LEUCAENA LEUCOCEPHALA FOR MILK PRODUCTION: EFFECT OF SUPPLEMENTATION WITH LEUCAENA ON COWS GRAZING GRASS PASTURES[1]

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Twenty-four Jersey cows in their second lactation and grazing well fertilized pasture were allocated to six groups of four animals. Four dietary treatments were imposed according to a 4 x 4 Latin square design, each group of four cows comprising one replicate. Periods were of 14 d, and the last 5 were used for measurement. The four treatments were: (I) Control: pasture alone; (ii) pasture plus 250 g/d formaline treated casein; (iii) pasture plus 2 kg/d Leucaena leucocephala forage; and (iv) pasture plus 4 kg/d Leucaena leucocephala forage. supplementation had a small but significant (P<.01) effect on milk production which was 9.6, 10.1, 10.3 and 10.3 ±.10 litres/d for the Control and 3 supplemented treatments respectively. The butterfat and solids-not-fat content of the milk were not affected. Protein content was slightly but significantly (P<.01) reduced by the leucaena treatments (3.70, 3.80, 3.64 and 3.64 ±.02% respectively). Expressed as daily yields, supplementation increase butterfat, protein and soluble-no-fat production by small but significant amounts as: 470, 504, 502 and 503 ± 7.1; 356, 385, 374 and 374 ± 3.2; and 873, 927, 933 and 933±10.6 g/d respectively for the control, formal-casein and two leucaena treatments. It is concluded that Leucaena leucocephala could usefully be used to supplement dairy cows in tropical conditions.

Key Words: Cows, milk production, pasture, Leucaena leucocephala

Well fed Boa taurus cows and their crosses are capable of high milk production in the tropics (Topps and 0liver 1950; Holder 1967; Marples Trial 1967; Phipps 1973). However, to achieve these high levels of production, large quantities of concentrate feeds have usually been used. Animals were thus using foodstuffs that could have been used for direct human consumption. If milk is to be made available in the tropics at prices that people can afford, then more attention needs to be given to producing milk from local feeds that are cheaper than grain.

Pastures suitable for dairy production exist in large areas of the moist tropics, using land not required for crop production for direct human consumption (Hutton 1970; Stobbs and Thompson 1975). However, lactation yields of cows grazing solely on tropical pastures are low compared with those achieved in temperate countries (Stobbs 1976). Level of milk production is basically determined by the daily intake of net energy, but maximum intake and performance is only achieved when the diet contains sufficient protein minerals and vitamins. The protein content in particular of tropical pastures is generally lower than that of temperate species (French 1957).

Feeding standards suggest that cows producing less than 20 kg milk/d require a diet containing 11.5% crude protein in dry matter (DM) (Thomas 1971). Moreover, Stobbs et al (1977) showed that cows grazing nitrogen fertilized areas pasture containing 20% crude protein (CP) in DM, produced 20% more milk when

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supplemented with casein protected by formaldehyde. Feeding formal-casein is an impractical and uneconomical way of providing protein, and the objective of this study was to measure the response of cows grazing young nitrogen fertilized pasture to small quantities of a high protein legume.

Materials and Methods

Animals, Treatments and Design: Twenty-four Jersey cows of about 350 kg, in their second lactation, and which had calved 6-17 weeks previously, were used. They were allocated to 6 groups of 4 cows by weight and stage of lactation. Four dietary treatments were imposed according to a Latin square design, and the squares were thus repeated 6 times, each group of cows consisting of one replicate. The dietary treatments were:

(1) Pasture alone (Control)
(2) Pasture plus 250 g formal-casein/d in 0.5 litres of water (Formal-casein)
(3) Pasture plus 2 kg fresh Leucaena leucocephala forage/d (2 Leucaena)
(4) Pasture plus 4 kg fresh Leucaena leucocephala forage/d (4 Leucaena).

Experimental periods were of 14 d; 9 d adaptation and 5 d measurement.

Management and Procedures

Pastures: Well established pastures of Rhodes grass (Chloris gayana cv. Pioneer) which had received 250 kg/ha/year single superphosphate, and 250 kg/ha/year nitrogen, during the main growing season prior to the experiment were used. The area was divided into 6 plots, each receiving 100 kg N/ha as urea 3 weeks before the start of the experiment, and the same amount every 4 weeks thereafter.

