THE INFLUENCE OF FORAGES ON DIGESTION PARAMETERS OF A SUGAR CANE DIET[1]

M Hughes-Jones[2], C Encarnacion, F Done and T R Preston[2]

Centro de Investigacion Pecuaria (CENIP)/CEAGANA, Aptd 1256/8, Santo Domingo, Dominican Republic.

Four young Zebu bulls of about 140 kg were fed a chopped sugar cane/1.3% urea (fresh basis) diet supplemented with a protein forage forage for 3 weeks periods in a changeover design. Forage proteins were Canavalia ensiformis, Leucacna leucocephala, Ipomea batata (sweet potato), wheat bran and fed in that order, wiLb a final period of leucaena as a reference to adjust for consumption changes with age. Feed intakes, digestibilities and gut clearances by marker disappearance in the faeces using chromic oxide and polyethylene glycol (PEG) were measured.

Total dry matter (DM) intakes were lower when canavalia was fed than leucanea (P <.05) sweet potato (P <.001) or wheat bran (P <.001). {makes were lower on leucanea (P< .05) than either sweet potato or wheat bran

The apparent DM digestibilities of the whole diets did not differ with the exception of the wheat bran supplemented diet which was more digestible than canavalia or leucaena (both P <.01) and sweet potato (P <.05).

There were differences in PEG clearance rate; sweet potato differed from both canavalia and leucaena (P <.05). There were no differences in chromic oxide clearances. The clearance rates of the two markers, when all diets and animals were considered, were different (P <.001). The implications of the results are discussed.

Key words: Digestibility, intakes, passage rates, *Leucaena leucocephala, Canavalia ensiformis, Ipomea batata*, wheat bran

Growth rates and feed intakes of cattle fed chopped whole sugar cane diets tend to be low despite the ready availability of the sugar component, because of the high levels of indigestible fibre.

Nitrogen levels ate also low (about 0.5 %) and hence supplementation with a nitrogen source is necessary. Several tropical forages have good potential as suppliers of nitrogen both to the rumen microbia and the lower gut. This experiment was designed to evaluate their abilities to affect total intake and digestibility,and their effect on total gut clearance rates of liquid and particulate matter.

Materials and Methods

Four young Zebu bulls averaging 140 kg liveweight were fed chopped whole sugar cane(plus 1.3% urea fresh basis) and a protein forage (both ad libitum) in a changeover design with 5 periods of three weeks each. Leucaena leucocephala was used as a reference forage and fed for the second and fifth periods, so that age effects on intakes could be adjusted for. Intakes were measured throughout the three

[1] *Work partially funded by UNDP/FAO Project DOM/77/002*

[2] *Consultants to the UNDP/FAO Project DOM/77/002*

week periods. The forages fed were *Canavalia ensiformis, Leucaena leucocephala, Ipomea batata* (sweet potato)and wheat bran in that order. In the last week of each period the animals were put in crates to measure digestibility and gut clearance rates by drenching orally with 40 g Chromic oxide and 100 g Polyethylene glycol 4000 (PEG) to mark particulate and liquid phases respectively. Faeces were bulked over 8 h periods and samples taken to measure PEG on fresh faeces weight basis, using the technique of Malawar and Powell (1967). Chromium was determined on a dry matter (DM) basis by digestion with perchloric and sulphuric acids and reading absorbance at a wave length of 375 nm.

For the first series of observations faeces samples were taken from dosing until the decay of measurable amounts of marker,in order to determine the period in which to measure the experimental decay of the marker (Grovum and Williams 1973).

Results and Discussion

The digestibilities for the 4 diets are given in Table 1. There were no significant differences between animals. The second leucaena treatment did not differ significantly from the first although there may have been a slight trend for improved digestibility. Of the diets, only that supplemented with wheat bran differed significantly from both canavalia and leucaena ($P<.01$) and from sweet potato ($P<.05$). These differences are likely to be caused by the higher digestibility of wheat bran rather than any interactions between dietary constituents within the gut.

Voluntary intake: The data for total dry matter (DM) intake and for the forage component are given in Table 1. The purpose of the repeated treatment of leucaena was to provide a reference intake on the basis of which consumption on the other treatments could be corrected. There was a slight increase in total DM intake, expressed in terms of kg DM/100 kg LW in the second period on leucaena compared with the first. Intake data for the other treatments were therefore adjusted to take into account the apparent increase due to time on experiment.

The total intake both of the DM and the forage fraction was highest on the diet with wheat bran and lowest on the diet with canavalia. The intake of sugar cane was less on the wheat bran diet than on the others. These results imply that the wheat bran was highly accepted by the animals and in addition contributed nutritionally to the overall utilization of the diet. In contrast, it seemed that the canavalia was not eaten readily and provided no nutritional advantage to the animal.

