RICE POLISHINGS AS A SUPPLEMENT IN A SUGAR CANE DIET EFFECT OF LEVEL OF RICE POLISHINGS AND OF PROCESSING THE SUGAR CANE BY DERINDING OR CHOPPING[1]

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Whole sugar cane was processed by derinding or by chopping and mixed with a solution of urea/molasses (283 g urea/litre) at the rate of 50 ml/kg of fresh cane. In addition there were 5 levels of rice polishings in the range of 0 to 1.2 kg/daily and minerals. The experiment was carried out in the dry season between January and May 1974 and involved a total of 400 Zebu bulls and steers. The experiment lasted 123 days. There was a very marked effect of rice polishings in increasing voluntary intake of sugar cane, total dry matter intake, live weight gain and in improving feed conversion. Least squares analysis of the live weight gain data showed tendency for better performances with chopped than with derinded cane ($P < .10$) while intact bulls grew faster ($P < .01$) than steers; crossbred animals (from insemination of Zebu with Brown Swiss and Holstein) were also better than commercial Zebu ($P < .01$). In general, carcass characteristics of the cattle fed on sugar cane were similar to those obtained with pasture feeding although there was a tendency for greater muscle and less fat thickness in the animals given sugar cane. Dressing percent, adjusted for differences in final weight, was related linearly with the level of rice polishings.

Key words: Sugar cane, cattle, processing, rice polishings

The first serious attempt to utilize sugar cane as the principal energy source for the fattening of cattle was carried out in Barbados (Dion 1972). The project had its origin in the development of a machine which separated the rind from the sugar cane stalk with the objective of utilizing the former as raw material for production of particle board. The residue, namely the sugar containing pith (derinded sugar cane stalk), was the fraction used as cattle feed. In a series of

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experiments, Donefer and his collaborators (CIDA 1973; Donefer et al 1973) showed that when the derinded cane stalk was supplemented with chopped cane tops, protein, urea, minerals and vitamins, it was capable of supporting live weight gains in Holstein steers of up to 1 kg/day with a dry matter conversion of 9.

Considering the application of this technology in other tropical regions, it seemed that the principal limiting factor was the relatively high cost of the machine which carried out the separation process. For example, the prices of the first commercial models of this machine (Model No C4, Canadian Cane Equipment, Edmonton, Canada) were of the order of US$35,000.00 FOP Canada. An attempt was therefore made to investigate simpler methods for processing the sugar cane, which would have a more general application in tropical regions, areas which tend to be associated almost always with conditions of underdevelopment. The simplest method of processing seemed to be with a conventional forage harvester. Such a machine was constructed in the work shops of the State Government of Quintana Roo. It consisted of a fly wheel with two knives, rotated in a vertical plane in a closed housing at a speed of 3,000 rpm using a 5HP electric motor.

The first attempts to process the sugar cane with this simple machine gave a final product which appeared to be similar in appearance to that obtained from the derinder. The productivity of the chopper (500 kg/hr) was less than for the derinder (3,000 kg/hr) but this was more than compensated by the simpler construction and much lower cost (approximately US$500.00).

The objective of this experiment was therefore to compare the two methods of processing and, at the same time, to provide information on the response to levels of supplementary rice polishings a by-product feed, relatively common in tropical regions.

Materials and Methods

Climate data: The experiment was carried out in a feedlot situated in unit No 13 of the Alvaro Obregón Ejido in the State of Quintana Roo. Average rainfall for the area is approximately 1,200 mm and is concentrated between June and December. The temperature varies in the range 18° to 35° with an annual average of 26°.

Sugar cane: The sugar cane utilized was the variety POJ 2878 which had been sown in June 1972, in a well drained medium clay-loam soil. It had not been irrigated when the trial began in January 1974, the sugar cane was 18 months old and was yielding approximately 120,000 kg/ha (including tops).

Treatments and Design: The two principal treatments were derinding or chopping. On each type of processing, the levels of rice polishing were 0, 300, 600, 900 and 1,200 g/head/day. There was a group of 40 (steers and bulls)on each of these subtreatments, giving a total of 400 head in the experiment. The design was a production function and statistical analyses were carried out by least squares.

