DRY MATTER DEGRADATION CHARACTERISTICS OF RICE STOVER WITH DIFFERENT PROPORTIONS OF *Ficus capensis* OR *Alchornea cordifolia* IN RUMEN FISTULATED SHEEP, GOATS OR CATTLE

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ABSTRACT

Rumen dry matter degradation characteristics (soluble fraction, degradable fraction, rate of degradation and effective degradability) of leaves of two browse species (*Alchornea cordifolia*, *Ficus capensis*) and rice stover and their varying proportions (10, 20 or 30% of each browse: crop residue mixture) were evaluated in rumen fistulated West African Dwarf sheep and goats and Bunaji cattle. The forages differed ($P < 0.05$) in soluble fraction (a) rate of degradation (c) and effective degradability (ED) but did not differ in the degradable fraction (b). Rice stover had the highest rate of degradation and *F. capensis* the least. Effective degradability (ED) was highest in cattle followed by sheep and goats with a high degree of correlation among them. The inclusion of the different proportions of browse in the mixtures show some significance in a, b and ED ($P < 0.05$). Mixture had a depressive effect on the soluble fraction of the feeds in rice stover: *A. cordifolia* mixtures. Degradable fraction differed mainly in *F. capensis* mixtures. The rate of degradation was affected mainly in sheep and cattle among the feeds in rice stover: *F. capensis* mixtures. The different mixtures influenced effective degradability. As with the sole feeds, ED was highest in cattle, followed by sheep and goats.

Keywords: Degradation, browse, crop residue, mixture effect.

INTRODUCTION

In the tropics, cattle, sheep and goats depend on crop residues. Crop residues are extremely important feed resources for ruminant livestock especially in the dry season (Jackson, 1981). During the dry season, forage from communal grazing land is inadequate. In addition, as agriculture intensifies, under expanding human and livestock population pressure, ruminants will depend more and more on crop residues. However, most of them are deficient in nutrients (Leng, 1990) and can barely sustain body weight of animals (Sundstol and Owen, 1984). Also available in the dry season are browse plants, some of which are rich in nutrients especially protein and minerals (Mecha and Adegbola, 1980). Improved animal performance may be obtained from crop residue utilization by supplementing with browse leaves (Saleem *et al.*, 1979). This will depend on the level of supplementation, tannin contents and the degree of utilization of protein in the browse (Osuji and Odenyo, 1995).

In Sacco, degradation techniques offer a relatively cheap and rapid method of assessing the potential feeding value of feedstuffs (Osuji *et al.*, 1993). It has been used to assess the degradability of many feeds by incubating them separately in the rumen of ruminants (Tuah *et al.*, 1986; Flachowsky *et al.*, 1991).

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Nevertheless, there are not many studies on the use of degradation in assessing the additive/mixture effect of feeds when incubated as mixtures in varying proportions compared to separate incubation. One of the studies available (Flashowsky and Schneider, 1992) investigated the degradability of varying straw to concentrate mixtures incubated in the rumen of sheep. They reported that the dry matter degradability of mixture calculated from individual feeds was highly correlated with measured values. It would be interesting, however, to know if there will be mixture effect on degradation of browse and crop residue given the high variability of their nutrient composition.

The feeding behaviour of goats differs from that of sheep and cattle. Goats are usually browsers while sheep and cattle are mainly grazers (Rutagwenda *et al.*, 1990), and goats are more selective feeders than cattle and sheep (Van Soest, 1982). Studies comparing the digestive ability of sheep and goats give varied responses (Adebowale, 1989; Flachowsky and Tiroke, 1993; Wahed and Owen, 1986). However, a review (Brown and Johnson, 1984) stated that differential species advantage is only important on low quality high fibre diets, while sheep tend to digest dry matter and fibre more completely than goats. Tolkamp and Brouwer (1993) concluded that no practical significance exists between sheep and goats in overall feed digestibility, except with diets low in crude protein in which case goats are at an advantage. They however, observed that feed digestibility was higher in cattle than goats and sheep. Cattle utilize neutral detergent fibre better than sheep due to increased ruminal microbial activity (Playne, 1978).