Markers: The results of the period of faeces collection from 8 hr up to 168 hr indicated that the concentration decay curve of both markers in the period 48 - 88 hr after dosing, could be used to measure gut clearance rates. Bulked faeces over 8 hr was found to give good regress ions (Figure l) which did not seem to justify more frequent sampling or taking samples as faeces were excreted.

There were large differences in the rate of passage of the markers ($P<.001$) when all values were compared using the paired t - test. This is to be expected as PEG is water soluble and normally considered a liquid phase marker whereas chromic oxide is indiscriminate or associated with the solid phase (Kotb and Luckey 1972).

Table 1:
Intakes[1] and apparent digestibilities of the diets of whole chopped sugar cane supplemented with protein-rich forages fed to young Zebu bulls

	Protein supplements					
	Canavalia	Leucaena	Sweet potato	Wheat bran	Leucaena II	SE diff
Digestibility %	61.6^{c} [2]	62.4^{c}	65.7^{b}	72.8^{a}	66.3	3.09
Total intake	1.38^{a} [2]	1.65^{b}	1.65^{b}	1.90^{d}		.098
Sugar cane intake[3]	1.26^{ae}	1.22^{a}	1.22^{a}	0.71^{c}		.098
Supplement intake[3]	$.11^{a}$	$.42^{ab}$	$.42^{ab}$	1.18^{c}		.071

[1] All intakes expressed as kg DM/100 kg liveweight

[2] Within rows, superscripts differ a - b P <.05
a - c P <.01
a - d P <.001
c - e P <.01

[3] Intake data corrected forage by regression through the two leaucaena treatments.

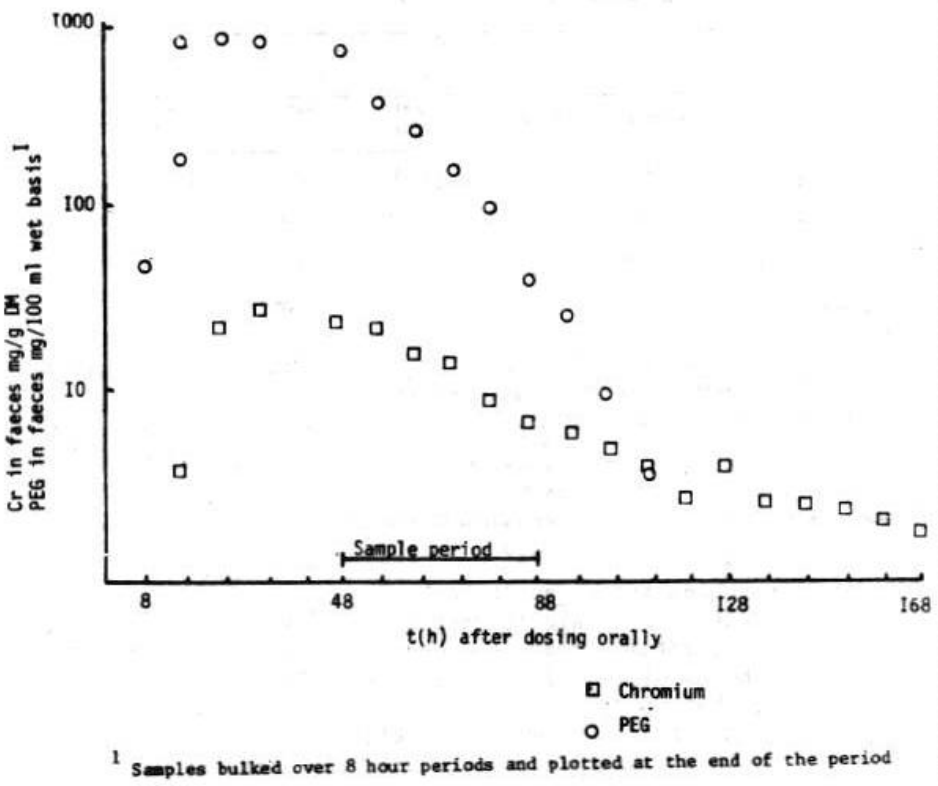
Marker clearances are given in Table 2.

Although there were no significant differences between diets the clearance rate of chromium seemed to be positively related with the total DM intake, the highest values being obtained for the diet with wheat bran. On the contrary, there were significant differences between diets for PEG clearance rates, but these bore little relation to relative DM intakes. These results could be interpreted as indicating that the wheat bran was acting to stimulate the passage of the particulate component of the diets while the sweet potato stimulated the turnover of the liquid phase. The observation that on the wheat bran diet the faeces became green within 6-8 hr of dosing as opposed to between 16-18 hr on the other diets, lends support to this suggestion.

For both markers, and especially so for chromium , the variation between animals was high. This could be because the marker does not associate well with the solid phase of digesta (Faichney 1975) and no more than the flow of the marker is being measured. This may be a greater problem with diets of chopped sugar cane fed once daily, as compared with the complete, often pelleted, diets favoured in studies of rumen kinetics (see MacRae 1974), and where chromium and DM flow are usually closely related.

