400 kg at about 18 to 20 months of age.

The experiment described in this paper is the first of a series designed to evaluate this concept and to produce the appropriate input/output data on which technical coefficients can be based, thus providing both a basis for economic evaluation as well as a model for future development and investment plans.

Materials and Methods

Treatments and Design:

The three treatments were: supplementation; (A) grazing on pangola with no supplementation (B) drylot feeding with chopped sugar cane and molasses/urea (50 g urea/kg molasses) both offered in separate troughs and available free choice; (C) the same as (B) but with restricted access to pangola pasture from 8 until 11 a.m. daily. Both groups (B) and (C) received cotton seed cake at the rate of 600 g/d and 50 g/d minerals.

In fact, the experiment as such was conducted in three phases. For the first 15 days the available cows were distributed equally over the three treatments; for the next 55 days , groups (B) and (C) were interchanged: in the third phase the animals which had previously been on the drylot treatment (B) were allocated equally to the other two treatments (A) and (C).

Animals:

The cows were Holstein x Zebu with an estimated 50 to 75% of Holstein "blood". An initial groups of 30 animals which had been calved for a period varying from 7 to 90 days, were allocated to the treatments according to their previous production and stage of lactation. Subsequently, new animals entered the experiment according to calving date, being introduced to the experimental treatments 7 days after calving prior to which they had been grazing pangola pasture with no supplementary feed, The calves ran with the cows on a full time basis during this period.

Phase 1 of the experiment was started on 5 August 1975 with 10 animals in each group but during this period there was almost continuous rainfall providing go d pasture growth but adverse conditions for the drylot treatments. Because of this, and as a direct result of a rapid fall in milk production, groups B and C were interchanged after 15 days. More animals entered the experiment and phase 2 began with 19 animals per treatment. Continuing rain over the second part of this stage appeared to contribute to a further fall of milk yield in the drylot cows (B) and at this point (phase 3) this particular treatment was reallocated between groups (A) and (C). The trial was continued with 31 cows in each of these two treatment groups .

Procedure:

The cows were hand milked twice daily first letting the calves suck each teat for a few seconds to stimulate let down. After each milking, cows and calves were run together for approximately 30 minutes in an adjoining corral for suckling to take place.

Diets:

The age of the sugar cane used in the trial varied at times but was generally about 12 months old. The whole cane, including the tops and stalk, were passed through a Gehl forage chopper to give a particle size of approximately 15 mm. The proportion of top to stalk was estimated on average to be 25:75.

Measurements:

Saleable milk and that consumed by the calf (by weighing before and after suckling) was recorded daily. The cows were, weighed at approximately 7 day intervals. The dry matter content, and the Brix of the juice, were recorded on sugar cane tops and stalk throughout the experiment.

Rumen samples:

During the last week of the experiment, samples of rumen fluid were taken by stomach pump from 4 cows selected at random in each of the two treatment groups; samples were taken at 11 a.m. immediately after treatment (C) had returned from grazing and again at 4 p.m. when this group was in drylot eating sugar cane and molasses/urea . Treatment (A) was on pasture at both sampling times. pH was recorded immediately as was the protozoal population. The packed cell volume method, outlined by Leng et al (1976), was used to determine the large holotrich organisms while the smaller protozoa mainly entodinea were estimated by direct counting. Other samples of rumen fluid were preserved with concentrated sulphuric acid for subsequent analysis for volatile fatty acids (VFA) according to the methods described by Gonzalez and MacLeod)1976).

Results and Discussion

Cow performance:

Mean values for total daily milk yield (saleable plus milk consumed by the calf) and average live weight during the experiment are set out in figures 1 and 2. The regression coefficients for change in the parameters, together with the mean values in each phase of the experiment are given in tables 1 and 2. Figure 3 shows the variation in Brix and dry matter in the cane stalk and tops during the trial while figure 4 illustrates the effect on milk production when the treatment (B) cows, previously fed in drylot, were divided equally between the pasture only and drylot plus restricted grazing treatments in phase 3.

Table 1: Mean values for daily milk yield and changes in daily milk yield during the experiment

	Pasture only	Sugarcane: molasses/urea		Significance level (P<)
		Drylot	Restricted grazing	
5 to 19 august 1975				
No of cows	9	9	9	
Mean milk yield, kg/d	11.1	7.54	8.72	
Change in milk yield, kg/d	.073	-.17	-.054	.001
r^2	.45	.48	.50	
20 August to 21 October				
No of cows	15	16	15	
Mean milk yield, kg/d	10.1	7.5t	8.69	
Change in milk yield, kg/d	-.051	-.045	.013	.001
r^2	.50	.52	.08	
22 0ctober to 14 January 1976				
No of cows	31		31	
Mean milk yield, kg/d	8.77		9.44	
Change in milk yield, kg/d	.0108		.0085	MS
r^2	.23		.15	

Table 2: Mean values for live weight and changes in live weight during the experiment

		Sugarcane: molasses/urea		Significance level (P<)
	Pasture only	Drylot	Restricted grazing	
5 to 19 August 1975				
No of cows	9	9	9	
Mean live weight, kg	409	372	365	
Change in live weight, kg/d	1.62	-1.64	.74	P<.001
r^2	.88	.93	.28	P<.001
20 August to 21 October				
No of cows	15	16	15	
Mean live weight, kg	428	384	405	
Change in live weight, kg/d	.032	.014	.072	
r^2	.005	.004	.019	P<.001
22 October to 14 January 1976				
No of cows	31		31	
Mean live weight, kg	411	41	412	P<.11
Change in live weight, kg/d	.038		.288	
r^2	.01		.69	

