THE EFFECT ON THE PERFORMANCE OF FATTENING BULLS OF SUPPLEMENTING A BASAL DIET OF DERINDED SUGAR CANE STALK WITH UREA, SWEET POTATO FORAGE AND COTTONSEED MEAL[1]

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Thirty-two crossbred Zebu bulls (initial weight 174-194 kg) were fed a basal diet of derinded sugar cane (Brix 17°) stalk to assess the effect on intake ant live weight gain of supplements designed to supply additional fermentable N (urea), roughage (sweet potato forage) and bypass nutrients (cottonseed meal). The 8 treatments arranged in a 2 x 2 x 2 factorial design, consisted of low or high levels of urea (6 or 25 g/kg fresh cane), the presence or absence of fresh sweet potato forage (5% of live weight) and presence or absence of cottonseed meal (750 g/d). Live weights were recorded at 14 d intervals for a period of 85 d.

Voluntary intake and rate of live weight gain on the basal diet of cane and low urea were significantly increased by both sweet potato forage-and the cottonseed meal, but not by the high urea treatment alone. The high level of urea increased both weight gain and intake when forage and cottonseed meal were also supplied. Effects of urea level on live weight gain appeared to be greater when the forage was given (71% improvement) than when only the cottonseed meal was given (26%)

It is concluded that on a basal diet characterised by low N ant high content of rapidly fermentable carbohydrate, the first limiting factors for efficient rumen function (and therefore animal productivity) are, in order of importance, roughage characteristic, bypass protein and energy ant fermentable N. It is hypothesised that the first two factors act so as to improve the rumen ecosystem (probably by increasing rumen turnover and outflow rate) and thus encourage fast microbial growth and therefore create a demand for additional ferment able N. There is also the direct benefit in Supply of amino acid. ant energy at the duodenum of the bypass nutrients.

Key words: Cattle, sugar cane, derinding, urea, roughage, bypass nutrients, voluntary intake, growth rate

This paper is part of the series on the use of high protein forages to supply both protein and roughage in diets based on molasses and sugar cane. These forages were chosen on the basis of their suitability for high yields and adaptation under tropical conditions. The paper also involves an evaluation of Cottonseed meal as one of the most suitable sources of by-pass nutrients available in the tropics.

In an experiment with chopped sugar cane stalk, supplementation with sweet potato forage led to a significant increase of total dry matter intake but there was no change in the consumption of sugar cane (Meyreles et al 1978). With a molasses based diet (Ffoulkes and Preston 1978) sweet potato forage as a source of protein and roughage supported live weight gains of 570 g/d; this was significantly improved by addition of 400 g/d of soybean meal to give a liveweight gain of 784 g/d.

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Results with sugar cane (Preston 1977) indicated that even with adequate supplementation, this basal diet was only able to support moderate levels of animal performance and that supplementation with molasses was necessary in order to achieve acceptable rates of liveweight gain (Silvestre et al 1976).

The derinding of sugar cane stalk has an effect similar to that of adding molasses, in that by eliminating the more fibrous part of the plant there is effectively an increase in the concentration of sugars thus satisfying the requirement for an adequate substrate for rumen microbial synthesis.

The hypothesis to be evaluated in the present experiment is that derinded sugar cane stalk, although an excellent source of fermentable carbohydrate is nevertheless deficient in fermentable nitrogen, roughage characteristics and by-pass nutrients. This experiment evaluated the addition of supplements providing these nutrients to the basal diet of derinded sugar cane.

Materials and Methods

Treatments and Design: 8 treatments were studied in a 2 x 2 x 2 factorial design with two replications using a basal diet of derinded sugar cane stalk. The treatments consisted of low or high levels of urea; the presence or absence of sweet potato forage and the presence or absence of cottonseed meal. There were 2 animals on each treatment/replication to give a total of 32 animals. The experiment lasted for 85 days. The animals were cross bred Zebu bulls with an initial weight between 174 and 194 kg and between 1 and 2 years of age.

Diets: The sugar cane was the variety 980. The tops were removed and the stalk and rind then separated in a mechanical separator (model C-5; Intercane Systems Ltd, Windsor, Canada). The derinded cane stalk, which resembles wet saw dust in appearance, had a mean dry matter (DM) content of 23.7 + ,18, 17.1 + .19!Brix and pH of 4.55 + .08. Urea levels were 6 and 25 g/kg of fresh derinded stalk respectively and were calculated to represent the requirements of rumen microorganisms for low or high rates of growth. The urea was prepared as a 50/50 (w/w) aqueous solution. The sweet potato was a local variety and was harvested after 6 to 8 weeks of regrowth. It had been irrigated and fertilized with cattle slurry. The content of DM in the forage varied between 13 and 15% and the average protein content was 13.4% in DM. The cottonseed meal contained 93% of DM and had 48% of protein in the DM.