Animals: The 400 head came from pasture areas in different parts of the State and had a wide range of live weight (226 ± 49). The principal breed was Zebu but there were some crosses by Holstein and Brown Swiss sires. The distribution of animals in the different treatments was completely at random. When the cattle arrived et the feedlot, they were numbered by branding, and treated against internal and external parasites. All the cattle received an injection of vitamins A, D and E at the rate of 1.5 million iu of A, 225,000 iu of D3 and 750 iu of E.

Processing of Sugar Cane: The sugar cane that was given in the morning feed had been harvested the previous day, while the sugar cane given in the afternoon feed was cut the same morning. The exception to this procedure was on Sundays when all the cane was harvested on the Saturday and the first feed on Monday which came from sugar cane harvested that morning.

The machine for derinding the sugar cane (model C-4 Canadian Cane Equipment, Edmonton, Canada) was driven by 4 electric motors of 37.5 HP in total. The stalk of the cane was directed between two rubber rollers which guided it onto a central knife which split it longitudinally. Each of these two pieces then entered a combination of steel rollers one of which acted so to separate the rind while the other was in the form of a tooth wheel which scraped the pith from the underside of the rind. The final products were the two strips of rind which were ejected from the machine at the sides and the sugar cane pith which fell in finely divided form onto an elevator.

In this experiment the entire cane plant was passed through the machine, i.e. both tops and stalk in integral form. This procedure differed from the method practised in Barbados (CIDA 1973), where the tops were removed first, and only the stalk was passed through the derinder. The tops were then processed in a forage chopper and the two fractions subsequently mixed together in a proportion of 30% derinded stalk and 25% of chopped tops. The justification for introducing the entire cane plant into the derinding machine in this experiment was to simplify the process, in view of the large number of animals in this experiment.

The final product used in the present experiment also differed from that utilized in Barbados in that parts of the leaves were incorporated into the pith in fairly long strips, while other parts remained attached to the rind and were therefore

lost. For example in two samples taken during the experiment the proportions of final products were (% fresh basis): pith and leaves 83, rind 13, and leaves attached to the rind 4. Strict records were not kept of the proportions of stalk and toss but this varied within the range of 20 to 30% tops (fresh basis).

The machine for chopping the whole sugar cane plant has already been described. The knives were kept sharp with the aim of producing a final particle size similar to that obtained from the derinding machine (between 3 and 5 mm).

Diets: The basal ration consisted of sugar cane supplemented with urea and rice polishings in order to obtain a nitrogen level in the diet dry matter of 2.16%. The urea was prepared as a solution in water and final molasses in the proportions (g/litre): final molasses (88° Brix) 817, water 208 and urea 283. The urea was mixed first with the water, later adding this solution to the molasses, in a mixer tanker equipped with a propeller which was driven from the power take off of the tractor. The solution of molasses/urea was spread over the sugar cane immediately the latter was put in the feed trough. In order to maintain a constant amount of nitrogen in the diets the solution of molasses/urea was given at the level of 50, 49, 48, 47 and 46 ml/kg of fresh cane for the treatments of 0, 300, 600, 900 and 1200 g/d of rice polishings respectively.

The sugar cane and molasses/urea were given twice daily (9 a.m. and 3 p.m.) adding immediately the rice polishings and mixing the total ration together in the feed trough. All the animals received clean water and a mixture containing (g/kg): salt 500, of rock phosphate 470 and trace element mixture 30.

Housing: The corrals were constructed in wood with a concrete feed trough; the floor space per animal was 5 m^2. There was a 2 m concrete pad behind the feeders, the remainder of the floor being of compacted chalk. A palm roof provided shade over the feeders and for a distance of 5 m into the corrals.

Measurements: The animals were weighed individually at the beginning of the experiment and subsequently every 28 days. The sugar cane was weighed for each feed and the residue collected before the first feed in the morning. The productivity and consumption of electricity of the two machines for processing the cane was recorded.