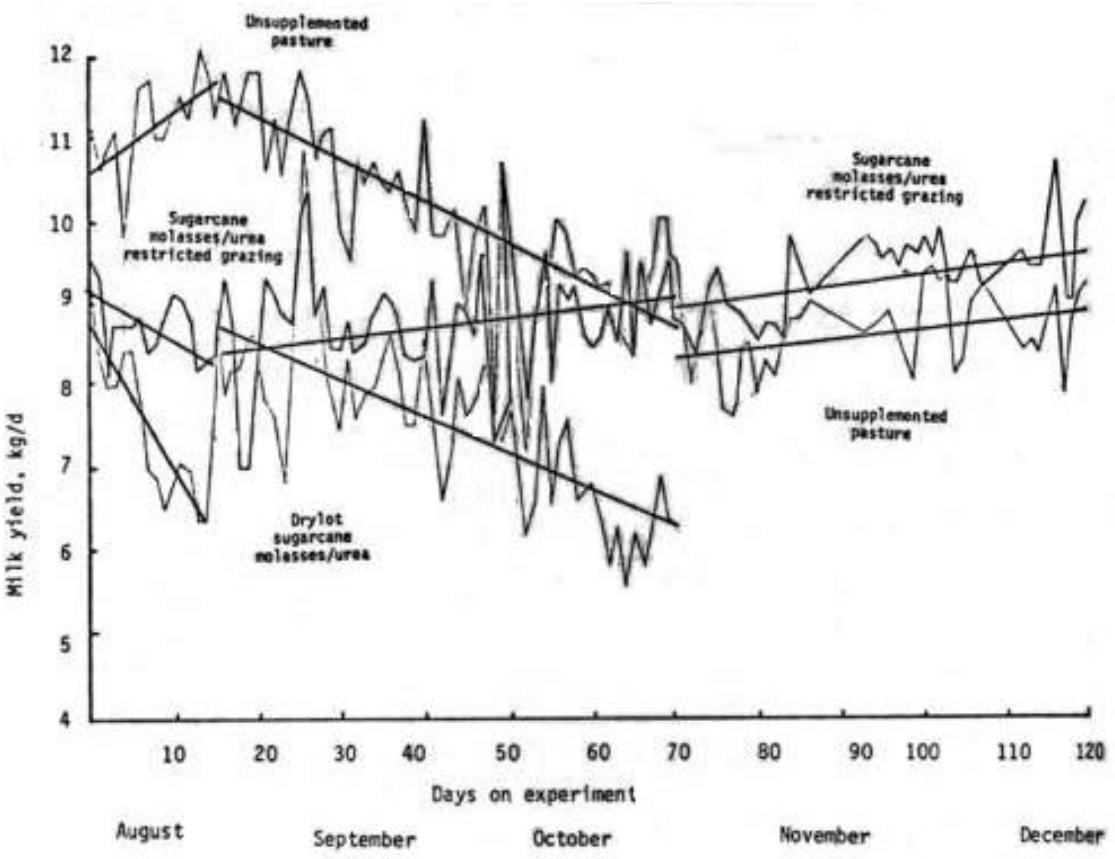
In the first phase of the experiment the cows on, unsupplemented pasture performed better, in terms of milk yield and live weight change,than either of the groups receiving sugar cane. Between the latter two treatments restricted grazing was obviously superior to the drylot treatment. It was observed that the quality of the pasture at this time (early August)was probably at its optimum, due to the recent onset of rain, while in contrast, conditions for the cattle in the drylot groups were at their worst partly due to lack of shade and also to accumulation of mud.

Table 3:
Rumen fermentation parameters (samples taken at the end of the trial)

Treatment	Unsupplemented Pasture		Sugarcane , molasses/urea, restricted pasture		SE_x	Significance level (P<)
Time, hr	1100	1600	1100	1600		
pH	7.43	7.14	7.35	7.00	±.17	.35
VFA, %molar						
Acetic	54.6[c]	59.7[b]	64.4[a]	51.2[c]	±2.02	.01
Propionic	21.4[a]	21.8[a]	19.5[a]	16.4[b]	±.72	.001
Butyric	24.2[b]	18.6[c]	16.2[c]	32.5[a]	±1.85	.001
Protozoa, X 10 5/ml						
Entodinea	2.53[a]	2.50[a]	.86[b]	1.13[b]	±.28	.001
Holotrichos	.12[b]	.28[a]	0.00[c]	.03[c]	±.04	.002

In the second phase of the experiment during which the two sugar cape groups were transposed, the drylot group continued to perform less well than the others, with loss in live weight and in milks yield. The cattle on restricted grazing plus sugar cane and molasses/urea in drylot performed better than the group on unsupplemented grazing, in both milk yield and change in live weight, but this probably reflected a degree of compensation, since half of the animals in the restricted grazing group had previously (in phase 1) been losing weight and falling in milk yield at a precipitate rate. Conditions in the drylot were still relatively bad, and it is difficult to draw reliable conclusions as to the extent to which environmental conditions as opposed to diet,were having the determining effect on animal performance. In any event, the results during this stage showed ;quite clearly that provision of a limited grazing period was more than enough to compensate any negative factor of the drylot per se since this group (C) had the best performance in phase 2.

Figure 1:
Daily milk yields during the experiment (mean values for each treatment)