The sugar cane was processed and fed once daily on a free choice basis. The urea solution was mixed into the sugar cane after this was placed in the feed trough. The sweet potato was harvested once daily and was chopped into pieces about 2cm long using a stationary forage harvester. It was offered at a feeding level of 5% of liveweight and was given on top of the sugar cane. The Cottonseed meal was given at the same time at the rate of 750 g/d.

Housing: The animals were housed in 16 pens (3 x 3) with slatted floors in an open-sided roofed building. A mineral mixture was given at the rate of 70 g per animal daily (50% salt and 50% dicalcium phosphate).

Measurements: The animals were weighed individually at the beginning of the experiment and subsequently every 14 days. The rate of live weight gain was determined by the regression of live weight on time in the experiment. Mean values for the two animals in each pen were used as the variables in the analysis of variance. A weekly record was kept of the DM, Brix! and pH of the sugar cane. The sweet potato and cottonseed meal were also analysed periodically.

Results

Mean values for the consumption of dietary ingredients and for animal performance parameters are summarized in Tables 1 and 2. Treatment effects for DM intake and liveweight gain are illustrated in Figure 1. Table 3 summarizes the analysis of variance for voluntary consumption index consumption of sugar cane and liveweight gain.

Table 1:
Voluntary intake of diet components

Supplement	None		Sweet Potato (SP)		Cottonseed meal (CSM)		SP + CSM	
Urea	Low	High	Low	High	Low	High	Low	High
Voluntary intake, kg/d								
Derinded cane stalk	8.57	8.67	11.1	11.4	10.8	12.9	13	13.5
Urea	.052	.217	.067	.285	.065	.322	.078	.337
Sweet potato forage			9.9	10.6			11.0	10.7
Cottonseed meal				.69	.72	.72	.73	
Minerals	.07	.07	.07	.07	.07	.07	.07	.07

Table 2:
Mean values for weight gain, voluntary consumption index and conversion of a basal diet of derinded sugar cane stalk supplemented with low (L) or high {H) levels of urea and sweet potato forage (SPF) and cottonseed meal (CSM)

SPF or CSM	Neither		SPF		CSM		SPF ± CSM		
Urea	L	H	L	H	L	H	L	H	SE (Prob)
Initial weight, kg									
Daily weight gain, g	10	-61	343	585	351	444	697	984	±110 (.001)
DM intake, kg/d									
Derinded cane	2.04	2.06	2.64	2.71	2.56	3.06	3.20	3.08	±.18 (.01)
Total	2.14	2.28	4.06	4.37	3.31	3.98	5.55	5.44	±.22 (.001)
Consumption index[1]	1.17	1.76	1.84	2.03	1.74	2.00	2.43	2.51	±.087 (.001)
Conversion[2]	*	*	11.9	8.1	10.9	9.0	7.8	5.7	

[1]kg DM/100 kgLW/d
[2]kg DM/kg LW gain

* Data meaningless as animals only maintained weight

Table 3:
Analysis of variance for treatment effect on live weight gain, voluntary consumption index index and consumption of derinded cane stalk

		Live weight gain		Consumption index		Cane intake	
Sources of Variation	Degrees of freedom	Mean square	significance	Mean square	significance	Mean square	significance
Total	15						
Treatments	7	237,644	.001	.434	.001	.395	.01
Main effects							
Urea	1	75,900	.10	.0967	.04	.055	.39
Supplements	3	503,078	.001	1.065	.001	.834	.002
U x S	3	26,171	.39	.0080	.68	.070	.43
Error	8	22,933		.0155		.0679	.

Voluntary intake: The voluntary consumption index (kgDM/100 kgLW/d) was increased by the high level of urea and by each of the supplements of sweet potato forage and cottonseed meal; highest values were recorded for the supplements combined. There was no response to urea on the basal diet; the improvements in intake were only significant when either sweet potato forage or cottonseed meal was also provided. The interaction urea X supplements was not significant (P< .68). The consumption of the sugar cane component of the diet was increased (P< .002) by supplementation with sweet potato forage and/or by cottonseed meal, but not by urea (P< .39), although there were tendencies for an increase on the diets that contained the other supplements.

