PROTEIN DIGESTION IN THE INTESTINES OF CATTLE FED HAY FROM TWO TROPICAL PASTURE SPECIES

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SUMMARY

The apparent digestion of crude protein (non-ammonia nitrogen x 6.25) in the intestines was measured in steers fed mature Spear grass (Heteropogon contortus) and mature Pangola grass (Digitaria decumbens). The amount of crude protein flowing into the intestines was 225 and 443 g per day, respectively. A major difference between the diets was the digestibility of crude protein in the intestines which was 0.30 for Spear grass and 0.68 for Pangola grass. There was also a large difference in the ratio of crude protein apparently digested in the intestines to digestible organic matter (DCPi:DOMI); being 0.05:l for Spear grass and 0.12:l for Pangola grass. The implications for protein supplementation of cattle are discussed. (Keywords: Protein, digestion, cattle, tropical).

INTRODUCTION

The protein supply to the tissues of ruminants is derived from that protein, microbial, endogenous and dietary which flows from the stomachs into the intestines, where a proportion of it is digested and absorbed. In sheep and cattle fed a range of temperate forages, the digestibility of crude protein in the intestines was about 0.65 to 0.75 (ARC 1980, Hogan et al. 1976). There is evidence that in cattle fed mature tropical forages, the digestibility of crude protein in the intestines is much less than this (Hunter and Siebert 1980, Kennedy 1982). Thus, if low values are common, it is probable that there is an imbalance between protein and energy in the end products of digestion, which may be one of the reasons for the relatively poor productive performance of cattle grazing some tropical pastures, and the marked improvement when protein supplements protected from rumen degradation are provided. This paper reports data on the digestion of crude protein in the intestines of cattle fed two tropical hays, one highly fibrous and resistant to ruminal digestion, Spear grass (Heteropogon contortus), and the other, Pangola grass (Digitaria decumbens), which is more rapidly digested in the rumen (Hunter and Siebert 1985). The Spear grass data have been calculated from the experiment reported by Hunter and Siebert (1980).

MATERIALS AND METHODS

In two experiments digestion was measured using steers fitted with fistulas in the abomasum and rumen. Five Droughtmaster steers were fed long-chopped (about 10 cm) Spear grass hay ad lib. and four Hereford steers were fed long-chopped Pangola grass hay near ad lib. Equal portions of the day's feed allotment were offered at regular intervals by automatic feeding devices. The flow of digesta through the abomasum was measured by reference to Cr-EDTA and lignin. A solution of Cr-EDTA was continuously infused by peristaltic pump for at least three days prior to and during digesta sampling from the abomasum. Calculations of digesta flow for Spear grass were made by the method of Weston and Hogan (1967) and for Pangola grass by the method of Faichney (1975).

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The amino acid compositions of Spear grass and Pangola grass were determined on an amino acid analyser after hydrolysis with 6N HCl. The pepsin soluble N and cell wall N were calculated after determination of N concentration on feed and on the residues remaining after incubation with acid-pepsin and digestion with neutral detergent solution respectively.

RESULTS

The chemical compositions of the diets are shown in Table 1. Spear grass contained 33 per cent less nitrogen and 26 percent more lignin than Pangola grass. The results for intake and digestibility (Table 2) show that cattle fed Spear grass consumed only about two-thirds as much energy (DOMI) as those fed Pangola grass, even though Spear grass was fed ad lib. and Pangola grass at about 85 percent of ad lib. intake. The nitrogen economy of steers fed Spear grass was poor (Table 2). More N was excreted in faeces than ingested in feed, the apparent digestibility of crude protein (non-ammonia nitrogen (NAN)) in the intestines was only 30 per cent, there was a wide ratio of protein to energy being apparently digested and a net loss of N from the body of 18 g per day. The steers fed Pangola grass had a slight positive *N* retention, digested 68 per cent of NAN flowing into the intestines and had a more favourable ratio of protein to energy being digested.

Table 1 Chemical composition of diets

	Organic matter (g/kgDM)	Nitrogen (g/kgOM)	Cell wall constituents (g/kgOM)	Lignin (g/kgOM)
Spear grass	930	7.2	782	102
Pangola grass	915	9.6	771	75

The samples of Spear grass and Pangola grass subjected to amino acid analysis had 25 and 75 per cent of total N as amino N respectively. Incubation with acid-pepsin removed 37 percent of Spear grass N and 56 per cent of Pangola grass N, while for both feeds 42 per cent of total N was associated with the cell walls.