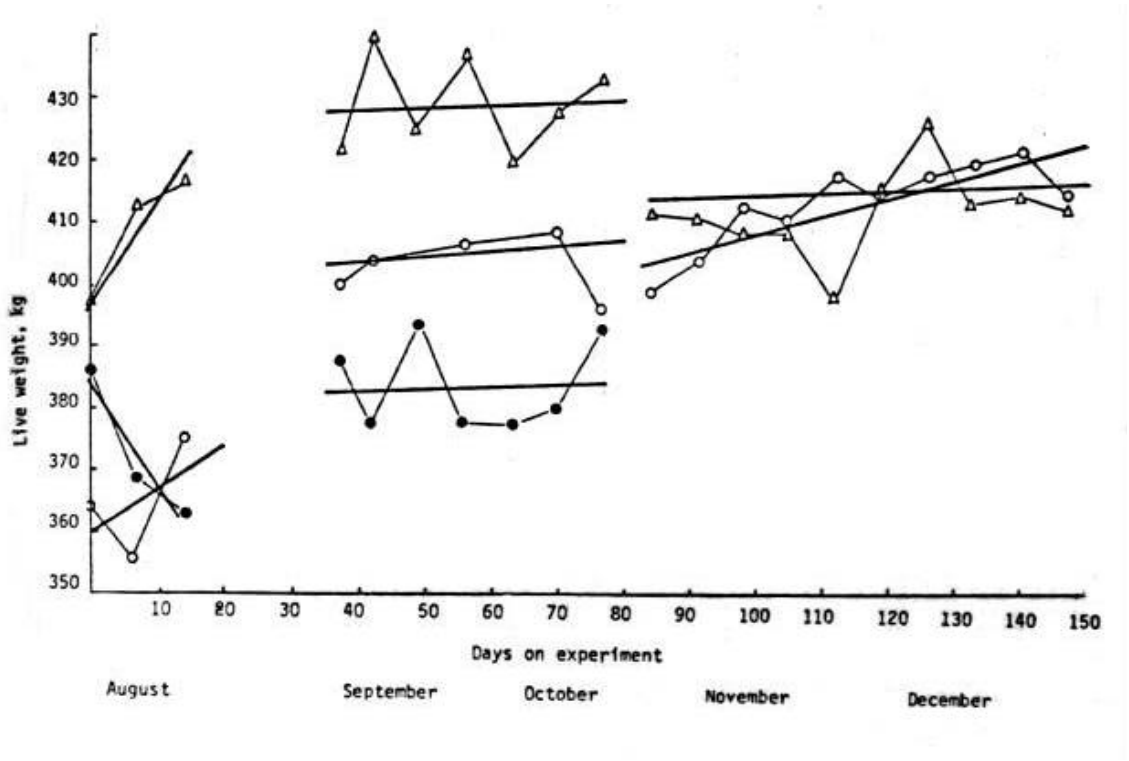


In phase 3 two comparisons are:possible. The first relates to: all the animals divided between the two remaining treatments of unsupplemented grazing (A),and sugar cane, molasses/urea and restricting grazing (C). There were no differences in milk yield response, both groups showing a slight increase over this period with a slightly:higher average milk yield for the groups on restricted grazing. The data for body weight change indicate a slight advantage to cows on restricted "razing,: both in terms of the daily change in live weight and the mean overall live weight.

With respect to the cows which previously (phase 2) were in drylot on treatment (B) and were then divided equally between unsupplemented grazing and restricted grazing and drylot, the pattern of response (figure 4)when the animals were changed to the new treatment was very similar, indicating little

difference between the two systems fin terms of maintaining milk production

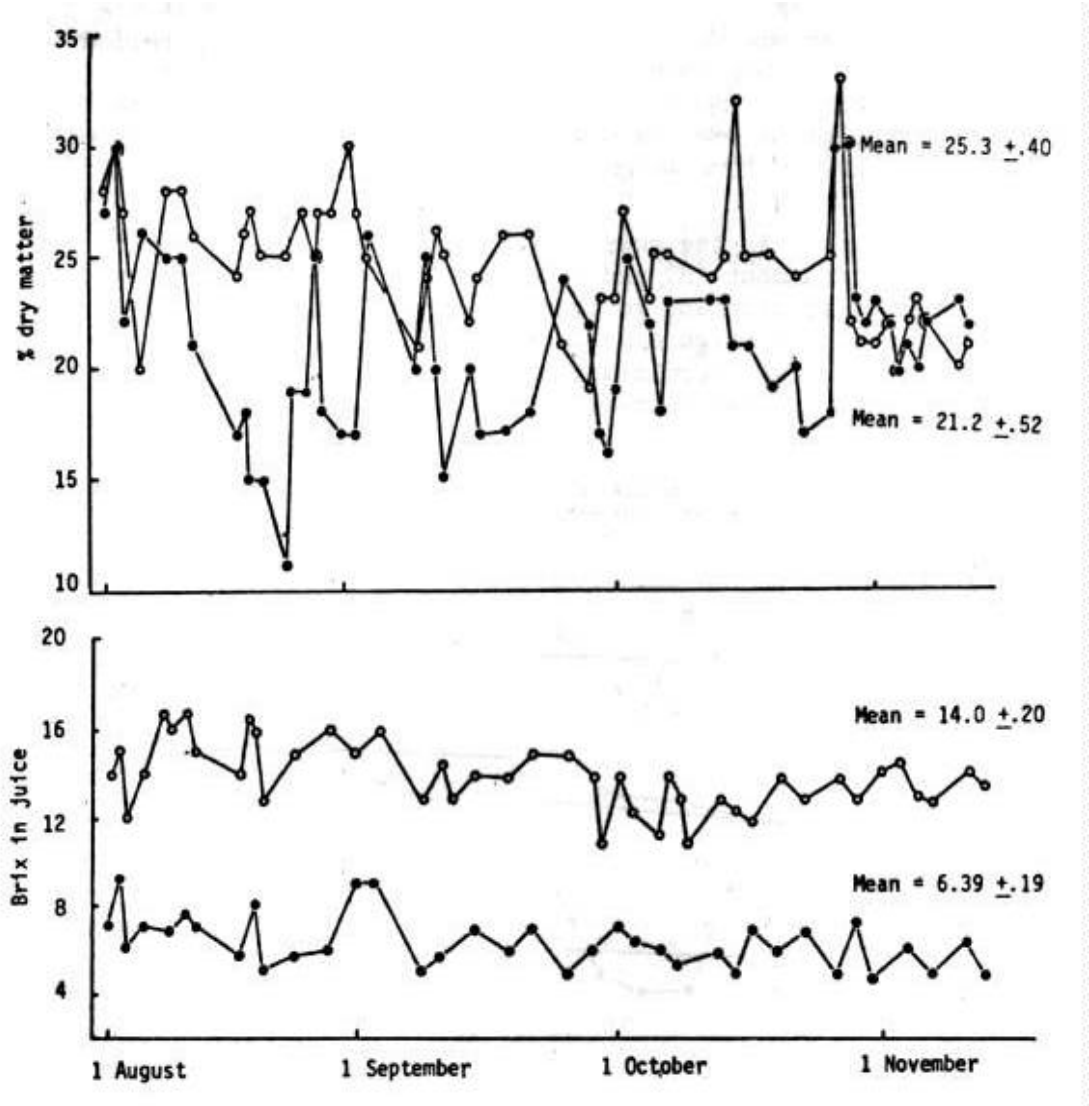
Figure 2: Mean live weights of cows in pasture only (△), drylot sugarcane, molasses/urea and restricted grazing (○), drylot sugarcane and molasses/urea (•)



Rumen fermentation:

The data on rumen fermentation parameters are set out in table 3. There were significant differences in several of these measurements' both due to time of sampling as we 1 as to feeding system. The most noteworthy findings were the almost complete absence of the large holotrich protozoa on the sugar cane treatment. This is in marked contrast with what is normally found in fattening cattle kept entirely in drylot conditions, and with no access to grazing (Leng and Preston 1976: Valdez et al 1976). It is not known whether the absence of protozoa reflected the effect the restricted grazing or the fact that the samples came from lactating animals. The former explanation seems the more likely.