Legume: Leucaena leucocephala (Cultivar Peru) which had been cut to ground level 3 months previously, and fertilized with 250 kg single superphosphate and 120 kg potassium chloride/ha, was harvested at a height of 1.5 - 2.0 metres. Leaves, stem (4 mm diameter) and green pods were collected 1-2 d before feeding and stored at 5°C.

Protection of Casein: A 10% solution of formaldehyde was sprayed into a revolving feed mixer containing 100 kg casein, at a rate of 0.1 litre/kg casein. The formaldehyde treated casein was then kept in open plastic container for 24 hr before being dried for 16 hr at 50°C in a forced fraught oven and stored in sealed plastic bags until use. Degradation by rumen bacteria (in vitro) was measured using the method of Ferguson et al (1967).

Management: The pastures were rotationally grazed so as to provide 3 weeks for regrowth of herbage. All cows grazed together and each day were allocated a fresh strip of pasture containing not less than 40 kg DM/cow/d. Water was provided at all times in the pasture. The cows were milked twice daily (06.30 -07.30 and 15.30 - 16.30 fur). The supplements were given after the morning milling. Cows on the Formal-casein treatment were dosed using a 2.5 litre bottle filled with a polyethylene pipe 20 cm long and 5 cm in diameter. The leucaena was fed to cows in individual pens and was eaten in less than 1 hr. The cows on the Control treatment remained in the yard while the supplements were being fed to the other cows.

Milk Yield and Composition: The yield of individual cows was recorded and a 1% aliquot taken at each milking. The samples were bulked (within cows) for each period and analysed for fat by the TeSa method for total solids (AOAC 1965), and SNF was obtained by difference. Protein was measured with amido black (Pro-milk) standardised by the Kjeldahl method (N x 6.38).

Forage Composition: Samples of pasture were taken from each pasture plot, four 0.5 m quadrats being taken during the first 3 d of each measurement period. Three non-lactating Jersey cows fitted with oesophageal fistulae were also used to obtain samples. Samples were analysed for nitrogen, organic matter, nitrogen solubility in mineral buffer (Burroughs et al 1950) and in vitro digestibility (Minson and McLeod 1972).

Results

Composition of Forage and Supplements: It was evident from the higher value for N of the sample obtained from the oesophageal fistulated animals that the cows selected a diet higher in N (Table 1). The herbage selected by the cows contained an

Table 1: Composition of Rhodes grass pasture and Leucaena leucocephala used in the experiment

	Pasture		Leucaena
	By cutting	Oesophageal fistula	By cutting
Crude protein, %DM	14.9	18.2	23.0
Protein solubility %[1]	31.8	-	21.1
Digestibility OM, %[2]	61.9	62.5	63.0

[1] Determined using mineral buffer (Burroughs et al 1950)
[2] Organic matter digestibility in vitro (Minson and McLeod 1972)

average of 87% leaf, 11% stem and 2% senescent material. Crude protein solubility was significantly different (P< .01) between the N fertilized pastures and leucaena herbage (31.8 vs 21.1% DM). Only 4.5% of the formal-casein was deaminated by rumen micro-organises in vitro compared with 82.8% for untreated casein.

Milk Yield and Composition: These are shown in Table 2. There was an increase in milk production (P <.001) by the supplemented cows compared with the Control. Treatment with formal-casein gave an increase of 5% and that of leucaena 7%. There were no differences between the two levels of leucaena supplementation. Supplementation with formal-casein increased milk protein concentration (P <.01), whereas the leucaena decreased milk protein concentration (P< .05). There were no other effects on milk composition. However, when the data are expressed as yield, then both formal-casein and leucaena increased butterfat (P<.01), protein (P <.001)

Table 2:
Milk yield of Jersey cows grazing nitrogen fertilized Rhodes grass (Chloris gayana) and supplemented with 250 g formal-casein or 2 or 4 kg of Leucaena leucocephala (means of 24)