Liveweight gain: Liveweight gain was increased by the higher level of urea and by the supplements given separately or together. There was no (P<.39) interaction between the effect of urea and of the other supplements. On the control diet there was no effect of urea (animals on this treatment lost 61 g/d). The degree of improvement due to the high urea was most evident on the sweet potato forage supplement (an improvement of 71%) followed by the combined supplements (an improvement of 41%) with the lowest response to urea being recorded when only cottonseed meal was given (26% improvement).

At the low level of urea there were improvements in liveweight gain due to supplementation with sweet potato forage or cottonseed meal and the degree of response was similar. However at the high level of urea, the response to sweet potato forage was much greater than to the cottonseed meal.

The highest rate of liveweight gain (984 g/d) was recorded on the treatment which combined high urea, sweet potato forage and cottonseed meal.

Feed conversion: There were dramatic effects of supplementation on the feed conversion ratio. Results generally were superior for the high compared with the low level of urea; the effects of sweet potato forage or cottonseed meal separately were similar, the best values for feed conversion being recorded when all supplements were combined (a DM conversion ratio of 5.7).

Figure 1:
Effect on live weight gain and dry mattes intake of supplementing a basal diet of derinded sugar cane stalk with high (obliquely shaded) or low (open column) urea, sweet potato forage or/and cottonseed meal like dotted areas represent the intake of the basal derinded cane stalk)

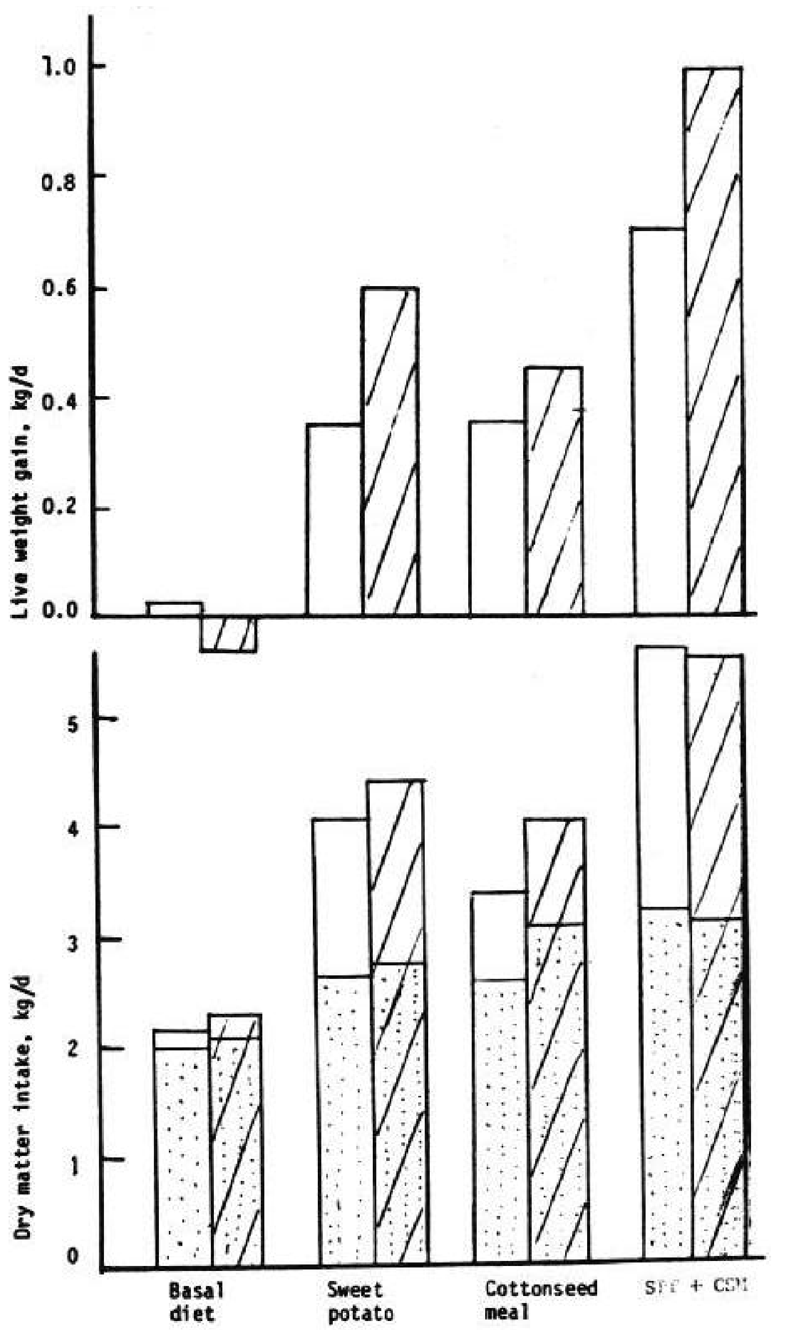
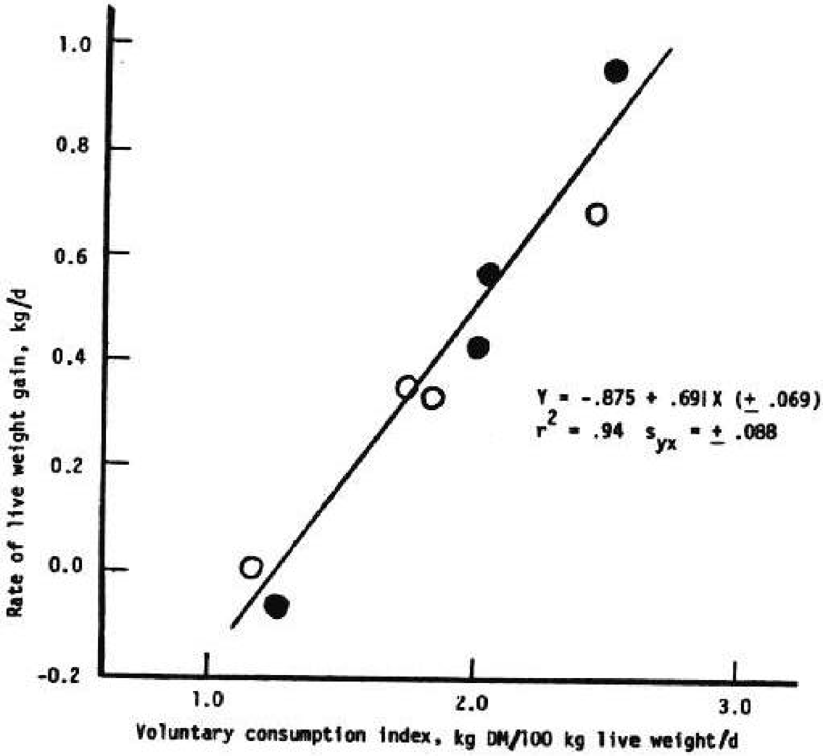


