COMPARISON OF LEUCAENA LEUCOCEPHALA AND GROUNDNUT CAKE AS PROTEIN SOURCES FOR BEEF CATTLE FED AD LIBITUM MOLASSES/UREA IN MAURITIUS[1]

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30 individually fed Creole or Creole x Friesian bulls of 80 to 300 kg live weight and aged 1 to 2 years were used to compare 5 treatments in a trial lasting 14 weeks. Treatments 1 to 3 involved supplementing molasses containing 3% urea given ad libitum with fresh Leucaena leucocephala at 2%, 3.5% or 4.6% (ad libitum)of live weight daily. Treatments 4 and 5 were designed to provide protein and crude fibre intakes equal to treatments 1 and 3 respectively using groundnut cake and Ischaemum aristatum. All animals received mineral mixture (50% Sodium Chloride and 50% Dicalcium Phosphate) ad libitum. Intake of groundnut cake was lower than planned no that protein intakes of treatments 1 and 5 were equal. Average growth rates for treatments 1 to 5 were 0.791, 0.737, 0.848, 0.595 and 0.744 kg/d. It is concluded that the optimum feeding rate of fresh Leucaena for maximising gain n and molasses intake is 2.0% of live weight daily and that it appears to be a satisfactory protein and fibre source.

Key words: Cattle, molasses/urea, leucaena, groundnut cake, growth

The legume shrub Leucaena leucocephala has been widely used in Mauritius as a combined source of protein and roughage in molasses/urea based dicta (see Preston 1974), however, there are no published data in the scientific literature concerning the optimum amount that should be fed, or its relative value compared with other proteins such as groundnut cake or fish meal.

The objectives of the present study were to determine the level of leuceana that would maximise the rate of live weight gain and to compare it with groundnut cake as a source of protein in a diet of molasses/urea for beef cattle.

Materials and Methods

Treatments and Design: 5 dietary treatments were compared in a randomised block design with 6 replicates. The treatments were:

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[1] Some of the results of this experiment were published at the 2nd International Conference on Sugar Cane as Livestock Feed, Morelos, Mexico, 28-27 1978. The data form part of a thesis submitted by the senior author for the degree of M Phil at the University of Reading

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1. Fresh leucaena at 2% live weight (2% leucaena)
2. Ad libitum fresh leucaena (ad lib leucaena)
3. Fresh leucaena at level mid-way between (1) and (2) (mid-leucaena)
4. Groundnut cake and bagasse to supply the same amount of nitrogen (N) and crude fibre as the 2% leucaena treatment (2% GNC)
5. Groundnut cake and bagasse to supply the same amount of N and crude fibre as the ad libitum leucaena treatment (ad lib GNC)

These dietary treatments were supplements to a basal diet of molasses containing 3% urea, minerals (equal parts dicalcium phosphate and sodium chloride) and water, all of which were freely available.

Animals on the 2% GNC and ad lib GNC treatments received vitamins A, D and E by intramuscular injection of a vitamin mixture (Vita-Veto), which contained 10,000,000 I U vitamin A, 10,000,000 I U vitamin D and 2.5 g vitamin E per vial of 50 ml. Every 14 days each animal was given 4-5 ml depending on its weight. Leucaena was assumed to supply the necessary vitamins in the other treatments (1) to (3).

Animals: Bulls of 1 to 2 years of age, weighing between 80 and 300 kg were randomly allocated to treatments within blocks based on their initial weight. Initial weight was a mean of three separate weighings taken on three different days during the week prior to the start of the preliminary period of the experiment. The bulls were of mixed breeds (Hereford x Friesian, Creole and Creole x Friesian). Before the trial was started they were drenched with Nilverm (ICI Ltd) to eliminate any worm infestation.

Procedure: The experiment was conducted at the Farm of the Mauritius Government Prison Services and lasted 18 weeks (from 1-2-77 to 6-6-77) which included 4 weeks preliminary feeding for the animals to get used to the diet and to determine the leucaena ad libitum feeding level.

The animals were previously on a diet of molasses/urea, grass, maize grain and fish meal. An 8 day period was allowed for the change-over from the previous diet to the experimental diet. During the first two days the animals were fed 25% of their experimental diet, the 3rd and 4th days 50%, the 5th and 6th days 75% and from the 7th day they received the experimental diet. This change-over period formed part of the preliminary feeding.

The animals were individually fed and housed in a closed shed, the roof of which was covered with corrugated iron sheets. The windows were fitted with fine wire netting in order to exclude the fly Stomoxys nigra. The floor was of concrete. The animals were neck-tied with ropes.