The objectives of this study were to determine the rumen degradation characteristics of dry matter in the leaves of two browse species (*Alchornea cordifolia*, *Ficus capensis*), crop residue (Rice stover) and its mixtures and to

assess the influence of mixture effects on degradation.

MATERIALS AND METHODS

Feeds

The samples used for the degradability were two browse plants (*Alchornea cordifolia* (A), *Ficus capensis* (F)), a crop residue (Rice stover (R)) and its mixtures. The feed mixtures were made up of 10, 20 or 30% (DM basis) of each browse with the crop residue.

Animals and their management

Three West African Dwarf (WAD) male goats, three WAD sheep and one White Fulani steer with average body weight of 18kg, 30kg and 200kg respectively fitted with permanent rumen cannulae were used for the degradability study. The animals were dewormed and housed in individual pens. They were offered fresh *Gliricidia sepium* and *Panicum maximum* at a ratio of 30: 70 respectively *ad libitum*. Feed was offered once daily at 09.00 hour. The animals were allowed to adjust to the feed for three weeks before the start of the experiment. The feeds offered the animals contained the following nutrient composition (DM basis g/kg): *Gliricidia*: ash, 28; nitrogen (N), 40.6; neutral detergent fibre (NDF): 381, and acid detergent fibre (ADF): 235 while guinea grass contained ash: 83, N:4, NDF: 765, and ADF: 360. The animals had free access to water and mineral licks.

Rumen degradability

The DM degradability of the samples was determined using the nylon bag technique (Orskov *et al.*, 1980). About 3g of each feed was weighed into nylon bags (pore size 40-50 µm) and incubated in the rumen of fistulated goats, sheep and cattle. The feed samples were ground through a laboratory hammer-mill with a 2.5mm screen size. Duplicate samples were incubated in each animal for 12, 24, 36, 48, 60, 72, 84 and 96h. In the case of cattle, the study was carried out three times to generate replicates.

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The bags were removed after incubation and rinsed in running tap water. The bags were

then dried in the oven at 60°C for 48h. The washing loss of each sample was determined

TABLE 1: CHEMICAL COMPOSITION OF THE FEEDS (g/kg DM)¹

	DM	NDF	ADF	HC	Cell	ADL	Nitrogen
Rice stover	980	672	442	230	298	42	10
<i>Alchornea cordifolia</i>	970	344	310	34	166	132	22
<i>Ficus capensis</i>	963	496	492	4	226	248	22

¹NDF = Neutral detergent Fibre; ADF = Acid detergent Fibre; HC = Hemicellulose; ADL = Acid detergent Lignin; Cell = Cellulose.

by soaking two bags per sample in warm water at 39°C for 1 hour before washing.

Disappearance of DM was measured as the loss in weight of the bag content. The results were fitted to the exponential equation $P = a + b(1 - e^{-ct})$ suggested by Orskov and McDonald (1979), where P = DM degraded (g/kg) from the bag after time t (h), a = soluble fraction, b = degradable fraction and c = rate of degradation of b . The effective degradability (ED) was estimated according to the method of McDonald (1981). The outflow rate was assumed to be constant at 0.04 per hour.

Chemical analysis

Dry matter (DM) of the samples was determined by drying in an oven at 60°C to constant weight. Nitrogen concentration was analysed by the Kjeldahl method (AOAC, 1980) while neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL) and cellulose were measured by the methods of Goering and Van Soest (1970). Hemicellulose was calculated as the difference between NDF and ADF.

Statistical analysis

Data were analysed as a 3x3 factorial arrangement in a randomized complete block design using the general linear model procedure of statistical analyses (SAS, 1987). Correlation analysis was used to establish the interspecies relationship for the effective degradability of the three sole feeds and the five types of rations considered at a time.