Figure 2:.
Relationship between voluntary consumption index (kg DM/100 kg LW/d) and and rate of live weight gain on a basal diet of derinded sugar cane stalk supplemented with low (◦) or high (•) urea, and sweet potato forage or/and cottonseed meal.



Discussion

The effect of the cottonseed meal in increasing intake of the basal sugar cane component of the diet is similar to that reported for rice polishings by Preston et al (1976) and Lopez et al (1976, 1977).

It is presumed that this response in intake reflected the rumen bypass properties of these supplements (see Kempton et al 1977; Preston and Leng 1979).

The increase in intake of the derinded cane, as a result of adding the sweet potato forage represents an improvement with respect to other reports in the literature. James (1973) and Ferreiro and Preston (1976) observed increases in total DM intake when chopped cane tops were added to derinded cane stalk, and chopped cane stalk respectively, however, the intake of the basal cane stalk component remained unchanged. The advantage in favour of the sweet potato forage presumably is because of its greater rate of degradation in the rumen (Santana and Hovell 1979) compared with cane tops (T1/2 values are 10 and 100 hr respectively) (Hovell and Fernandez 1979; F D DeB Hovell, 1979 unpublished).

There was also an obvious deficiency of fermentable N when roughage and bypass supplement were also fed with the derinded cane. However, on derinded cane supplemented only with minerals, there was no response to urea, and therefore no need for supplementary fermentable N. Presumably other factors were limiting microbial growth (probably rumen digesta turn over rate; see Bergen 1979), and the recycling of N to the rumen was sufficient for the slow microbial growth rates under these circumstances.

On the assumption that a response to the high level of urea reflected an increased rate of growth of the rumen microorganisms and therefore a more efficient conversion of fermentable carbohydrate into microbial protein, then it can be concluded that both the principal supplements acted at least partially at the level of the rumen. The effect of sweet potato forage probably was to increase rumen motility and therefore rate of turn over of rumen digesta and rate of rumen outflow, leading finally to a greater flow of protein to the duodenum.