DISCUSSION

Digestion studies with sheep fed a range of medium and high quality temperate zone forages have shown that usually the ratio of crude protein digested in the intestines to digestible organic matter (DCPi:DOMI) is 0.12-0.13:1 (Hogan 1982), which was that supplied by the Pangola grass. Spear grass on the other hand supplied a DCPi:DOMI ratio of only 0.05:1. Even wheaten hay with a similar N content to the Spear grass supplied approximately twice as much digestible protein per unit energy as Spear grass (Hogan and Weston 1967). The reason seems to be that a higher proportion of the *N* in the Spear grass diet was not in the form of amino acids, was resistant to pepsin digestion in vitro and probably also resistant to bacterial attack, acid hydrolysis (6N HCl) and enzymic breakdown in vivo. It is apparent that at least a proportion of this indigestible N fraction was not associated with cell walls. The chemical nature of the fraction is not known but warrants further investigation. Kennedy (1982) found that a diet of pasture hay, consisting mainly of Panicum maximum fed to steers also supplied low amounts of protein relative to energy, DCPi:DOMI of

0.05:1 compared to a ratio of 0.11:1 for lucerne (*Medicago sativa*). *Panicum* and Spear grass are both erect, tussocky grasses whereas Pangola grass is low growing and creeping. It is possible that an N fraction of some erect tropical grass species is resistant to digestion, whereas the N in other grasses such as Pangola grass is more digestible and fits the same model as that described for temperate forage species.

It is possible that the difference in DCPi:DOMI between Spear grass and Pangola grass was exaggerated because apparent, rather than true, digestion of protein in the intestines was measured. Because of the lower N intake from Spear grass, the endogenous N of intestinal origin would probably have contributed a greater proportion of faecal N on this diet. However, it is unlikely that this was the sole reason for the difference between feeds as the N intake from the pasture hay (DCPi:DOMI, 0.05) fed by Kennedy (1982) was higher than that from either the Spear grass or the Pangola grass diets.

Table 2 Digestion of nitrogen

	Spear grass		Pangola grass	
	Mean	SEM	Mean	SEM
OMI (kg/d)	2.65	0.169	3.99	0.000
Digestibility of OM	0.56	0.012	0.59	0.009
DOMI (kg/d)	1.47	0.098	2.36	0.051
N intake (g/d)	21	1.7	39	0.0
Digestibility of N	-0.14	0.021	0.45	0.012
NAN flow at abomasum (g/d)	36	5.6	66	0.9
Digestibility NAN in intestines	0.30	0.051	0.68	0.005
Faecal N : DOMI (g/100g)	1.6	0.03	0.9	0.04
DCPi:DOMI (g:g)	0.048	0.012	0.12	0.004
N retention (g/d)	-18	1.3	2	0.4

OMI : organic matter intake
DOMI : digestible organic matter intake
NAN : non-ammonia nitrogen
DCPi : crude protein apparently digested in the intestines

The protein requirements of cattle, heavier than 100 kg and fed roughage diets supplying 0.13 g DCPi per gram DOMI can be met by the roughages alone without additional protein supplementation (ARC 1980). Thus it would not be expected that steers fed Pangola grass and supplemented with protected protein would respond to the additional protein supply. On the other hand, cattle fed Spear grass would be grossly deficient in protein, even for maintenance, and a production response to protected protein would be expected. That this occurs can be seen from the experiment of Lindsay and Loxton (1981) who reported that steers fed Spear grass supplemented with 500 g per day of a protein supplement which

contained mostly formaldehyde-treated cottonseed meal had a daily gain of 109 g/d compared to a loss of 320 g/d for steers supplemented only with rumen degradable N and S. Some of this impressive response could be attributed to additional energy supply as cottonseed meal is approximately 40 per cent crude protein. However, as the increase in energy intake was insufficient to account for the additional 430 g/d of live weight gain, improvement in protein supply would have had the major effect.

This study has shown that tropical pasture hays differ markedly in their capacities to provide digestible protein to the intestines of cattle. It is suggested that if protein supplementation programmes are to be biologically effective and economically efficient, a knowledge of the digestion characteristics of the pasture is essential.

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