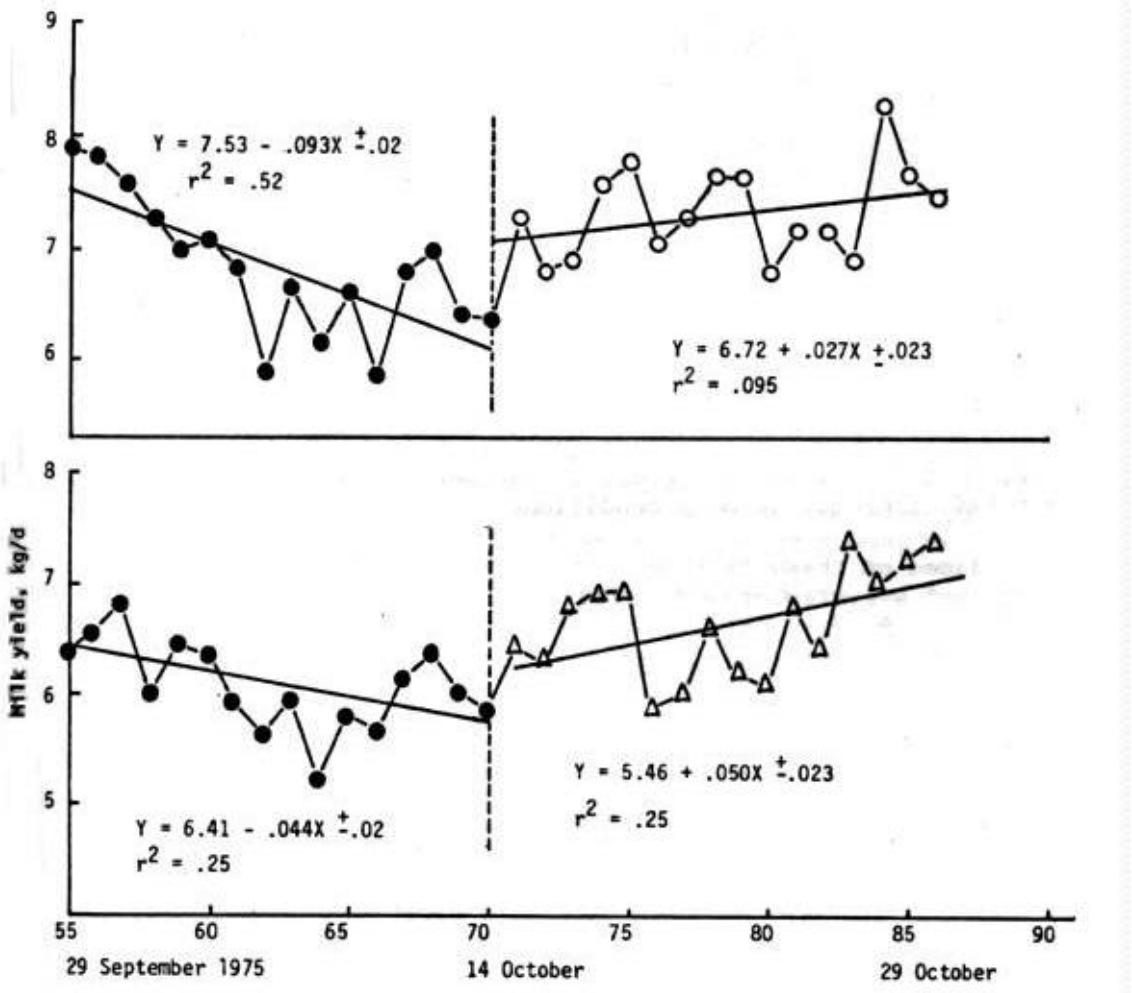
Figure 3 : Variarions in brix and dry matter content of cane stalk (◦) and tops (•) during the experiment



Surprisingly, the molar proportion of butyric acid was quite high in the cows on unsupplemented pasture. Levels for propionic acid, on the other hand, were comparable with the what would be considered normal for this feed. The marked contrast was in the VFA data for the cattle fed sugar cane and restricted pasture. Butyric acid was at a moderate level, similar to that in the grazing group, for the morning sample taken immediately after the animals had returned from their period of restricted grazing. However, after having had access to the molasses and sugar cane there was an immediate reaction to the

diet, in terms of an almost twofold increase in butyric acid at the expense of both propionic and acetic . A much higher production of butyric acid, when large amounts of molasses are fed has been reported consistently in other experiments (see Preston 1972).

Figure 4 :
Milk yields of treatment (B) cows (sugarcane and molasses/urea in drylot) before (•) and after being reallocated to treatments (A) of pasture only (△) and treatment (C) of sugarcanem molasses/urea and restricted grazing (○)



The general consensus on the rumen fermentation data is that these do not represent the most desirable combination of end products for high level milk

production (too high in butyrate and too low in acetate and propionate). However, they present no serious limitations to the level of production aimed for in the dual purpose system which is considered to be most appropriate for the tropics.

Calf performance:

These data are reported in a companion paper (Giraldez et al 1976).

Conclusions

This experiment was carried out during the rainy season when it is not normally intended to use a drylot system of feeding. This treatment was included in order to gain some experience of the feeding of large quantities of sugar cane to cattle on a dual purpose management programme. For these reasons, an assessment of the drylot treatment, in which the cattle had no access to grazing, is not relevant at this stage.

What is obvious however, is that even in the wet season, production from sugar cane,molasses/urea, limited supplementation with cotton seed mea, (600 g/d) and restricted grazing for 3 hr daily, will give the same performance in terms of milk production and maintenance of body weight as unrestricted grazing. Infact, there was some suggestion, from the results at the end of the experiment when pasture quality was obviously deteriorating, that the sugar cane/grazing treatment was superior at least in terms of promoting body condition.

Based on these findings it would seem reasonable to conclude that a system of restricted grazing, plus free access to chopped sugar cane, molasses with 10% urea and the equivalent of some 200 g/d of true protein, is a satisfactory feeding and management programme for dual purpose cattle expected to produce about 9 kg milk daily.

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RUMEN FERMENTATION IN CALVES REARED ON RESTRICTED SUCKLING, SUGARCANE AND MOLASSES/UREA

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Summary

Rumen fluid was taken from 12 calves of different ages in the range 23 to 266 days. The animals were from a dual purpose milking herd of crossbred Holstein/Zebu. The feeding system was based on restricted suckling twice daily, the calves having access to their dams for a few seconds before milking to stimulate let down and after milking for 30 minutes. The rest of the time they were housed in shaded pens where they had free access to chopped whole sugar cane and a mixture of molasses/urea (100 g urea/kg of solution). They also received 250 g/d of cotton seed meal and minerals. The rumen samples were taken with a stomach tube at 1100 hr, approximately three hr after the morning feeding of sugar cane. The pattern of fermentation was uniform in all the animals older than 60 days . Mean value for pH was 6.93 , and % molar VFA's were: acetic 50, propionic 35 and butyric 15. Packed cell volume of holotrichs was .32 (% of rumen fluid) and entodinea 1.25 X 105/ml. There was a significant relationship between daily live weight gain and molar proportion of propionic acid (r2 = .71). The results indicate that by 60 days of age, calves raised by restricted suckling and supplemented with sugar cane and molasses/urea reach a degree of rumen development typical of adult animals.