In contrast, the ruminal effect of the cottonseed meal is likely to be an indirect one, associated with the role of by-pass protein in elucidating increased voluntary intake (Kempton et al 1977) and also (or as a consequence of the greater intake), a faster rumen turn over (see Preston and Leng 1979).

The highest level of animal performance obtained on the derinded cane supplemented with high urea, sweet potato forage and cottonseed meal presumably reflects the result of optimising conditions for rumen microbial synthesis (addition of sweet potato forage and urea) plus the amino acids and energy contributed via gastric digestion of the cottonseed meal which would have escaped (bypassed) the rumen fermentation.

Figure 2 shows the extremely close relationship between voluntary intake and liveweight gain. All the treatments lie close to the regression line, indicating that a major effect of these supplements was mediated through improvements in voluntary intake and the related effects on rumen function.

Conclusions

It is concluded that the rate of fermentability of a feed is only an indicator of its potential value in ruminant diets and that even when this potential is high (the sugar content of the DM of derinded cane stalk is 60% or more) the level of animal performance will be dictated by: a) the presence (or absence) in the diet of adequate roughage characteristics in order to guarantee efficient rumen function; and b) a supplement providing by pass nutrients.

The results also show that the presence of slowly degradable cell wall material (fibre) in a diet is no guarantee of the roughage status of that diet. It is assumed that the problem is mainly one of particle size and that the length of the fibres in derinded sugar cane stalk is too short for them to have an effective role in maintaining rumen function.

The rates of liveweight gain and the feed conversion on the properly supplemented derinded sugar cane stalk show that this energy source is capable of supporting high levels of productivity in ruminants which are comparable with what would normally be expected in diets based on cereal grains.

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References

Bergen W G 1979 Factors affecting growth yields of microorganisms in the rumen Tropical Animal Production 4:13-20

Ferreiro H M & Preston T R 1976 Fattening cattle with sugar cane: the effect of different proportions of stalk and tops Tropical Animal Production 1:178-185

Ffoulkes D & Preston T R 1978 Cassava or sweet potato forage as combined sources of protein and roughage in molasses based diets: effect of supplementation with soybean meal Tropical Animal Production 3:186-192

Novell DeB F D & Fernandez A 1979 Effect of the diet of the host animal on the rate of degradation in the rumen, of different tropical feeds Tropical Animal Production 4:104-105 Abstracts :

James L A 1973 Comfith in rations for livestock Proceedings CIDA seminar on sugar cane as livestock feed Barbados 30-31 January 1973

Kempton T J, Nolan J i & Leng RA 1977! Principles for the use of non-protein nitrogen and by-pass proteins in ruminants World Animal Review 22:2-10

Lopez J M, Preston T R, Sutherland T M & Wilson A 1976 Rice polishings as a supplement in auger cane diets: effect of level of rice polishings in wet and dry season conditions Tropical Animal Production 1:164-171

Lopez J M, Priego A, Wilson A 6-Preston T R 1977 Rice polishings as a supplement in auger cane dicta: affect of giving it as a separate meal or mixed with the auger cane Tropical Animal Production 2:323-327

Meyreles Luz 6 Preston T R 1978 Sweet potato forage as cattle feed: effect on voluntary intake of different amounts added to a basal diet of chopped sugar cane stalk Tropical Animal Production 3:224-228

Preston T R 1977 Nutritive value of auger cane for ruminants Tropical Animal Production 2:125-142

Preston T R & Leng R A .1979 The digestion of tropical feeds by ruminants Proceedings of the fifth International Symposium on Ruminant Physiology Clermont-Ferrand France (September 1979)

Preston T R, Carcano C, Alvarez F J & Guttierez D G 1976 Rice polishings as a supplement in a auger cane diet: effect of level of rice polishings and of processing the auger cane by derinding or chopping Tropical Animal Production 1:150-163

Silvestre R, MacLeod N A & Preston T P. 1976 Supplementation of auger cane/urea for growing cattle: different levels of maize grain and a protein concentrate Tropical Animal Production 1:206-214

Sanatana A 6 Hovell DeB F D 1979 Rate of rumen digestion of the dry matter of leaf, petiole and stem of banana, sweet potato and cassava forages using the in vivo nylon bag technique with cattle fed auger cane or molasses based diets Tropical Animal Production 4:192 Abstracts

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