Results

Health: Of the 400 animals in the experiment only one died in the adaptation period apparently from bloat. There were no other losses and, in this respect, the results are in agreement with those report ed from Barbados (CIDA 1973), in the sense that there are few digest and metabolic upsets related with the use of sugar cane as a feed. Productivity and Energy Consumption for Processing the Cane: Some observations on the productivity and energy consumption for

the two types of machine utilized in the experiments are given in table 1.

Table 1:
Productivity and power consumption of the sugarcane processing machines (X ± SE)

	Chetumal chopper	Canadian derinder
Productivity, kg/hr	434 ± 27[1]	3168 ± 170[1]
Power consumption, KWhr/t	4.72 ±.13[1]	6.17[2]

[1] Monthly data recorded in February, March, April and May [2] Total experiment

As was to be expected, the derinding machine had a higher productivity than the chopper, however efficiency of energy utilization favoured the chopper by 24%. There were few technical problems with the small cane choppers and the occasional difficulties encountered were readily resolved in a local workshop. In contrast, the derinder required frequent adjustments to the separating rollers, a task which had to be performed by a skilled mechanic.

Figure 1: Relation between level of rice polishings and intake of fresh cane and total dry matter (open symbols are for chopped cane and solids ones for derinded cane)

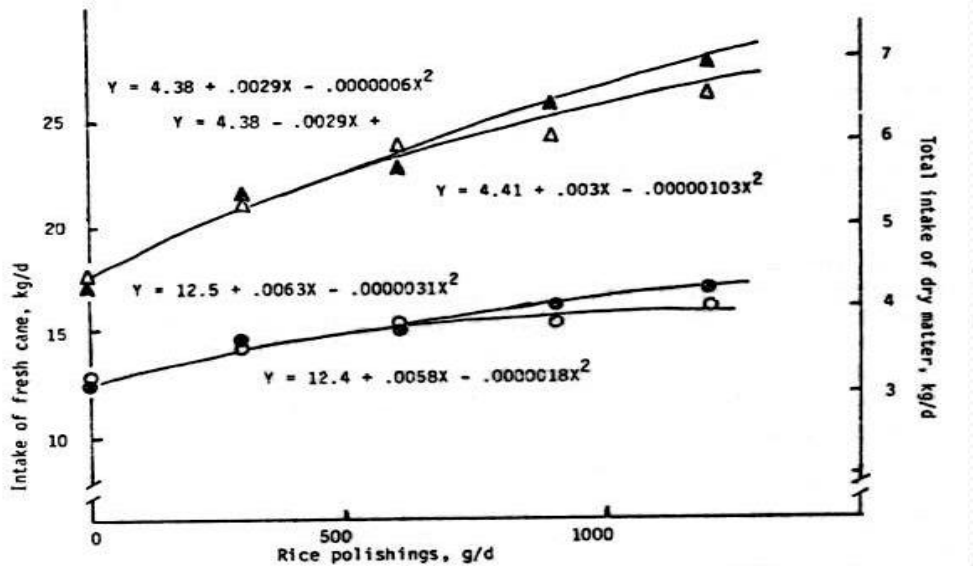


Table 2:
Mean values for feed intakes

	Level of rice polishings g/day				
	400	600	800	1000	1200
Sugarcane[1], kg/d					
Chopped	12.41	14.33	15.39	15.31	15.87
Derinded	12.32	14.39	14.87	14.69	16.89
Molasses[1], kg/d					
Chopped	0.507	0.574	0.604	0.588	0.596
Derinded	0.503	0.566	0.583	0.633	0.635
Urea, kg/d					
Chopped	0.176	0.199	0.209	0.204	0.207
Derinded	0.174	0.200	0.202	0.219	0.220
Mineral, kg/d					
Chopped	0.065	0.065	0.065	0.065	0.065
Derinded	0.065	0.065	0.065	0.065	0.065
Total DM, kg/d					
Chopped	4.368	5.292	5.929	6.141	6.631
Derinded	4.337	5.317	5.722	6.547	6.938
Total N, g/kg DM					
Chopped	22.1	21.7	21.4	21.1	20.6
Derinded	22.1	21.7	21.4	21.1	20.9
N as vegetable protein, g/kg DM					
Chopped	3.55	4.36	5.18	5.59	6.37
Derinded	3.54	4.48	5.17	5.72	6.27
N as urea, % of total N					
Chopped	84	80	76	72	69
Derinded	84	79	76	73	70

