THE EFFECT OF MOLASSES SUPPLEMENTS ON VOLUNTARY FEED INTAKE, LIVEWEIGHT GAIN AND RUMEN FUNCTION IN BULLS FED BASAL DIETS OF ENSILED SISAL PULP[1]

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Three experiments were carried out to evaluate the effects of molasses supplements in animals fed basal diets of ensiled sisal pulp. In the fires experiment Brown Swiss/Zebu cross bulls of approximately 260 kg initial liveweight were used in a random block design experiment to evaluate the effects of 0, 2, 4 and 6 kg of molasses/head/day when fed an ad libitum diet of ensiled pulp. The animals also received daily, 5 kg of leucaena forage, l kg of sunflower meal, 200 g of urea (as a solution mixed with the pulp) and minerals (50 g). The experiment lasted 105 days.

The second experiment was of similar design and duration using 16 bulls. The quantities of molasses as percentages of liveweight were 0, 0.33, 0.66 and 0.99.

In both experiments the daily liveweight gains were not affected by increasing the levels of molasses. There was however a reduction in intake of the ensiled pulp but overall dry matter intakes remained similar.

In the third experiment four ruminally fistulated bulls of 250 kg liveweight were used in a 4 x 4 latin square design experiment to evaluate the effects of the molasses supplements (0, 2, 4 and 6 kg molasses/day) on rumen function. Nylon bags containing samples of the dietary ingredients were placed in the rumen and removed at intervals over a period of 48 hours. The degradation rate WAS expressed as half life (T1).

The water-soluble marker polyethleneglycol (PEG) was used to measure rumen volume (litres),turnover rates (volumes/day) and outflow (litres/day). Each experimental period lasted 21 days for each molasses level. There was a significant increase in $T_{1/2}$ for sisal pulp degradation in the rumen but not for leucaena forage or sunflower meal, as the level of molasses intake increased. There were no significant differences in rumen function.

It was concluded that molasses should not be included in the diets for growing ruminants if sisal pulp is to be used as the basic energy source.

Key words: Sisal pulp, molasses, silage, rumen function, dacron bags, cattle, fattening

The principal limitation in the use of sisal (*Agave fourcroydes*)[3] byproducts as animal feed is the low protein content of the material. Godoy et al (1979a) and Herrera et al (1980) demonstrated that protein supplements improved liveweight gain considerably in cattle fed basal diets of ensiled sisal pulp. Moreover, Godoy et al (1979a) showed that supplements of fishmeal also produced dramatic increases in voluntary feed intake of the basal diet.

It has been suggested that another important limitation in the utilisation of sisal pulp is the low content of soluble sugars present in the material after the ensiling process. Reyes et al (unpublished data) found that fresh sisal pulp contains at least 10% soluble sugars (DM) but this falls to less than 1% after seven days. The rapid drop in soluble sugar content could be offset by the addition of aqueous ammonia (Godoy et al 1979b) but this product, however, could not be used on a commercial

[1] *This research was financed partly by a loan from FIRA, Banco de Mexico S A; the CONACYT Project for research on sisal by-products and the International Foundation for Science (IFS) under Research Arrangement: R242*

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[3] *Although referred to in this paper as "sisal", Agave fourcroydes is more correctly called Henequen*

scale due to its high cost. Subsequently, addition of anhydrous ammonia in a water/molasses mixture was used both as a preservative and to provide a source of Non Protein Nitrogen (NPN) and additional energy (Godoy et al 1979c).

The results of a brief feeding trial conducted to compare feed intake and liveweight gains in cattle fed sisal pulp ensiled with or without this addition showed there was significant improvement in performance in the animals fed the treated silage (Godoy et al 1979c). It was decided therefore to conduct several feeding trials in which additional energy supplements (as molasses) would be offered at the time of feeding the ensiled pulp thus eliminating the labour intensive process of mixing additives with the pulp in the silo.