Key words: Sugarcane, calves, rumen fermentation

Introduction

Most studies on rumen development in calves have related to systems of artificial rearing, usually with milk substitutes and/or early weaning.

Few studies has been made on calves reared by suckling, and specifically the system of restricted suckling combined with normal milking which was developed in Cuba (Preston and Ugarte 1972), and which forms the basis of the calf rearing method in the dual purpose integrated milk and beef programme proposed by Preston (1976).

The objective of the study reported here was to measure certain parameters of rumen fermentation in calves raised by restricted suckling and having free,access both to chopped sugar cane and molasses/urea.

Materials and Methods

Animal and Diets:

The 12 calves used in the experiment were from the same herd and under the same management system described in a previous paper (MacLeod et al 1976). They were Holstein/Zebu crosses in the age range 23 to 130 days and with a range in live weight from 41 to 180 kg.

All the calves were suckled by their dams twice daily for approximately 30 minutes after the morning and afternoon milkings; on average,the daily quantity of milk consumed was 2.5 kg . Chopped sugar cane was offered ad lib as was molasses/ urea (100 g urea/kg molasses). 250 g/d of cotton seed meal and 50 g/d of minerals were also given. Housing was in shaded corrals adjoining the milking parlour and the feed and molasses troughs had adequate protection against the rain.

Rumen samples:

These were obtained with a hand pump and stomach tube at 1100 hr, approximately 3 hr after the calves had been offered the chopped sugar cane. pH and protozoal counts were determined immediately on the freshly strained rumen fluid. Holotrich protozoa were determined by the method of Leng et al (1976) using a packed cell volume technique, while the entodinea were counted directly. Other samples were preserved with concentrated sulphuric acid for subsequent volatile fatty acid (VFA) analysis according to the method described by Gonzalez and MacLeod (1976).

Results and Discussion

The data on the performance of the selected group of calves are summarised in table 1, while rumen fermentation parameters are in table 2. Some relationships between these different paramenters are given in figures 1 and 2.

The pH value is probably unreasonably high in view of the samples having been taken by stomach tube and the risk of contamination with saliva. The molar proportions of VFA are similar to,those found normally in weaned calves reared on mixed diets of concentrates and roughage . They vary slightly from the normal picture in fattening cattle receiving sugar cane based diets, where average values (24 hr sampling) were acetic 62, propionic 24 and butyric 14 (Leng and Preston 1976); thus propionic was considerably higher and acetic lower in the young as opposed to the adult animals.

Table 1: Age and live weight of calves

	Mean	Range
No	12	
Live weight, kg		
At birth	38.1	32 - 45
At sampling	104.9	41 - 187
Daily gain	.43	.17 - .66
Age at sampling, days	139	23 - 240
Intake, kg/d		
Milk		2.5 - 2.8
Sugarcane		1 - 5
Molasses/urea[1]		.3 - 1.5

[1] Contains 10% urea.

There was a wide range in concentrations of protozoa. The maximum values observed were lower than has been reported in adult animals fed sugar cane (maximum values were as high as 4 and the average in a group of slaughter animals was 2.6 PCV, % rumen fluid) (Minor et al 1976). There was a tendency for protozoa counts to increase with age (r^2 = .61 for entodinea and .214 for

holotrichs; figure 1). This supports the suggestion that the values recorded were lower than would be expected normally in adult animals fed sugar cane diets. .

There was a positive relationship between molar proportion of propionic acid and rate of live weight gain (r^2 = .71), which is in line with reports on sugar cane where these two parameters have been related (Alvarez and Preston 1976; Ferreira and Preston 1976). Such relationships are in line with the hypothesis that availability of glucose precursors is a constraint to animal productivity on sugar cane based rations (Leng and Preston 1976).

Conclusions

The data show conclusively that calves raised by restricted suckling, and receiving the major part of their diet in the form of sugar cane and molasses/urea, have normal rumen fermentation parameters by 60 days of age . In this respect they differ from adult animals fed the same ration only in the ratio of the end products and in the numbers of protozoa. This conclusion is substantiated by the shape of the growth curve (figure 3), which shows a marked acceleration of growth at the 50 to 60 day of age mark, indicating higher intakes of the basal ration of sugarcane and molasses/urea, commensurate with achieving full rumen function.