Feeding was done once each day, in the morning, just after the shed was cleaned. The molasses (78% DM and 0.9% N in DM) was mixed daily with 3% urea (46% N) before feeding. The required amount of urea was dissolved in an equal weight of water before it was added to the molasses.

During the preliminary period it was found that bagasse was not readily consumed by 8 out of 12 animals. Consequently it was decided to feed-a poor quality grass (Ischnemum aristatum) to replace the fibre that bagasse supplied. Animals on the two bagasse treatments were therefore getting Ischaemum aristatum (at the level of crude fibre that leucaena would have supplied) from the beginning of week one of the experimental period until the end of the trial

During the 4 weeks of preliminary feeding animals on the ad lib leucaena treatment consumed 4.7 to 5% of their live weight of fresh leucaena daily. Consequently from the beginning of the experimental period animals on the ad lib leucaena treatment were fed the forage at 5% of their live weight and this continued until the end of the trial. Animals on the mid leucaena treatment were therefore fed leucaena at 3.5% LW.

Leucaena was hand-cut daily from established hedges found on experimental stations of the Ministry of Agriculture. The hedges were more than 20 yr old and they had been regularly trimmed to heights of 1.5-1.9 and widths of 0.7 to 0.9 m. The part cut for feeding wag that judged to be consumed by the grazing animal, i.e. material of 45 cm length from the growing tip of a branch.

Ischaemum aristatum was hand cut from waste lands belonging to the Government. The length of the grass varied from 75 to 100 cm and it wee fed as such.

Chemical Analysis: In order to adjust feed allowances, leucaena was analysed weekly for DM, N and crude fibre (table 1). Ischaemum was not analysed weekly but representative samples of what was fed were periodically analysed for DM, N and crude fibre since the grass was cut from the same field for 2 or 3 weeks. These analyses were undertaken by the Chemistry Division, Ministry of Agriculture.

Representative samples of leucaena and groundnut were analysed at Reading University. Total N wee determined by the Kjeldahl method. For protein N the samples were first extracted with 100 ml of a 10% solution of trichloroacetic acid (TCA), filtered and N determined on the residue. Ether extract and ash were determined by the methods outlined by AOAC (1965). Neutral detergent fibre, acid detergent fibre and lignin determinations were according to the methods of Goering and Van Soest (1970). Analyses for calcium and magnesium were by atomic absorption using an Atomspek H1550; sodium and potassium were determined by emission spectrophotometry using a flame photometer and phosphorous by colorimetry, using an auto analyser. Gross energy determinations were done using a Gallenkamp adiobatic bomb calorimeter. The Folin-Denis method (Burns 1963) wee used to determine tannin (as tannic acid equivalent) in leucaena

Statistical analysis: The data were analysed as a randomized block with four missing values according to standard procedures (Snedecor and Cochran 1969; Cochran & Cox 1957).Live weight gains were calculated from the regression of live weight on time.

Table 1:
Mean content of dry matter, nitrogen and crude fibre in the supplements during the trial

		Dry matter	Nitrogen	Crude fibre
Leucaena		%	%in DM	
Weeks	1-3	27.1	3.81	24.9
	4-10	28.0	3.60	28.9
	11-14	34.2	3.10	30.9
Groundnut cake		92.1	8.16	4.4
Ischaemum aristatum		47.2	.61	37.3

[1] Obtained from Richelieu weeks 1-3 Reduit weeks 4-10 and Barkly weeks 11-14

Table 2:
Chemical composition of representative samples of leucaena and groundnut cake (% in DM)

	Source of leucaena			
	Richelieu	Reduit	Barkly	Groundnut cake
Total N	3.68	3.91	3.75	6.95
Protein N	2.76	3.13	2.91	6.35
Ether extract	-	3.51	3.26	8.53
Ash	7.22	7.00	6.62	6.00
NDF	42.0	37.0	38.1	16.4
ADF	34.6	34.1	36.1	*
Hemicellulose	7.40	2.88	2.01	*
Cellulose	25.7	21.1	21.7	*
Lignin	11.7	10.7	10.8	*
Calcium	0.93	1.20	1.31	2.04
Phosphorus	0.38	0.29	0.25	0.39
Potassium	2.11	1.66	1.54	1.63
Sodium	0.08	0.10	0.08	0.03
Magnesium	0.34	0.44	0.48	0.55
Chloride	0.19	0.17	0.15	0.03
Silica	2.27	2.21	3.56	*
Tannic acid	0.15	0.14	0.14	0.05
Gross energy, MJ/kg DM	18.3	18.7	19.0	20.3

* Not determined
[1] The leucaena was brought from Mauritius in a blast frozen condition and all the analyses were done with freeze-dried samples. Groundnut cake was not freeze dried.

