SUGAR CANE JUICE AS CATTLE FEED: COMPARISONS WITH MOLASSES IN THE PRESENCE OR ABSENCE OF PROTEIN SUPPLEMENT

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An experiment was carried out with fattening cattle to compare diets based on fresh sugar cane juice or final molasses in the absence or presence of 1 kg/d of sunflower meal. Urea was added to the juice (.5%) and to the molasses (2.5%) All animals received minerals and African star grass forage at the rate of 3% of body weight (fresh basis). A total of 16 animals was used and the design was random block with a factorial arrangement of the main treatments. the cattle were mixed bulls and steers and crossbreds (Holstein or Brown Swiss on Zebu). Initial liveweight was approximately 270 kg and the trial period lasted 75 d.

Feed intake and liveweight gain were significantly higher on juice than on molasses and in the presence, as compared with the absence of the sunflower meal. Supplementation increased growth rate on molasses from 252 g/d to 525 g/d whereas on cane juice the comparable values were 800 and 1,300 g/d, respectively.

Liveweight gain was closely related with intake of soluble sugars and it is suggested that the better performance on the cane juice could perhaps be explained by the much lower content Or soluble minerals, which it was argued could be a factor restricting intake on final molasses.

Key words Cattle, sugar cane juice, molasses, bypass supplements, growth and fattening

In the tropics, one attractive way of substituting part of the requirement for fossil fuel, and especially that fraction which is utilised for the generation of electrical energy, could be through the utilization of a renewable source of biomass. In this respect, sugar cane offers a unique potential. It is one of the most efficient plants known for capturing solar energy. Furthermore, in comparison with traditional sources of solid fuels, eg forest products, sugar cane has the specific advantage of synthesising carbohydrates in two forms, one of which is rapidly digested both by mammalian and microbial enzymes (the soluble sugars) while the other (the fibrous cell wall) has a very slow rate of degradability, and is only attacked by microbial enzymes. It has been shown in feeding trials with cattle, that when whole sugar cane is fed, it is the soluble sugar fraction which contributes the greater part of the metabolisable energy that the animal obtains from this feed. The fibrous component is digested to only a minimum extent (about 20%), but of greater concern is the fact that it has a detrimental effect on the overall nutritional status of the animal, because its slow rate of degradability results in a very low rate of turnover of digesta within the digestive tract. Thus feed intake is low, and so is the efficiency of rumen microbial synthesis (Preston & Leng 1980). To use sugar cane efficiently for animal feeding, it would therefore be highly desirable to extract and use only the soluble sugars and to find an alternative use for the fibre.

The increasing importance of renewable sources of biomass as a solution to the present energy crisis offers a unique opportunity for the utilization of the fibre in sugar cane as a source of fuel , thus permitting the cane juice to be directed into animal feeding. Possible pathways for the utilization of the fibre as fuel are through charcoal or producer gas (see Preston 1980).

This paper is the first in a series, which will examine the nutritive value of sugar cane juice both for ruminant and monogastric animals. It describes an experiment to compare diets based on cane juice and final molasses, the latter being chosen as the feeding system which to date has given most promise for intensive cattle fattening in the tropics.

Materials and Methods

Treatments and Design: Four treatments were studied in a random block design with 8 groups, each of 2 animals, using a 2 x 2 factorial arrangement for comparisons of main effects and interactions. The main treatments consisted of sugar cane juice or final molasses; on each of these main treatments there were two sub-treatments consisting of levels of 0 or 1 kg/d of sunflower meal. There were two repetitions of each individual treatment giving a total of 16 animals in the experiment.

Animals: The animals were crossbreds by Holstein or Brown Swiss sires on Zebu cows. The initial liveweight was approximately 270 kg and it was estimated that the ages were between 18 and 24 months. During the previous five months, the animals had been receiving diets composed of ensiled sisal pulp and different levels of sunflower meal supplement. During this period, the rate of growth had varied from 550 to 700 g daily. Six of the animals were intact bulls and ten were castrates. The animals were allocated to the principal treatments taking account, as far as possible, of sex and breed type.