[1] Fresh basis

Figure 2:
Relation between level of rice polishings and rate of live weight gain for chopped whole cane (open circles) and derinded cane (solid circles)

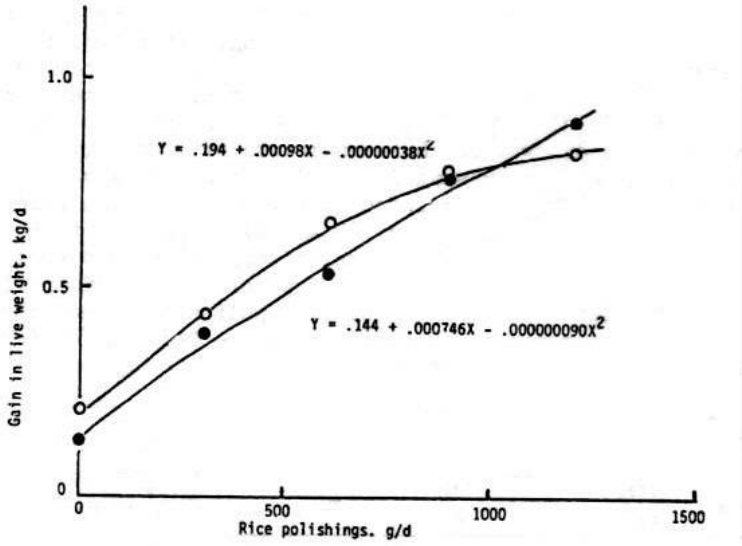
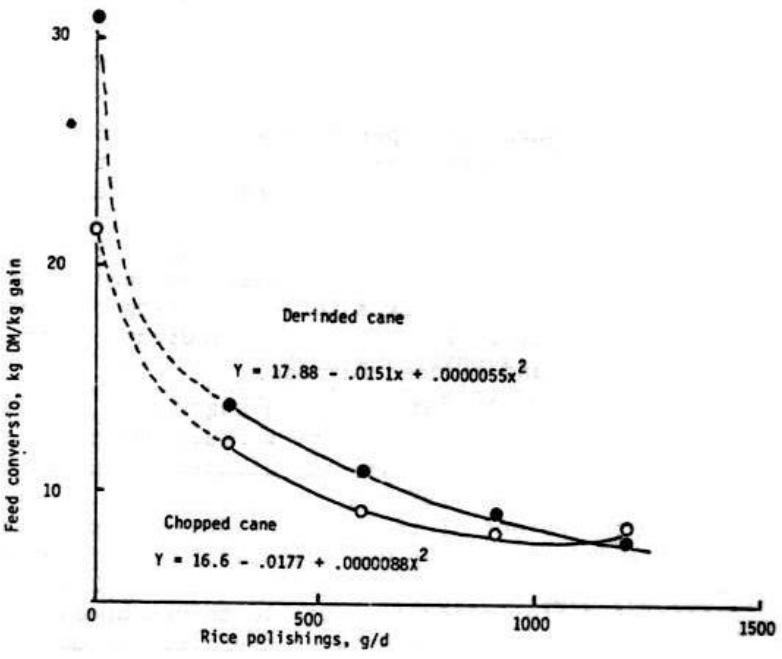


Figure 3:
Relation between level of rice polishing and feed conversion



Animal performance: The analysis of feed intake, live weight gain and feed conversion was made on the data (see table 2) from the complete group of animals on each subtreatment, adjusting regression curves by the method of least squares (figures 1, 2 and 3). In addition, an analysis of variance (table 3) was carried out on live weight gain, using the least squares method applied to data for individual animals (table 4).