Previous work (Herrera et al 1980) had shown that liveweight gains increased when supplements of leucaena forage and sunflower meal were offered to steers fed basal diets of ensiled sisal pulp. Consequently these supple meets were included in the experiments reported here. In order to evaluate the effects the molasses supplements had on rumen digestibility of the individual dietary components and the sisal pulp, the dacron bag technique of Mehrez and 0rskov (1977) was used in bulls equipped with permanent rumen fistulas.

Materials and Methods

Dietary treatments:

Experiment 1: Bulls were fed four levels of molasses supplements (0, 2, 4 and 6 kg/head/day) to a basal diet of ensiled sisal pulp. 5 kg(fresh weight) chopped leucaena leucocephala forage/head/day and 1 kg of sunflower meal (35% crude protein) were offered before the morning feed of ensiled pulp. A solution of urea in water (1 kg/litre) was mixed with the pulp at a rate of 8 g urea/kg of fresh material. A commercial mineral mixture was also sprinkled over the pulp (50 g/head/day) at the time of feeding.

Experiment 2: Four levels of molasses supplements were offered to another group of bulls but at a fixed percentage of their body weight in order to reduce the difference between the amounts of molasses fed. These levels were 0, 0.33, 0.66 and 0.99% of liveweight. The remaining dietary components were similar to those described previously in Experiment 1.

Experiment 3: This experiment was conducted concurrently with Experiment 1. The four dietary treatments described in Experiment 1 were offered to four bulls each equipped with permanent rumen fistulas.

Experimental design:

Experiments 1 and 2: A random block design with two replicates (4 animals per treatment) was used in these experiments. Two animals had to be removed from Experiment 1 during the adaptation period leaving only 14 animals. 16 animals were used throughout experiment 2. Both experiments lasted for 105 days after initial 45 day adaptation periods.

Experiment 3: A Latin square design experiment was chosen to evaluate the effects different molasses intakes had on rumen function and digestibility of the other three dietary components (sisal pulp, leucaena forage and sunflower meal). A 21 day adaptation period was used between different molasses levels.

Animals

Experiments 1 and 2: All the animals used in these growth trials were Zebu x Brown Swiss bulls of approximately 260 kg initial liveweight. The animals were treated against internal and external parasites and bovine rabies before the experiments started. During the experiments the animals were housed in open sided corrals (2 animals/corral) on slatted floors. Fresh water was available to the animals at all times.

Experiment 3: The four rumen fistulated bulls used in this experiment were also Zebu x Brown Swiss crosses of approximately 250 kg liveweight. The fistulas had been placed in the animals at least 6 months previously. Each animal was housed individually in pens similar to those described above.

Measurements

Experiments 1 and 2: The animals were weighed every three weeks during the growth trial. Intakes of ensiled sisal pulp were measured daily for each pair of animals.

Experiment 3: After a 21 day adaptation period during which intake of ensiled sisal pulp was measured daily the effect of level of molasses supplementation on rumen fermentation was determined.

Rumen volume (litres), turnover (times/day) and outflow (litres/day) were measured using polyethyleneglycol (PEG) as a marker (Priego et al 1977). Ammonia levels were also determined on aliquots of the rumen liquor removed for PEG determinations.

Quantities of ensiled sisal pulp, chopped leucaena forage and sunflower meal were dried et the beginning of the experiment and milled to pass through a 1 mm sieve. These samples were used in each period throughout the experiments to evaluate the effect the different levels of molasses supplements had on rumen digestibility.

Results

The mean liveweight gains and voluntary intakes of the animals in Experiment 1 are shown in Table 1. There were no significant differences in daily liveweight gain between dietary treatments. Although the voluntary intake of the ensiled pulp fell appreciably with increasing molasses supplementation, the overall dry matter intakes remained constant. The animals showed no signs of ill health during the trial.

The results of Experiment 2 (Table 2) confirmed the results obtained previously. The molasses supplements reduced intake of the ensiled pulp without any significant changes in overall dry matter intake. were also similar between daily treatments.