Results

Nutritive value of feeds: There was a slight increase in DM and fibre and a decrease in N content (table 1) of the leucaena during the 14 weeks of the trial Leucaena contained three times more tannin than groundnut cake; the calcium to phosphorus ratio in both was approximately 4:1. In vitro digestibility coefficients (table 3) appeared to be higher with freeze-dried than with oven-dried leucaena; but, these analyses were carried out at different times, although it was the same original sample of leucaena. Groundnut cake was much more soluble in rumen liquor in vitro than leucaena.

Animal Health: On day 19 of the experimental period one animal in the ad lib leucaena treatment died. The death was apparently not due to urea, molasses or mimosine toxicity; the exact cause could not be determined. The other animals were in good health throughout the trial. There were no obvious cases of urea, molasses or mimosine toxicity.

Table 3:
Mean values for in-vitro digestibility coefficients of leucaena and GNC and for ammonia evolved during digestion in-vitro (x±SEx)

	Digestibility (%)[1]		
	Organic matter	Dry matter	NH_3-N (mg/100ml)[2]
Oven-dried leucaena[3]			
Richelieu	45.8 ± .10	49.5 ± .10	
Reduit	55.6 ± .9	59.9 ± 2.5	60 ± 8.5
Barkly	51.0 ± 30	54.2 ± .20	45 ± 9.0
Oven-dried groundnut cake	73.3 ± 1.0	73.6 ± .10	360 ± 59
Freeze-dried leucaena			
Richelieu	54.9 ± 0.50	59.4 ± 1.0	
Reduit	59.2 ± 1.1	61.9 ± .50	
Barkly	56.2 ± 0.7	57.8 ± 1.0	

[1] By the method of Tilley & Terry (1963
[2] Determined in vitro adding the sample to rumen fluid and measuring NH_3 concentration after 1 hr
[3] From the three experimental stations named in the text

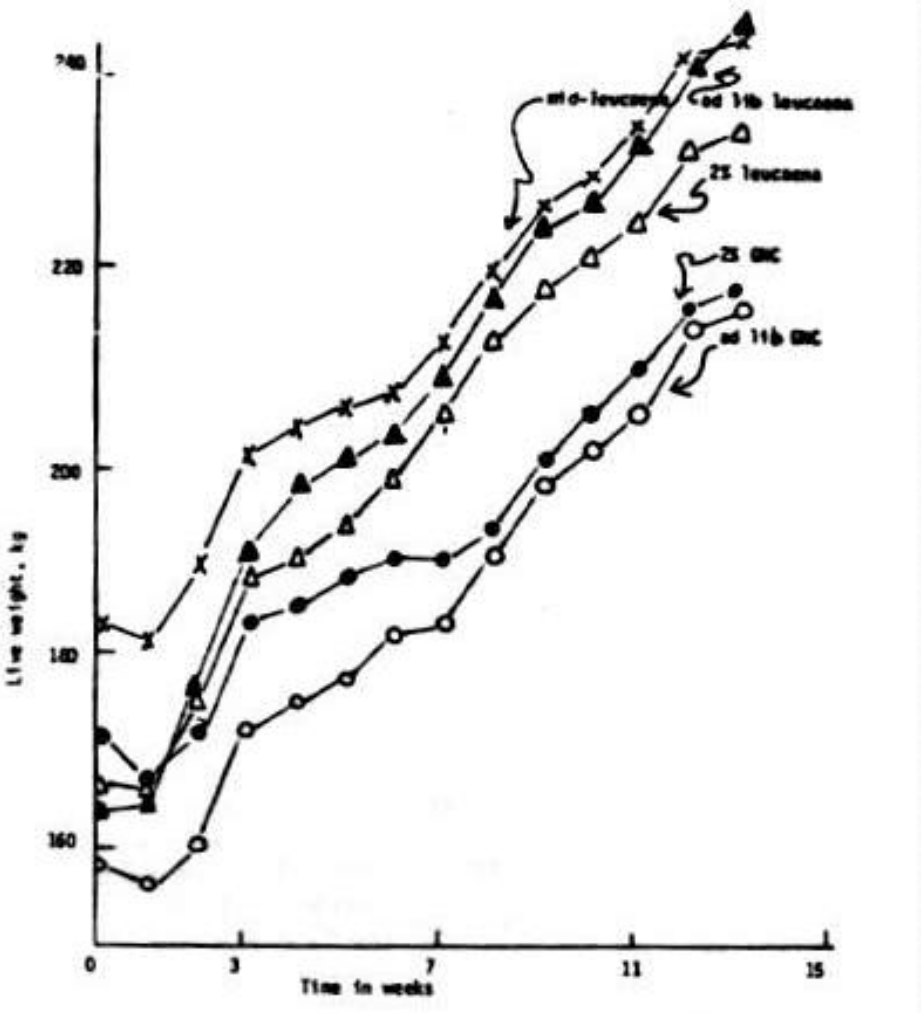
Throughout the trial, three animals (one on each of the treatments of mid-leucaena, 2% GNC and ad lib GNC) were not eating well ad their performance was below the average for the respective treatments. The two animals on the GNC treatments (2% and ad lib GNC) used to leave part of their groundnut cake uneaten every day. The data (growth rates and intakes) were therefore analysed with 4 missing values (one dead animal and 3 not growing well).