There were no differences in intake of fresh cane or of total dry matter attributable to method of processing. In contrast, both these parameters increased in a linear fashion according to the intake of rice polishings. As was to be expected, the rate of live weight gain showed a similar tendency to the feed intake data; mean values increased by almost 400% between levels of 0 and 1,200 g/d of rice polishings. There was an indication of better live weight gain for chopped rather than derinded cane (P <.09). The effect of breed and of sex was significant (P <.06) in favour of crossbred rather than pure (12%) and intact males compared with steers (30% Feed conversion showed a different type of response improving very markedly between 0 and 300 g/d of rice polishings, and there after smaller improvements to the point of there being no difference between 900 and 1200 g/d of rice polishings.

Table 3 :
Analysis of variance for principal effects

Source	df	MS	Significance
Breed	1	0.2824	P<.006
Sex	1	0.2815	P<.006
Processing	1	0.1053	P<.090
Rice polishings	4	5.8619	P<.001
Residual	391	0.0365	

Carcass Characteristics: When the experiment was ended, 60 animals selected as the most finished, were taken some 500 km to the abattoir in Tabasco in Villa Hermosa. Certain parameters of the carcass were measured and compared with data taken from animals of similar genetic make up, which had been fattened on pasture according to the traditional method in the area (table 5). The animals fed sugar cane weighed less and showed a tendency for a better dressing percentage than those fattened on pasture. There were also indications of greater muscle development and reduced fatness.

The dressing percent of the cattle fed on sugar cane (51.3%), based on cold carcass and live weight in the corrals was slightly lower than was reported in Kenya (52.4%) for animals of the same breed fed a similar diet (Murder 1975).

With respect to the effect of treatment on dressing percent, in the first instance this parameter was adjusted for differences in final live weight (Y = 44.7 +.00168X; sb ±.0086; P <.06). There were significant differences attributable to sex/breed (P <.07). There was also a linear relationship between dressing percentage and level of rice polishings (Y = 49.5 +.00202X; sb = ±.001; P <.06).

Table 4:
Least squares constants for live weight gain (kg/day)

	Least squares Constants	Adjusted Means
Overall mean	5983	
Sex		
Intact males	.0316	.630
Steers	-.0316	.567
Breed		
Crossed	.0368	.636
Zebu	-.0368	.562
Processing		
Chopping	.0165	.615
Derinding	-.0165	.582
Rice polishings, g/d		
0	-.3737	.225
300	-.1528	.446
600	.0188	.617
900	.2100	.808
1200	.2977	.896

Discussion

It was surprising to find no significant difference between the two methods of processing the sugar cane. The implication is that there is some factor in the rind which compensates for its greater content of structural carbohydrate (Anon 1974) and its lower digestibility (Montpellier and Preston 1976a,b), compared with the pith. It has already been mentioned that owing to the method of

passing the entire sugar cane plant through the derinding machine there was a slight loss of leaf. In other experiments, improvements have been reported in voluntary intake and in live weight gain - although with deterioration in feed conversion - as the proportion of top (which includes the leaves) mixed with the chopped stalk was increased (Ferreiro and Preston 1976). However, there were no differences in voluntary intake or in feed conversion, between the two methods of processing in this experiment; in other words, it is highly improbable that there was any negative effect due to the slight loss of leaf in the derinding treatment.

The highest rate of live weight gain obtained in this experiment (900 g/d) was less than that reported by Donefer et al (1973) for a diet of derinded cane stalk plus 25% of tops, urea and protein. These authors reported live weight gains in Friesian steers of approximately 1 kg/day over an overall fattening period from 100 to 450 kg live weight. Results for a small group of Zebu steers were approximately 0.70 kg daily (James 1973). No data were given on the composition of the supplement and therefore it was impossible to calculate the exact amounts of urea and true protein which were used. However, it is probable that the levels of true protein supplied in the supplement was higher than that used in the present experiment (James 1975, personal communication).