Figure 1: Effect of age on protozoal population

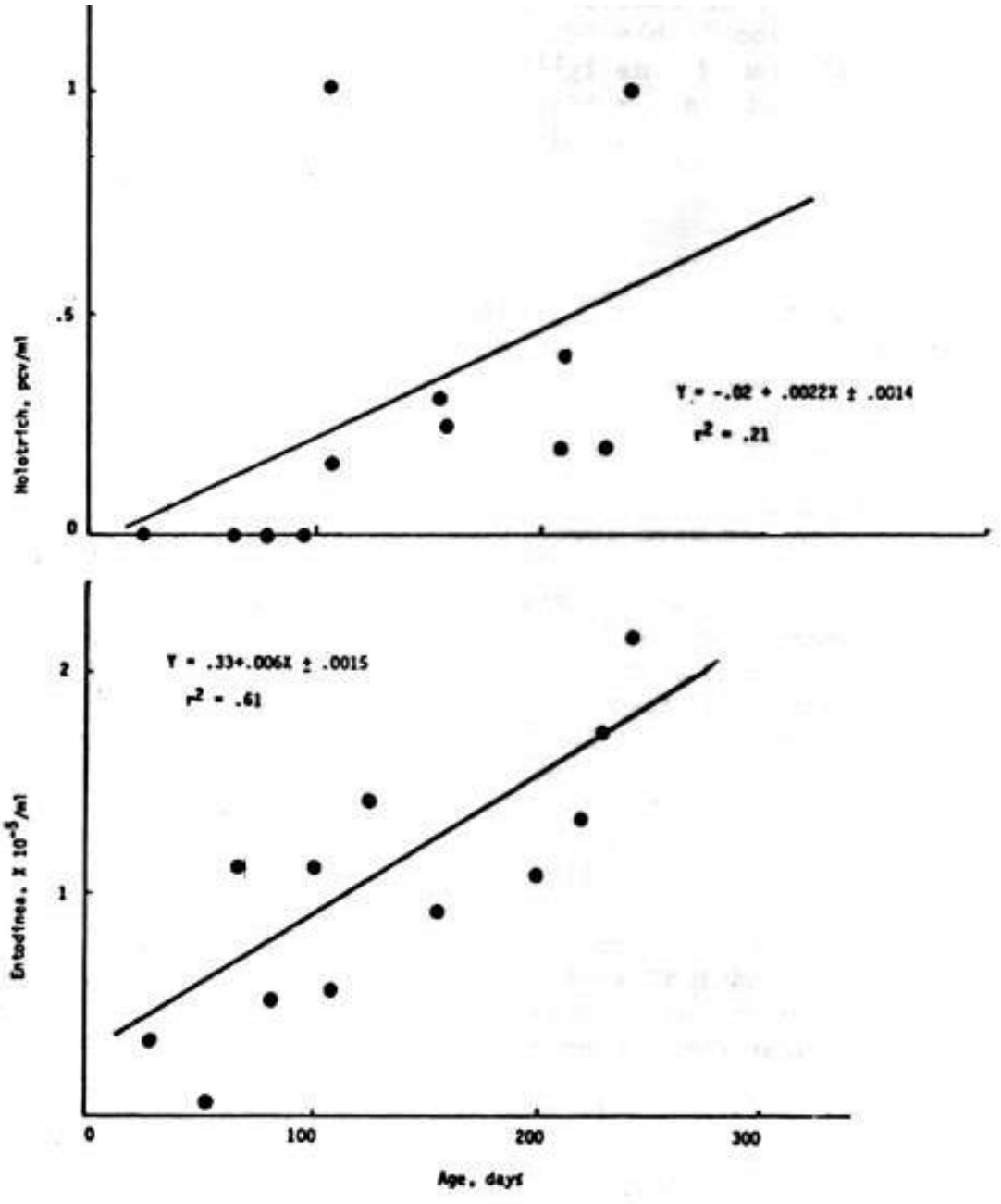

Figure 2: Relationship between gain in live weght and molar % propionic acid in rumen fluid

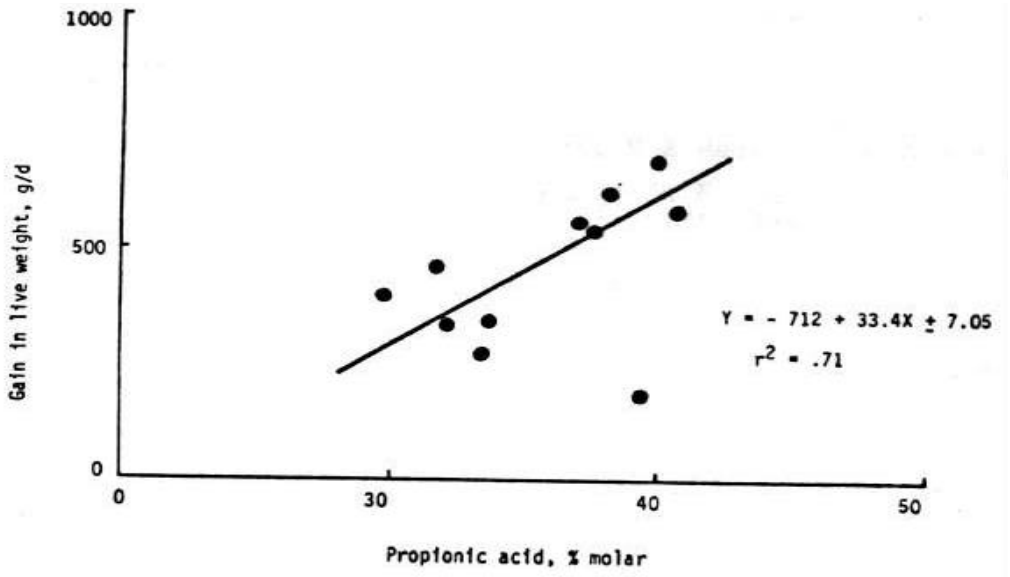

Figure 3: Growth rate of crossbred calves reared by restricted suckling, supplemented with sugarcane and molasses/urea (from Giraldez et al 1976)

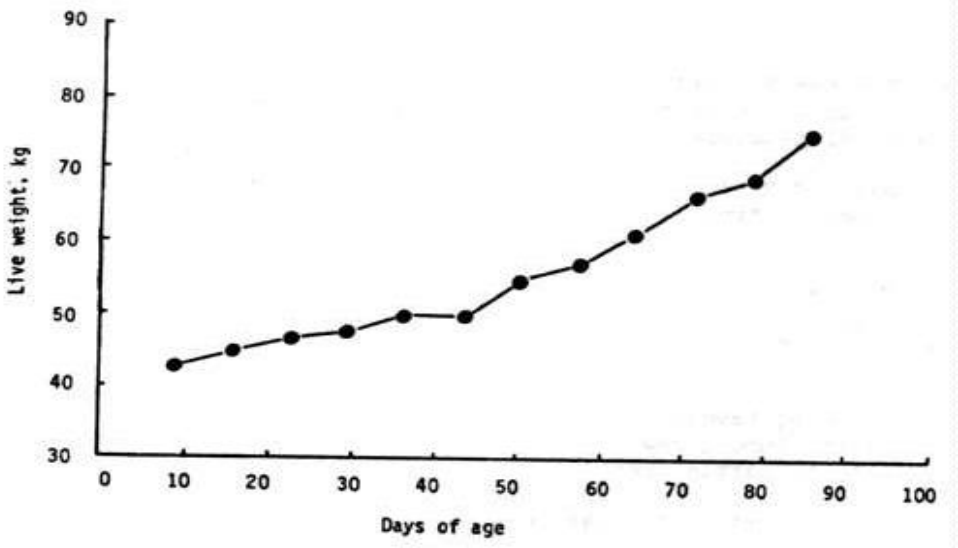

Table 2: Fermentation parameters

	Mean ± SE_X	Range
pH	6,93 ± ,24	5.7 - 7,6
VFA, % molar		
Acetic	50 ± 1,4	36 - 55
Propionic	35 ± 1.0	31 - 36
Butyric	15 ± 1.1	11 - 24
Protozoa Holotrich PCV[1], %		
rumen fluid	.32 ± .10	0 - 1.0
Entodinea, X 10^5/ml	1.25 ± .15	.3 - 2.1

[1] Packed cell volume

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STUDIES ON THE GROWTH OF CALVES REARED ON RESTRICTED SUCKLING SUGAR CANE AND MOLASSES/UREA

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Summary

Analyses were made on 33 calves from a herd of crossbred Holstein/Zebu cows which received the following treatments: (A) grazing on pangola pasture without supplementation; (B) feeding in drylot with chopped sugar cane, molasses/urea (50 g urea/kg of molasses) and 600 g/d cotton seed cake with restricted grazing for 3 hr daily. The cows were milked twice daily by hand, being allowed to suckle their calves for a few seconds prior to milking to stimulate let down and for 30 minutes after milking. In general, the cows suckled only their own calves but there were some instances of crosssuckling. The calves were kept in open shaded pens with free access to chopped sugarcane, morasses with 10% urea and 250 g/d of cotton seed cake . They were mostly crossbred by Zebu and Holstein sires. Analysis of regression of live weight on age for these two groups of calves gave daily live weight gains of 419 - 28 g/d for crossbred calves and 260 ± 11 for Holstein calves, significantly in favour of the former. Milk intake was in the range 2.88 to 2.4 kg/d and was related to age (days) by the equation Y = 2.76 - .002X. Average intakes of the nonmilk components of the ration at three months of age were 3.5 kg /d of sugar cane and 1.01 kg/d of molasses/urea, the last representing a daily intake of 101 g urea. Predictions from these data indicate that the calves should reach a ,live weight of over 170 kg at 300 days.