An endogenous marker such as liquid, would overcome this problem (Faichney 1980), but for this method it i,s necessary to sample the whole rumen contents for the endogenous marker which means either slaughter, to remove the complete contents, or sampling from the rumen cannula. Sampling of contents may be acceptable on the wholly pelleted diets used by Faichney (1980), where particle sizes are small and rumen contents are fairly homogenous but is not practicable on sugar cane-based diets in which particle size may be as large as 2-5 cm. Furthermore, the assumption that the lignin passage rate is representative of solids outflow from the rumen may

Figure 1:
Concentration of Chromium and Polyethylene (PEG) in the faeces[1] of one an animal fed chopped whole sugar cane and canavalia ensiformis



[1] Samples bulked over 8 hour periods and plotted at the end of the period

Table 2:

Fractional clearance rates (%/hr) of Polyethylene glycol (PEG) and chromic oxide from the gut of young Zebu bulls fed chopped whole sugar cane supplemented with protein-rich forages

Marker	Protein supplements					
	Canavalia	Leucaena	Sweet potato	Wheat bran	Leucaena II	SE diff
PEG	6.6[b]	6.85[b]	11.1[a]	7.2[b]	6.8[b]	1.41
Chromic Oxide	2.88	3.7	3.6	4.2	4.6	0.8

[1] Within rows, superscripts differ a - b P <.05

not be correct since a substantial amount of the lignin in the rumen pool will be tied up in large particles which are unable to pass out and will take some time to break down. The small and easily broken down particles of the materials used in this study would be unlikely to leave as slowly as rumen flow measured by lignin may suggest, a large amount of which will be in the sugar cane fibre fraction of the diet

The final problem concerns the reliability of clearance rates measured in faeces, as compared with determinations made in the rumen contents. According to Lemerle et al (1981) and Grovum and Williams (1973), there were no differences in flow rates determined from analyses of samples taken at these two sites when the liquid and solid phase markers were Cr-EDTA and ruthenium-phenanthroline.

However, only one (solid) diet was investigated by each group of authors.

In liquid-based diets of sugar cane juice, the relationship between rumen and faeces sampling was better for the liquid phase marker (PEG) than for the solids marker (chromium) (Hughes-Jones et al 1981).

The fact that in this experiment the differences in flow rate of chromium were not significantly different, may indicate that changes in rumen through-put of dry matter were either small and hence presumably of little importance, or that animal variation associated with the sampling and analysis was large, and indeed animal variation was of a similar magnitude to that between diets.

Godoy add Elliot (1981) were unable to detect between diet differences in duodenal appearances of chromium EDTA when cattle were fed a molasses based diet and it would seem that there are few comparative data to substantiate between diet differences in clearance rates from either the rumen or the rectum.

The fact that the wheat bran supplement was more effective than the for age in stimulating feed intake agrees with other reports in the literature on sugar cane supplementation (Preston and Leng 1981). It appears that this basic feed responds better to supplements rich in bypass nutrients than to forages which act within the rumen.

References

Faichney G J 1975 The use of markers to partition digesta within the gastro-intestinal tract of ruminants In: Digestion and metabolism in the ruminant McDonald & Warner (Eds) University of New England Publishing Unit Australia

Faichney G J 1980 Measurement in sheep of the quantity and composition of rumen digesta and ofthe fractional outflow rates of digesta constituents Australian Journal of Agricultural Research .....

Godoy R & Elliott R 1981 Effect of five tropical forages on rumen function and flow of nutrients to the proximal duodenum in cattle fed a molasses/urea diet Tropical Animal Production 6. 159-166

Grovum W L & Williams V J 1973 Rate of passage of digesta in sheep British Journal of Nutrition 30:313-329

Hughes-Jones M, Encarnacion C & Preston T R 1981 Supplementation of sugar cane juice with protein forages Tropical Animal Production 6:271-278

Kotb A R & Luckey T D 1972 Markers in nutrition Nutrition abstracts and Reviews 42:813-845

Lemerle C, Murray R M & Leng R A 1981 Dilution rate of Chromium and Ruthenium markers in the rumen and faeces of cattle Proceedings Australian Society of Animal Production 13:454 Abstract

MacRae J C 1974 The use of intestinal markers to measure digestive function in ruminants Proceeds of the Nutrition Society 33:147-154

Malawar S S & Powell D W 1967 Improved turbimetric analysis of polyethylene glycol using an emulsifier Gastroenterology 53:250-256

Preston T R & Leng R A 1981 Utilization of tropical feeds by ruminants In Digestive Physiology and Metabolism in Ruminants (Y Ruchebush & P Thivend) MTP Press Ltd London

Received June 1981