Diets: The sugar cane juice was obtained by passing sugar cane stalk through a small 3 roll mill (3 HP), of the kind used in establishments which sell fresh cane juice for human consumption. Pressing of the cane was usually carried out between 8 and 11 am and the fresh juice given immediately to the animals. Immediately prior to being fed, the juice was supplemented with urea, using a 50% aqueous urea solution (w/w) added at the rate of 10 ml per litre of juice. Feeding was ad libitum, but the amounts given were adjusted so that residues were minimal. The sugar cane stalk was brought once or twice weekly from the growing area situated some 200 km away. It was between 12 and 18 months of age and the Brix! values were in the range of 15 to 19. The Brix! was always adjusted to a value of 15, by adding water. The nitrogen content of the juice was 0.059% fresh basis, which would correspond to approximately 2.5% of protein in dry matter assuming all of the nitrogen was in the form of protein.

The final molasses came from a sugar factory some 600 km away. The same 50% urea/water solution was added to the molasses, but at a ratio of 50 ml/kg to give a final concentration of 2.5% urea (w/w). The molasses/urea was always available, the feed troughs being replenished usually on a daily basis.

The sunflower meal came from a local oilseed processing plant. The protein content was in the range 25 to 35% and varied slightly between batches.

All animals received fresh African Star grass, at a daily rate equivalent to 3% of liveweight. During the first 45 and the last 15 d of the trial, the grass came from an area which had been heavily fertilized with slurry from a nearby pig unit. A chemical analysis of this material showed that it contained 37% of DM and (% of DM) nitrogen 3.4, fibre 30.8, ash 8.9, ether extract 0.89. From 45 to 60 d the star grass came from another location and had not been fertilized; it was also considerably older, with probably only one third of the nitrogen content recorded for the younger fertilized material.

A commercial source of minerals was given daily at a rate of 50 g per head.

The animals were housed in partially paved and shaded pens which measured 2.5 by 6 m. The pens were completely open at the sides and fitted with water, and concrete troughs for the forage. The juice and the molasses were given in half 55 gallon oil drums.

Measurements: : The animals were weighed individually at the beginning of the experiment and subsequently at 15 d intervals. Feed intake was recorded. The rates of liveweight gain were calculated from the slope of the linear regression fitted to the points relating liveweight and time.

Results

The growth curves of the animals on each individual treatment are shown in Figure 1. Mean values for liveweight gain, feed intake and conversion are summarized in Table 1.

Figure 1:
Growth curves of cattle fed basal diest of cane juice (△, ▲) I or molasses (○ ,•)
without (unshaded or with shaded) sunflower seed meal