Growth rates: As there was a large range (80-300 kg) in the initial weights of the animals, the data for live weight gains are presented (table 4) with and without adjustment for initial weight by covariance analyses. The pattern of live weight change during the 14 weeks on trial is shown in figure 1.

Animals on the treatment 2% GNC grew at a significantly ($P < .05$) slower rate then the animals receiving leucaena, but the difference in growth rates of the animals on the 2% GNC and ad lib GNC treatments (0.595 and 0.744 kg/day respectively) did not reach significance. The growth rates of the animals consuming different amounts of leucaena were not significantly different.

Feed intake: The data in table 4 were obtained after adjustment by covariance for differences in initial weight and for missing values. Animals consuming leucaena ate more molasses and more total DM than those receiving groundnut cake and the Ischaemum forage. Although it was planned that the comparisons between groundnut cake and leucaena should be isonitrogenous, in fact, due to poor consumption, the amounts of total nitrogen consumed were less for the GNC treatments then for leucaena, Nevertheless, even at the lowest level of intake (on the 2% GNC treatment) the amounts of nitrogen and of protein were above theoretical requirements (2.8 g N/100 g DM consumed, or 3.6 g N/100 g of digestible DM; assuming a digestibility of the molasses diet of 74%, Martin et al 1968a).

Figure 1:
Live weight change time for the different treatment groups



Discussion

In molasses-based diets, where intakes/of molasses were between 60 and 80% of the dietary energy, the growth rates of beef cattle were between 0.7 and 0.8 kg/d in trials carried out in Cuba (Preston et al 1967; Martin et al 1968b;Elias et al 1969). In these trials, the protein supplement was mainly fishmeal and the roughage was either elephant grass (Penisetum purpureum) or sorghum (Sorghum vulgare) forage. The results of the present trial indicate that leucaena forage is able to provide both the roughage and bypass protein needed for growth rates of about 0.7 to 0.8 kg/d.

Table 4:
Live weight change (regression of weight on time), feed intake and conversion for young bulls fed ad libitum molasses/urea and leucaena or groundnut cake

Protein source	Leucaena			Groundnut cake		SE diff	Probability
Feeding level	2%	mid	ad lib	2%	ad lib		of "F" test
No of animals[1]	6	5	5	5	5		
Live weight, kg							
Initial	159	182	163	172	157	15	
Final	232	244	246	219	217		
Daily gain (unad)	.790	.740	.847	.597	.742	.076	.05
Daily gain (adj[2])	.791	.737	.848	.595	.744	.076	.05
Dry matter intake, kg/d							
Total	6.71	7.24	8.02	5.10	6.89	.47	.001
Molasses	5.30	4.95	5.04	3.74	3.61	.39	.001
Leucaena	1.17	2.21	2.83	-	-		
Ischaemum[3]	-	-	-	.92	2.11		
Groundnut cake	-	-	-	.44	1.17		
N X 6.25	1.16	1.31	1.44	.88	1.17	.098.	.01
Consumption index[4]	3.43	3.40	3.92	2.61	3.69	.12	
Molasses as % DM	79	68	62	73	53	1.91	.01
Conversion[5]	9.18	12.2	9.73	10.5	10.4	1.2	

[1] Statistical analyses were done with 4 missing values
[2] Adjusted by covariance for differences in initial weight
[3] Animals receiving groundnut cake had Ischaemum as forage source
[4] kg DM/100 kg Live weight
[5] kg DM/kg gain in live weight

There was no apparent response to level of leucaena forage and it can be tentatively concluded that giving this at the level of 2% of body weight (fresh basis) is likely to be the moat economical and convenient in commercial practice.

Although true protein levels were not strictly comparable as between the treatments of leucaena and corresponding levels of GNC, nevertheless intakes were theoretically sufficient for a growth rate of 0.8 kg/d (ARC 1965), it can be concluded therefore that the leucaena is a better protein source than groundnut cake for molasses-based dicta. The lower level of rumen ammonia associated with in vitro fermentation of leucaena compared with groundnut cake (table 3) supports this conclusion indicating that the degradability of groundnut cake is considerably greater than that of leucaena.

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