	Control	Formal casein	2 leucaena	4 leucaena	SEx	P[1]
Milk yield, litres/d	9.6	10.1	10.3	10.3	0.10	***
Butterfat,%	4.9	5.0	4.9	4.9	0.06	NS
Protein %[2]	3.70	3.80	3.64	3.64	0.02	***
Solids-not-fat %	9.10	9.14	9.08	9.08	0.05	NS
Butterfat g/d	470	504	502	503	7.1	**
Protein g/d[2]	356	385	374	374	3.2	***
Solids-not-fat, g/d	873	927	933	933	10.6	***

[1] Probability of "F" test NS>.05; ** P<.07; *** P<.007
[2] N x 6.38

and solids not fat (SNF) (P <.001) yields. There were no differences between leucaena and fonmalcasein in providing better butterfat and SNP yields. However, formal-casein supplementation resulted in greater (P <.05) protein yields than leucaena (there were no differences in leucaena level). The casein:total protein ratio remained constant at about 0.67 irrespective of treatment.

Discussion

From the factors of Milford and Minson (1965), the extrusa samples of the pasture which had a mean of 18.2% CP (Table 1), would have contained 12.9% digestible crude protein (DCP). It was estimated that the daily consumption of organic matter by the unsupplemented cows was about 9.2 kg/d, and therefore the intake of pop was about 1.5 kg/d. The pop requirement for 350 kg cows producing 9.6 kg milk/d is 722 g (ARC 1965). The cows in this experiment were therefore consuming about twice as much pop as required. It could therefore be assumed (Grover and Dougall 1961; Hardison 1966) that milk production from cows grazing tropical grasses at a young stage of growth is limited by the quantity of digestible energy consumed/d, and not by the level of pop. These calculations are based on the assumption that the quantity of plant and microbial protein entering the small intestine is similar to the quantity of pop eaten. The protein in the fresh grass used here was 32% soluble (Table 1).

Protein synthesis in the rumen of the unsupplemented cows can be calculated to have been between 0.35 and 1.09 kg/d (taking a daily intake of 5.75 kg DDM, 60% degraded in the rumen with microbial production of 9.7 - 30.7 g/100 g DDM (Walker et al 1975). Thus if rumen synthesis of microbial protein was at the lower end of the scale, the cows would have been deficient in protein according to the feeding standards cited. That they were capable to responding to supplemental protein (as formal-casein) was clearly demonstrated, and is in agreement with the results of Stobbs et al (1977), who observed a 20% increase in milk production as a response to formal-casein, despite the fact that their cows were grazing a pasture with 20% CP in

DM. If the casein was not protected, then they only observed a 3% rise. The mechanism involved is difficult to ascertain due to the problem of predicting accurately voluntary intake of pasture under grazing conditions (Langlands 1975; Minson et al 1976). However, post-ruminal feeding of amino acids are known to effect secretion of glucagon, insulin and growth hormones, all of which are active regulators of metabolism (Machlin 1973; Clarke 1975), and it is possible that abomasal supplementation with casein operates through a similar mechanism.

The leucaena had a lower nitrogen solubility than the Rhodes grass, but the protective mechanism is unknown (Hegarty, private communication). However, since it is likely that retention time of the legume in the rumen is less than than for grass (Thornton and Minson 1973), the amount of nitrogen irreversibly lost via production of ammonia in the rumen could be considerably reduced. In this context, it is of interest that there was no additional response to the higher level (4 kg) of Lachine, whereas the response to protected casein is known to increase up to 500-1000 g/d (Clarke 1975; Spires et al 1973; Stobbs et al 1977). Responses to leucaena as a protected protein supplement are not limited to milk production. When fed as a supplement to steers on a basal diet of sugar cane, liveweight gains were comparable with those of steers supplemented with meat meal (Sievert et al 1975).

Conclusions

The results of this experiment have important practical implications. Small quantities of leucaena can give useful increases in milk production at low cost, since it is possible to produce 10-22 tons of edible DM/ha (Hutton and Beattie 1976). It is also one of the few tropical legumes that is persistent under both cutting or grazing regimes. Any detrimental effect due to the amino acid, mimosine, is unlikely to influence animal health or performance when leucaena constitutes such a small proportion of the diet. Restricted grazing of the legume for 30-60 minutes daily before the cows are allowed onto pasture could be one practical method of supplementation. The important point arising from this study is that the need for the concentrate supplementation could be reduced or even eliminated.

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