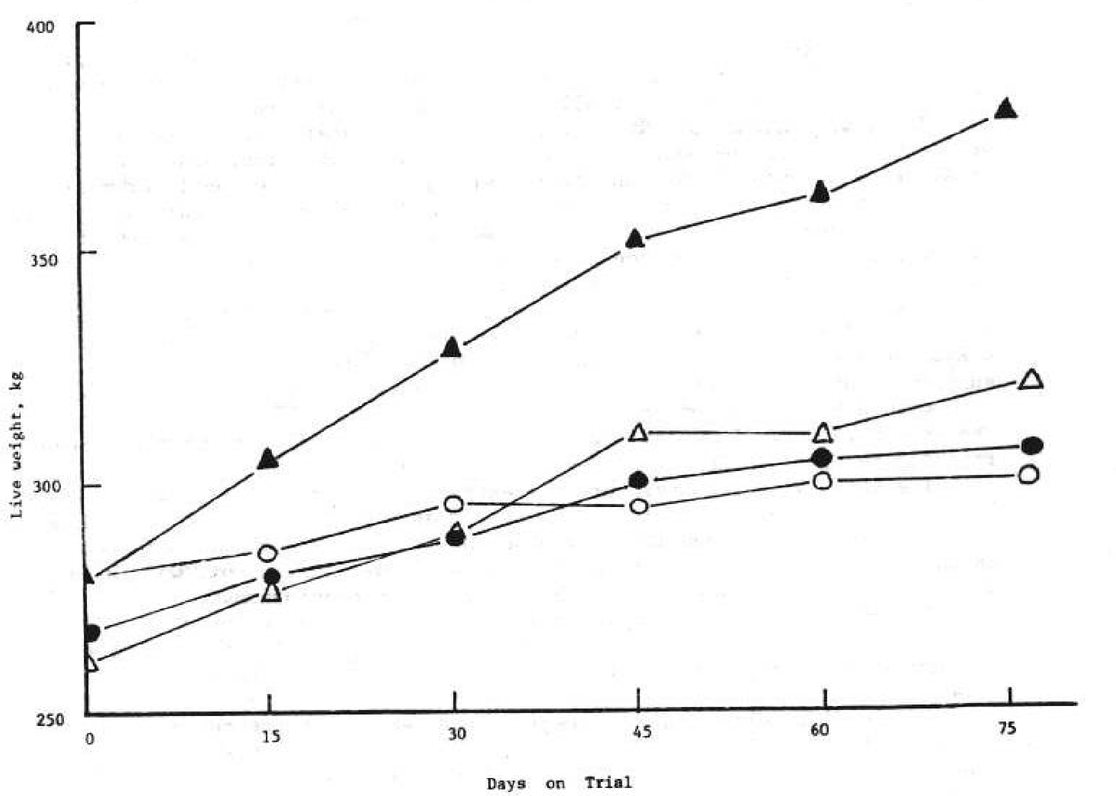


Table 1:
Mean values for liveweight gain, feed intake and conversion of crossbred bulls deaf basal diets of cane juice or molasses.

	Molasses		Cane juice		SEx (Prob)
	No supplement	1 kg/d sunflower meal	No supplement	1 kg/d sunflower meal	
Liveweight, kg					
Initial	279	266	261	279	
Final	300	304	309	361	
Daily gain	0.252	0.545	0.795	1.315	±.17(P <.001)
Feed intake kg/d					
Juice/molasses					
Fresh	3.95	4.00	22.69	31.92	
DM	2.96	3.00	3.40	4.79	±.12(P <.001)
(Sugars)	(2.17)	(2.20)	(3.06)	(4.31)	
Forage(DM)	2.48	2.52	2.45	2.74	
Supplement (DM)	-	O.90	-	0.90	
Total DM	5.44	6.42	5.85	8.43	±.22(P <.001)
Feed conversion	21.54	11.78	7.42	6.44	±.57(P <.001)

Growth rates were uniform throughout the experimental period, except for the period between 45 and 60 d when the lower quality forage was given. These tendencies were noted on all the four individual treatments.

There were highly significant effects on voluntary intake and live weight gain due to the basal diet of molasses or cane juice, and to the presence or absence of the sunflower meal supplement. The sunflower meal increased performance by 116% on molasses and by 65% on the sugar cane juice. The use of cane juice rather than molasses more than tripled the rate of liveweight gain in the absence of supplement, and doubled the gain when the supplementary sunflower meal was given.

The rate of liveweight gain on the molasses diet was rather lower than would normally be expected for the 1 kg/d level of supplementation. Fielding & Kyomo (1979) reported liveweight gains of 800 g daily when a mixed supplement of cotton seed meal (700 g/d) and rice polishings (300 g/d) was used with a basal diet of molasses/urea and restricted poor quality forage. The growth rate of 252 g daily without supplement is close to what has been reported by other workers (see Gaya et al 1979).