Table 1:

The effect of different levels of molasses on voluntary intake and liveweight gain in bulls fed a diet of ensiled sisal pulp

	Molasses (Kg/d)				$SE_{\bar{x}}$
	0 [1]	2	4	6	
Liveweight gain g/d	600	690	651	672	±.117
Intake, kg/d					
Sisal pulp silage	21.3	10.4	5.9	6.7	± 2.45
Total DM	7.0	6.5	7.0	8.8	± .49
Consumption Index [2]	2.4	2.1	2.4	3.1	± .32
Feed conversion [3]	11.7	9.3	10.8	13.2	± 2.67

[1] This treatment was not replicated and not included in the analysis

[2] Kg DM/100 kg liveweight /d

[3] Kg DM consumed/kg liveweight gain/ d

Table 2:

Effect of molasses level on daily liveweight gain and intake of bulls fed ensiled sisal

	Molasses (kg/100 kg liveweight/day)				
	0	.33	.66	.99	$SE_{\bar{x}}$
Liveweight gain g/d	698	519	478	525	±84
Sisal pulp silage	20.99	11.93	11.19	6 02	± 3.29
Total DM	7.13	6.26	7.14	6.99	± 0.78
Consumption index [1]	1.98	1.72	1.90	1.93	± 0.11
Feed conversion [2]	10.3	12.1	14.8	12.9	± 3.4

[1] kg DM/100kg liveweight/d

[2] kg DM consumed (kg liveweight/d)

The results relating to the effect of molasses supplements on rumen function are presented in Table 3. There were no significant effects on rumen outflow or volume although "between animal" variation was considerable. Rumen ammonia levels (ma NH3/100 ml rumen liquor) were constant between the dietary treatments.

Table 3:
Effect of molasses level on rumen function and digestibility in bulls fed a basal diet of ensiled sisal pulp

	Molasses, kg/d				
	0	2	4	6	$SE_{\bar{x}}$
Half time ($T_{1/2}$) for DM loss, hr					
Ensiled sisal pulp	28	29	66	114	±15.6
Leucaena forage	68	81	92	82	±8.4
Sunflower meal	64	61	66	78	±5.4
Rumen function					
Liquid volume, litres	52	41	43	42	±4.2
Turnover rate, volumes/d	1.65	2.13	1.66	2.69	±0.75
Outflow rate, litres/d	83	104	95	86	±8.4
Rumen ammonia, mg NH_3-N/ 100 ml	28.3	38.4	37.1	32.4	±4.2

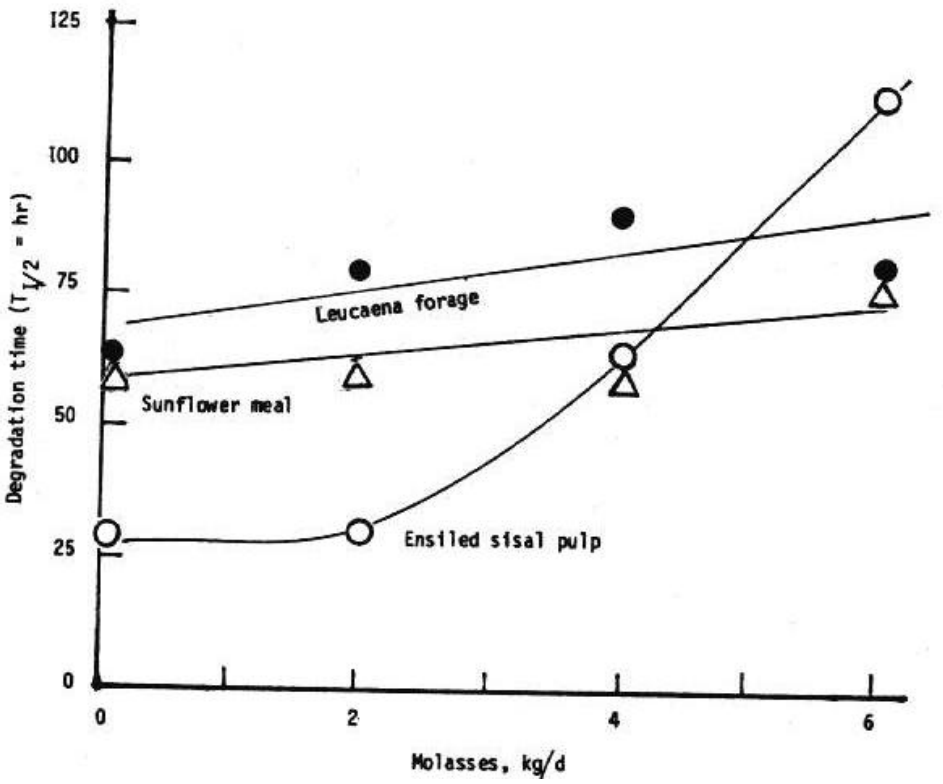
There was,however,a marked increase in the time taken to degrade sisal pulp in the rumen (Figure 1). The half life of the pulp increased significantly as the level of molasses supplementation increased. Although the half life of the leucaena forage and sunflower meal also increased these were not so badly affected as the sisal pulp and no significant differences were observed.