Key words: Sugarcane, calf growth, suckling

Introduction

It has been proposed that an important component in a dual purpose scheme for milk and beef production under tropical conditions is the rearing of the calf by restricted suckling (Preston 1976). The justification for restricted suckling as

a rearing system in the tropics is based on the findings reported by Preston and Ugarte (1972) that for cows which suckle their calves on this system: (1) there is up to 20% more total milk per lactation than in cows that are milked without calves; (2) there is less mastitis (3) the growth rate of their calves is higher and mortality and incidence of diarrhoea is reduced; (4) apparently there are no effects on cow fertility.

Rearing calves by restricted suckling is a traditional system in many tropical countries and therefore more likely to be adopted at the practical level;an important factor in developing countries where the technical level of workers is relatively low.

The objective of the study described in this paper, which is the first in a series, was to obtain preliminary data on the performance of calves raised by restricted suckling as part of a dual purpose management system (MacLeod et al 1976) where the diet is based on sugar cane and molasses/urea.

Materials and Methods

Animals:

A total of 33 calves was used in the study. These were the progeny of crossbred Holstein/Zebu cows (60 to 80% Holstein "blood") sired by either Zebu or Holstein bulls. The calves were born over the period April to December 1975.

Management and Feeding:
The calves were suckled by their dams for a few seconds prior to milking in order to stimulate let down and then for a period of 30 minutes after hand milking was completed. At this time the cows and calves were held in one large group and there were some instances of cross suckling. Milking and suckling was twice daily at 6 a.m. and 3 p.m.. After suckling, the calves were separated from the cows and put in a shaded corral with a cement floor where they had free access to chopped sugar cane and molasses with 10% urea, fed on a free choice basis in separate troughs. In addition, 250 g/d of cotton seed meal was given and there was free access to minerals. Milk consumption was determined by weighing the calves before and after suckling at each milking/suckling period.

Measurements:

Weekly live weights were computed as the mean of 4 measurements daily carried out 7 times per week. Group intakes of the different diet components were determined daily.

Statistical Analysis:

The data were grouped according to age of calves at weekly intervals. The means of these measurements were then calculated and regressed against the average age (in days). This was done for the complete group of animals and separately (for live weight) for those judged to be crossbred as opposed to mainly Holstein (more than 75% Holstein breeding).

Results and Discussion

The mean values for the different parameters are given in table 1. Figure 1 shows the average growth rate for the total group of calves and for the two breed groups separately. Figure 2 is feed conversion ratio. Table 2 summarises the relationships between feed intake components and age.

Rate of growth was essentially linear up to 100 days of age and significantly higher for crossbred as opposed to Holstein type calves. The growth rate of the crossbred animals (490 g/d) is only slightly less than was reported by Alvarez and Preston (1976) for similar animals over a slightly older age range. There was a tendency for daily milk consumption to decrease with increased age of calf, while intake of fresh sugar cane and values was linearly related to age (table 2).

The intake of milk by the calf represented approximately 27% of the total milk production (total milk yield of the dams was 9.5 kg/d; see MacLeod et al 1976). On the assumption that suckling stimulates total milk production by 20% (Preston and Ugarte 1972), then it would appear that only some 10% of potentially saleable milk was lost by the restricted suckling programme. Or, to put the matter in another way, if the calf had been raised by bucket feeding using liquid milk, than the true quantities of saleable milk would have been only some 3 kg/d.

Table 1: Mean values for live weight and feed intake

			Feed intake			
No of calves	Age	Live weight	Milk	Sugarcane	Molasses/ urea	Total DM
	days	kg		kg/d		
33	9	40	2.9	0.75	0.33	0.44
33	17	42	2.8	0.73	0.32	0.43
33	24	44	2.6	0.76	0.44	0.50
33	31	45	2.7	0.73	0.41	0.50
33	38	47	2.6	0.81	0.30	0.42
33	45	48	2.7	0.82	0.43	0.53
26	52	52	2.6	1.20	0.48	0.66
26	59	55	2.7	1.24	0.58	0.74
26	66	58	2.6	1.50	0.61	0.84
22	73	61	2.5	2.05	0.56	0.93
22	80	66	2.5	2.66	0.76	1.23
20	87	69	2.4	3.48	1.01	1.63
12	94	69	2.6	3.88	0.98	1.71
11	101	74	2.7	3.91	1.05	1.76
10	108	78	2.5	4.05	1.07	1.82
9	115	80	2.6	4.38	1.04	1.87
9	122	86	2.5	4.70	1.28	2.14
6	129	94	2.8	4.60	1.02	1.91
6	136	98	2.3	5.01	1.12	2.09

Table 2: Relation between age (X = days) and daily intake of the different diet components

Y	Equation	r^2
Intake, g/d		
Milk	Y = 2760 - l.98X ± .75	.29
Molasses/urea	Y = 151 + 7.85X ± .65	.90
Sugarcane	Y = 450 + 40X ± 2.7	.93
Total DM	Y = 5.9 + 16.0X ± 1.1	.93

According to the regression equation of live weight on age, it can be estimated that by 300 days the crossbred calves would reach 179 kg live weight. In fact, this is almost certainly an underestimate as the data show a tendency to curvilinearity in the higher age range. Moreover, the mean weaning weight of the first calves produced on the system (Giraldez J, unpublished data 1976) was 210 kg at 300 days.