The surprising findings were the extremely high rates of growth on the basal diet of sugar cane juice. The performance recorded on the unsupplemented cane juice diet is considerably superior to what is normally obtained on unsupplemented molasses and , in this particular experiment, was in fact superior to the molasses diet which received supplementation.

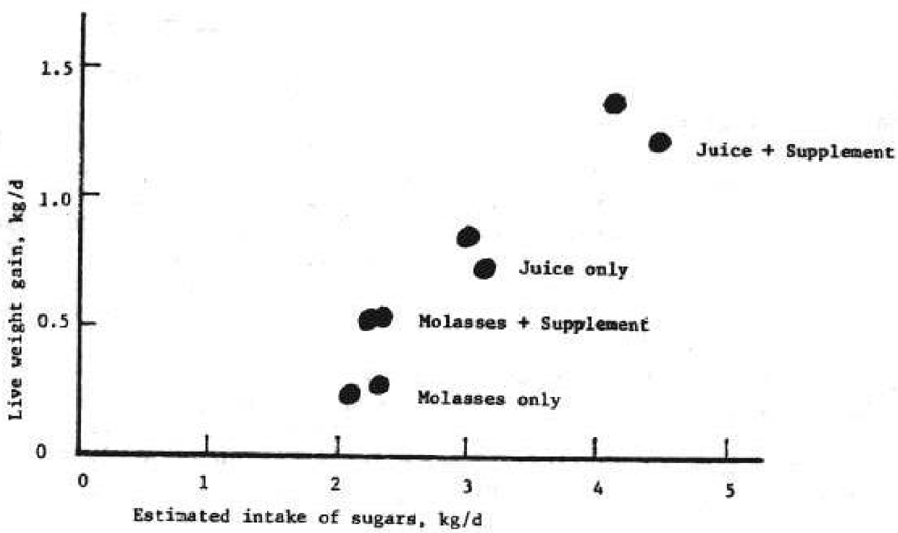
The growth rate of 1.3 kg/d obtained with the supplemented cane juice is comparable with what has been reported in temperate climates from the feeding of all concentrate diets based on cereal grains (Preston & Willis 1974).

It was difficult to obtain precise measurements of the consumption of nutrients from the forage, due to the variable nature of this input, nevertheless this was a constant factor affecting all treatments equally. The intakes of juice and molasses were recorded accurately and it is interesting to compare the estimated intakes of soluble sugars.

The DM of both the juice and the molasses represents soluble solids, but it must be remembered that the proportion of this in the form of sugars is considerably higher in juice than in molasses. It can be estimated that probably some 75% of the DM of molasses and some 90% of the DM of the cane juice is present in the form of sucrose and reducing sugars. Using these estimates, then the calculated intakes of soluble sugars would be 2.17, 2.20, 3.06 and 4.3 kg/head/d, for the molasses without and with supplementation and the cane juice without and with supplementation, respectively.

If the rate of liveweight gain is plotted against the estimated consumption of soluble sugars (Figure 22, it can be seen that there is a close relationship between sugar consumption and liveweight gain, at least for both sugar cane juice treatments and the supplemented molasses treatment. The only point falling outside the relationship is the control group on molasses receiving no supplementation.

Figure 2:
Relationship between estimated intke of soluble sugars and rate of live weight gain on basal diets of molasses or cane juice with or without protein supplement



An interesting observation concerned the drinking (or eating) habits on the two principal treatments of juice and molasses. It was found that the animals receiving cane juice were apparently able to consume quite a large quantity of the juice at any one time, while the animals consumed molasses on a basis of little and often. It was also noted that when, on occasions, there was a shortage of water, then the cane juice was drunk in very much greater quantities, than when water was freely available.

Discussion

The close relationship between consumption of soluble sugars and rate of liveweight gain would indicate that the principal advantage offered by the cane juice over the molasses was the opportunity to consume greater quantities of fermentable organic matter.