Discussion

Urea/molasses supplements have been used frequently in attempts to increase the nutrient intake of animals grazing pastures containing dead herbage (Loosli and McDonald 1968). However the responses to the various components of urea/ molasses supplements ie nitrogen, energy and minerals has been confounded by environmental conditions in most experiments. Nolan et al (1975) concluded that most of the response by sheep grazing dry annual pastures to urea/ molasses supplements was due to the energy portion of the supplement. A similar conclusion was obtained by Mulholland and Coombs (1979).

However, an earlier study by Leng et al(l973) concluded that molasses alone as a supplement failed to produce any liveweight response. Hennessey et al (1978),in a study of urea/molasses mixtures for beef cattle fed a basal diet of extremely low

Figure 1:
Effect of amount of supplementary molasses in a basal diet of ensiled sisal pulp on degradation of pulp, leucaena forage and sunflower meal suspended in dacron bags in in the rumen (curves are hand-drawn)



quality grass, concluded that molasses alone may be deleterious as it has been shown to depress intake of the basal diet. In contrast, however, Ernst et al (1975) obtained increased intake of native grass pasture hay of 27.8% and 65% with supplements of molasses and urea/molasses respectively in growing steers.

A significant depression in sisal pulp intake was observed in experiments reported here (Tables 1 and 2). This depression was most marked at levels of molasses intake in excess of 2 kg/head/day. Overall dry matter intakes however were remarkably similar between the daily treatments emphasising the substitution effect caused by the molasses intakes. There was no response in liveweight gain between the dietary treatments. Similar responses were obtained in steers by Ahmed and Kay (1975).

An important feature of the data concerning rumen function reported here (Figure 1) was the dramatic reduction in degradation rate of ensiled sisal pulp in the rumen as the level of molasses supplement increased.

It has been suggested for some time that rumen ammonia would be used by micro organisms fermenting the rapidly available sugars rather than by those organisms fermenting the structural carbohydrates of pasture (Hungate 1967). In this way,molasses given as an energy supplement may depress fibre digestion and therefore forage intake (Ahmed and Kay 1975). It may be for this reason that Holroyd et al (1977) and Winks et al (1979) considered the NPN component of a molasses/ urea supplement to be the crucial factor in the mixture responsible for improved animal performance.

Although urea was not included in the molasses supplement in the experiments reported here it was mixed in with the sisal pulp. There was also a substantial quantity of N in the diet coming from the leucaena forage and sunflower meal, but rumen ammonia levels were remarkable similar on all dietary treatments. Rumen turnover rates and outflows were also similar on all dietary treatments.