Figure 2: Regression of cumulative feed intake on live weight (coefficient of X is feed conversion)

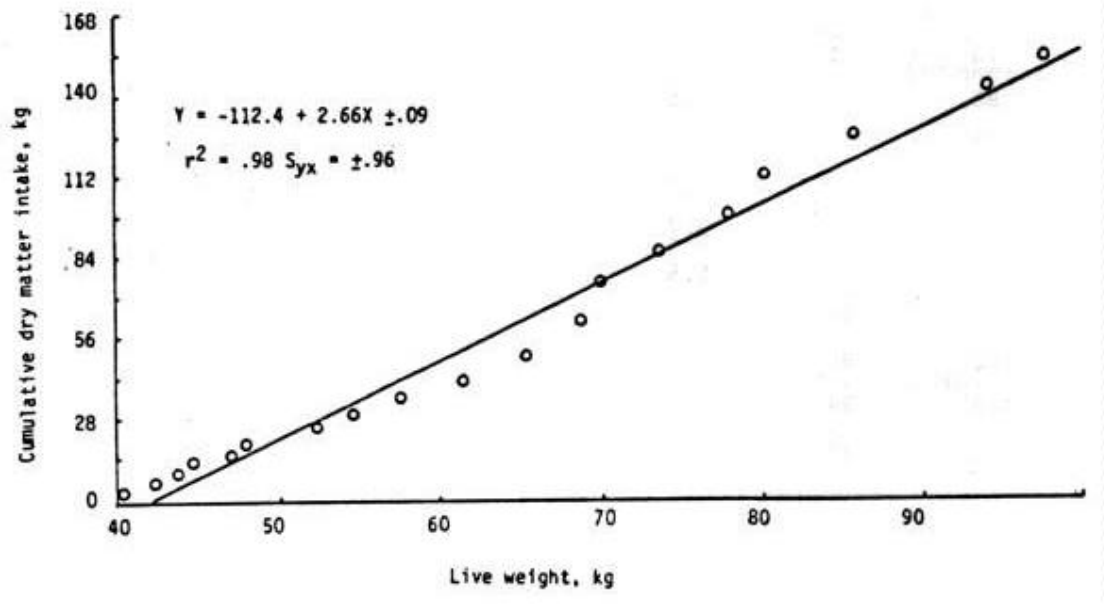
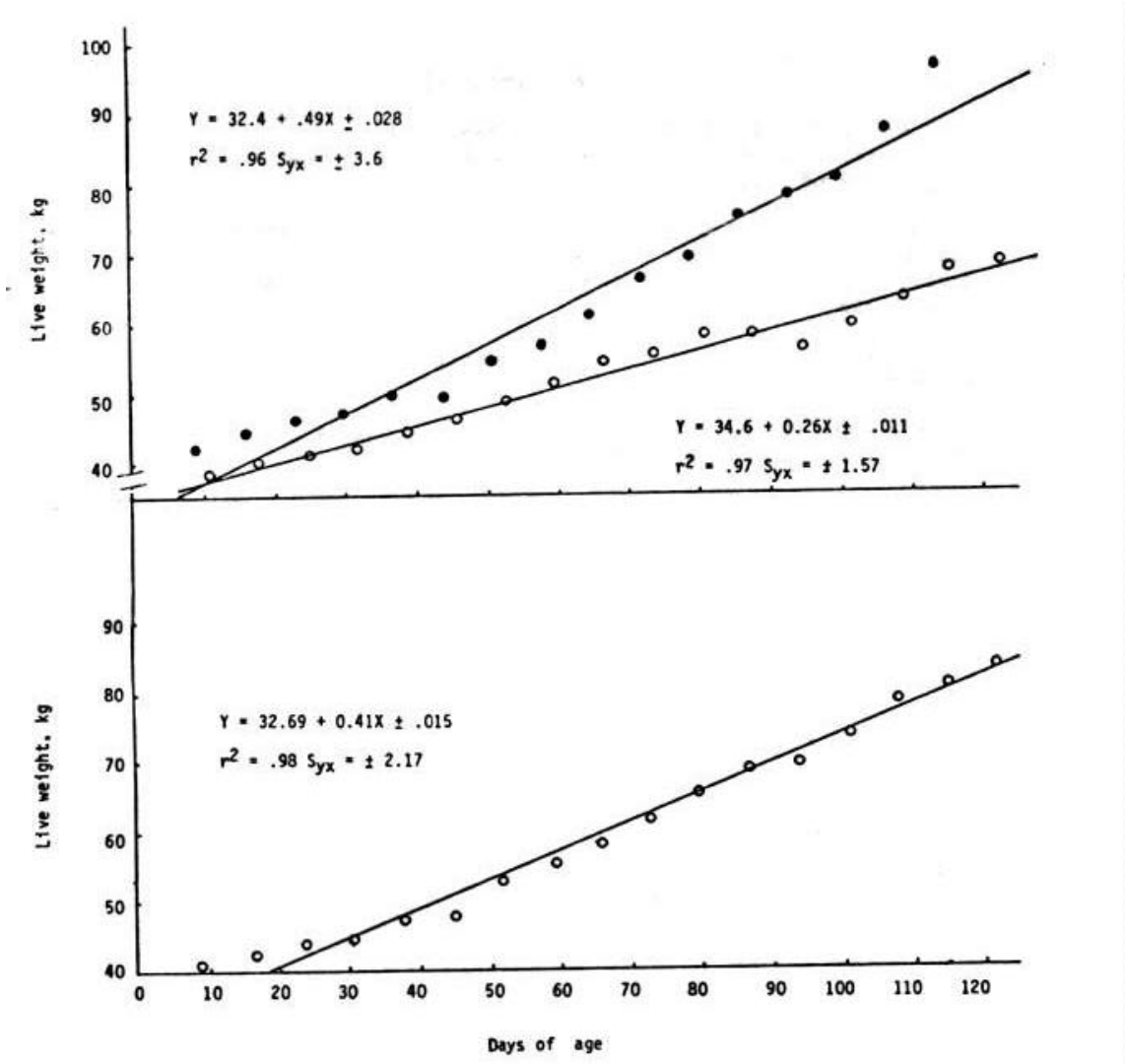


Figure 1: Regression of live weight on age for the total group of calves (lower graph) and for crossbred (•) and Holstein type (◦) calves (upper graph)



The mean daily milk intake was relatively low (2.6 kg/d) and considerably less than required for the maintenance requirements of the calf . This indicates a relatively high efficiency of utilization of the other supplements of the ration, which was principally sugar cane and molasses/urea. In view of its composition and the fact that suckling provokes an efficient closing of the oesophageal groove with direct passage to the abomasum, milk is thus a perfect supplement

for a sugar cane, molasses/urea based ration, in view of the metabolic limitations of this feed requiring supplementation with sources of amino acids and precursors of glucose (see Leng and Preston 1976).

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