A similar experiment to the one reported here was carried out in Kenya using a ration based on chopped whole sugar cane (contributing 70% of the total dry matter) supplemented with cotton seed meal at level equivalent to 8.94 g N/kg of DM and urea at 1.84 g N/kg (Murder 1975). Commercial Zebu cattle were used and the gain reported was 673 g/d during the first 70 days of the trial and 793 g/d over the total period of 105 days. These rates of gain are similar to ours although the composition of the nitrogenous fraction was different, being much higher in true protein and lower in urea.

In Australia, Siebert and Hunter (1975) compared chopped whole sugar cane supplemented with meat meal, Leucaena leucocephala or urea plus sodium sulphate. They used only 4 animals in individual pens on each treatment, and live weight gains were 550 and 290 g/d in 59 days for meat meal and Leucaena leucocephala, and 210 g/d in 87 days for the ration containing only non-protein nitrogen. The rate of gain for the urea/sulphate treatment was similar to that reported for the control treatment in the present experiment, while the results with meat meal were considerably inferior to those reported in the present experiment for the highest levels of rice polishings. Poor results with meat meal as a supplement for sugar cane were also reported by Preston and Bonaspetti (1974).

Table 5 :
Live weight at slaughter and dressing percent

	n	Live weight	Dressing %	
Breed/sex		kg	%	%[2]
Zebu bulls	12	410[b]	5l.7[a]	5l.6[a]
Zebu steers	33	396[c]	51.5[a]	51.9[a]
Crossbred bulls	9	412[b]	49.8[b]	49.7[b]
Crossbred steers	6	430[a]	51.5[a]	5l.6[a]
SEx		± 7.0	±.46	±.48
Processing				
Derinding	21	414[a]	51.7	51.5
Chopping	39	399[b]	51.1	51.4
Sex		± 5.1	±.34	±.34
Rice polishings				
600	8	392	50.7	50.9
900	2 1	401	51.3	51.4
1200	22	413	52.0	51.8
SEx		± 6.6	±.46	±.43

[1] Cold carcass/live weight at feedlot
[2] Adjusted for live weight at slaughter
[abc] Means in same column within principal treatments without common superscript differ at P<.05

In many aspects the fattening of cattle with sugar cane is similar to the use of high levels of final molasses as reported in Cuba (Munoz et al 1970). With this feed live weight gains of 885 g/d were obtained in commercial fattening systems with 22,000 animals. In this case, the amount of nitrogen as true protein was 12.9 (5.4 coming from final molasses) g/kg of DM and the urea nitrogen 14.0. The corresponding data for the present experiment with sugar cane were 6.37 g of N as vegetable protein and 14.2 as urea.

Table 6:
Carcass characteristics (X ± SE)

	Sugarcane	Pasture
Live weight, kg		
At feedlot	404 ± 3.7	_[1]
At abattoir	363 ± 2.6	383 ± 8.9
Cold carcass, kg	208 ± 2.4	213 ± 78
Dressing %		
Feedlot weight	51. 3 ±. 24	_[1]
Abattoir weight	57.2 ± 1.15	55.4±1.68
Longissimus dorsi		
Area, cm^2	265.2±1.87	61.5±3.06
Colour[2]	3.15 ±.096	3.55±.12
Fat Thickness, cm	.46 ±.052	.50±.10
Kidney fat, % of carcass wt	2.43 ±.16	_[1]

[1] No data available [2] Scale (light to dark)

With respect to the carcass data, dressing percentage was lower for sugar cane (52%) than would be expected with molasses (about 54%; see Preston et al 1971). The lower dressing percentage of intact males compared with steers is well documented (Preston and Willis 1974), however in this experiment the effect was only apparent in the cross-. bred animals. The tendency for dressing percentage to increase with level of rice polishings probably can be related to changes in the final products of digestion towards an increase in glucogenic precursors (see Leng and Preston 1976) since it is known that such effects are directly related with dressing percentage (Preston and Willis 1974).

The improvement in rate of gain in crossbred animals, derived from mating Zebu females with Bos taurus sires (Swiss and Holstein), and from the use of intact males as compared with castrates, is in agreement with results of many experiments carried out in temperate and tropical regions (Preston and Willis 1974).

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