Conclusions

In conclusion, therefore, it appears to be disadvantageous to use sugar rich supplements such as molasses in diets based on ensiled sisal pulp. Such supplements would only result in dietary substitution by the animal, with reduced intake of the basal diet. The results of the growth trials (experiments 1 and 2) do illustrate, however, the potential of sisal pulp in combination with a forage source such as leucaena and a protein meal as the basis for an economically v-table intensive beef production system.

Whether or not the inclusion of a NPN/molasses additive at the moment of ensiling sisal pulp confers other nutritional advantages has yet to be verified. However the lack of a suitable simple method of mixing additives with the sisal pulp is restricting further investigation in this area.

References

Ahmed F A & Kay M 1975 A note on the value of molasses and tapioca as energy supplements to forage for-growing steers Animal Production 21 :191-195

Ernst A J, Limpur J F & O'Rourke DK 1975 Effects of supplements of molasses and urea on intake and digestibility of native pastures hay by steers Australian Journal of Experimental Agriculture and Animal husbandry 15:451 458

Godoy 8, Elliott R i Preston T R 1979a Byproducts of the sisal industry as cattle feed: effect of ground sorghum, fishmeal or rice polishings in cattle given diets based on sisal bagasse and ensiled sisal pulp Tropical Animal Production 4 :268-275

Godoy R, Elliott R & Preston T R 1979b The effects of ammonium hydroxide upon the total soluble sugar contents and pH of ensiled pulp-and bagasse Tropical Animal Production 4:94 (abs)

Godoy R, Herrera F, Carcano R, Elliott R & Preston T R 1979c Preliminary observations on the use of anhydrous ammonia with and without molasses for the preservation and utilization if ensiled sisal pulp Tropical Animal Production 4:268-275

Hennessy D W, Nolan J V, Noron B W, Ball F M & Leng R A 1978 Response of beef cattle to infused supplements of urea and of urea molasses when offered a low quality grass Australian Journal of Experimental Agriculture and Animal Husbandry 18:477-478

Herrera F, Whyllie D & Preston T R 1980 Fattening steers on a basal diet of ensiled sisal pulp and molasses/urea supplemented with sunflower meal and leucaena forage Tropical Animal Production 5:18-24

Holroyd R G, Allen P J & O'Rourke D K 1977 Effect of pasture type and supplementary feeding on the reproductive performance of cattle in the try tropics of North Queensland Australian Journal of Experimental Agriculture and Animal Husbandry 17:197-203

Hungate R W 1967 The rumen and its Microbes Academic Press New York

Leng R A. Murray R M, Nolan J V,& Norton B W 1973 Supplementing grazing ruminants with urea/molasses mixture Australian Meat Research Committee Review No 15:1-15

Loosli J K & McDonald I W 1968 Non protein nitrogen in the nutrition of the ruminant FAO Agricultural studies No 75

Mehrez O E & Orskov E R 1977 A study of the artificial fibre bag technique for determining the digestibility of feeds in the rumen Journal of Agricultural Science (Cambridge) 88:645-650

Mulholland J G & Coombs J B 1979 Supplementation of sheep grazing wheat stubble with urea, molasses and minerals Quality of diet, intake of supplements and animal response Australian Journal of Experimental Agriculture and Animal Husbandry 19:23-31

Nolan J V, Norton B W, Murray R M, Ball F M, Rosiby F 1!B, Rohan-Jones Hill M K & Leng R A 1975 Body weight and wool production in grazing sheep given access to a supplement of urea and molasses: intake of supplement, response relationships Journal of Agricultural Science (Cambridge) 84:39-48

Priego A, Wilson A & Sutherland T M 1977 The effect on parameters of rumen fermentation, rumen volume and fluid flow rate of Zebu bulls given chopped sugar cane supplemented with rice polishings or cassava root meal Tropical Animal Production 2:292-299

Winks L, Leng R A, O'Rourke P K & Wright G S 1979 Factors affecting response to urea/ molasses supplements by yearling cattle in Tropical Queensland Australian Journal of Experimental Agriculture and Animal Husbandry 19:522-529

Received January 10 1981