As there have been no reports of soluble sugars in cattle fed molasses (Geerken & Sutherland 1969) or sugar cane (Elliott et al 1978a), reaching the duodenum, it can be assumed that on the diets used in this experiment, the principal difference between the two basal diets was manifested at the level of the rumen fermentation. The greater voluntary intake of sugar not only would increase microbial protein synthesis due to increased supply of fermentable carbohydrate per se; it can also be expected that the greater intake would be associated, in turn, with an increased efficiency in the conversion of fermentable carbohydrate into microbial protein (Elliott et al 1978b). However, although there are no reports of sugar escaping rumen fermentation on other sugar-containing diets, this does not eliminate the possibility that because of the amount and concentrations of the sugars in cane juice, that some of these might have passed through to the omasum before they were fermented.

There were obvious positive effects due to supplementation with sunflower meal. It is assumed that this effect reflected the bypass properties of much of the protein in the supplement and that it was the protein escaping fermentation reaching the duodenum which stimulated the greater intake (at least on the sugar cane juice) and the better animal performance. It was surprising that there was no increase in the consumption of molasses due to supplementation with sunflower meal as this has been recorded when other protein supplements such as fishmeal have been given (Gaya et al 1979). However, although intake of molasses was not increased by supplementation, there was a very marked improvement in animal performance presumably due to the direct nutritional value of the sunflower meal as a source of both bypass protein and bypass energy (see Preston & Leng 1980). Molasses, in fact, is derived from cane juice after clarification (removal of some of the protein and minerals) and extraction of most of the sucrose. However, despite the similarities, there are also important differences between these two substrates.

The water content of molasses is only about 25% whereas in the juice it is about 85%. This is not thought to be an important factor since in Cuba there were no differences in performance of cattle when molasses concentrations ranging from 15 to 75 Brix! were fed (Preston et al 1968); preliminary results of trials at this centre also indicate few differences between molasses of a similar Brix! range.

The major difference perhaps lies in the concentration of soluble minerals, which is very much higher in molasses compared with cane juice. The observations on eating patterns between the two feeds may be related to this characteristic.

Thus, Benvides and Rodriguez (1971) concluded that osmotic effects were an important factor in molasses-based diets and could be responsible for the observation that animals consumed small amounts of molasses at any one time, but at frequent intervals. It was hypothesised that it was the osmotic pressure of the molasses which restricted intake, in a similar way as has been observed in the feeding of salt solutions in monogastric animals.

Addition of minerals is also a traditional method of controlling intake of supplements by grazing animals. The fact that the animals receiving cane juice appeared to be able to consume quite large quantities at any one time, in contrast with the eating pattern on molasses, would seem to corroborate the idea that osmotic effects might limit voluntary intake on molasses and explain why carbohydrate intakes were so much higher on cane juice.

Conclusions

It must be emphasised that the results obtained in this experiment relate to a relatively small number of animals and a total feeding period of only 75 d. Nevertheless, the uniform growth pattern on all the diets, and the obvious superiority of those animals receiving cane juice compared with molasses, lends support to the conclusion that on this type of basal feeding system it should be possible to obtain performance rates in ruminants comparable with those reported from the feeding of cereal grains in temperate countries.

An even more significant feature of the results is the indication that levels of performance of almost 800 g daily were achieved without the use of a protein supplement other than that provided by the forage. In all previous trials with tropical feeds, the usual performance has been only of the order of 300 to 400 g daily in the absence of bypass supplements.

The original justification for fractionating the sugar cane into juice and fibre was that it would provide a means of overcoming the limitations to animal performance, which have always been observed when whole sugar cane has been the basal diet (Preston 1977). It was hoped that by eliminating the fibre, it would be possible to raise performance to that observed on molasses based diets. The results of these experiments indicate, however, that not only was the first objective achieved, namely the removal of the constraints caused by the sugar cane fibre, but that much higher levels of performance were achieved than had been predicted based on all previous work with sugar based feeds.

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