RESULTS

Chemical composition of sole feeds

The chemical composition of the sole feeds is given in Table 1. The browse leaves contained about twice the amount of nitrogen as in the crop residue (22 versus 10 g/kg DM respectively). The crop residues had higher levels of cell wall contents than the browse as defined by the NDF (672 versus average 420 g/kg DM). Lignin level ranged from 42 in rice stover to 248 (g/kg DM) in ficus.

Dry matter degradability of the sole feeds

The dry matter degradability of the three sole feeds is given in Table 2. The soluble fraction ($P < 0.05$) and the degradable fraction ($P > 0.05$) ranged from 225 to 285 and 255 to 488 g/kg DM respectively. All the feeds had low effective degradability (296 to 372 g/kg DM). However, these differed ($P < 0.05$) within each species. Effective degradability (ED) was highest in cattle followed by sheep and goats. The interspecies coefficient of correlation for ED among the three species was very high (over 0.90). This was highest between cattle and sheep (0.99). The rate of degradation (C) ranged from 1.0 to 3.7% per hour. This was significantly different ($P < 0.05$) for sheep and cattle. There was a clear superiority in this constant for rice stover compared with the other feeds. However, the c of ficus appeared to be slower (in cattle) than that of the other feeds. This result was the same for goats, which also had a much lower c value for ficus

than the others. The average correlation (0.673) indicates that no difference can be identified between the rate of degradation between the c results for sheep and cattle

TABLE 2: RUMEN DEGRADATION CHARACTERISTICS OF DRY MATTER IN RICE STOVER (R), *Alchornea cordifolia* (A), *Ficus capensis* (F) LEAVES IN BUNAJI CATTLE (C), WEST AFRICAN DWARF SHEEP(S) AND GOATS (G)

Forage type	a	Degradation characteristics ¹ (g/kg DM)						c(%h ⁻¹)		
		b		ED		c(%h ⁻¹)		G	S	C
		G	S	C	G	S	C			
R	239	372	350	367	327	372	371	2.4	3.7	3.3
A	285	255	312	261	361	360	365	2.5	2.7	2.4
F	225	488	280	408	291	290	303	1.0	2.5	1.6
Significance	*	NS	NS	NS	*	*	*	NS	*	*

¹a = Soluble fraction, b = Degradable fraction, ED = Effective degradability

c = Rate of degradation, NS = Not significant (P>0.05), * = significant (P<0.05).

according to the type of feed given to the two species.

Rice-Alchornea (RA) mixtures

There were no significant differences (P>0.05) in the degradation characteristics among the three RA mixture (Table 3). Within the feeds, significant variations (P<0.05) were recorded only in the a, b (for cattle) and ED (for goats) fractions (Table 3).

Rice-Ficus (RF) mixtures

There were significant differences (P<0.05) in the soluble fractions among the five feeds and the three RF mixtures (Table 4). Also differences (P<0.05) were observed in the b values for sheep, ED (in the three species) and c for sheep and cattle among the five feeds. The ED values were least in goats but ficus had an almost identical ED values in the three species. The ED values were strongly correlated (0.94) among the species. There were no significant differences (P>0.05) in the degradation characteristics (b, ED, c) of the three RF mixtures.

DISCUSSION

The low effective degradability (ED) values for the feeds and their mixtures may be attributed to some factors. These include the

high neutral detergent fibre (NDF) in the crop residues indicating low soluble cell contents and hence low energy value. Also the high lignin contents of the browse would interfere with the utilization of the moderate level of nitrogen in browse. The presence of polyphenols in browse could chelate the protein in the browse (Barry and Reid, 1984) and hence reduce the rate of bacterial colonization (Cheng *et al.*, 1994) and the degradation of fibre. The generally non-significant difference in dry matter degradation (DMD) between the proportions (10, 20 or 30%) of browse in the mixture is in sharp contrast to the finding of Flachowsky and Schneider (1992) who reported that the DMD of feed combinations was enhanced from 42.3 to 66.9% when concentrate component of straw-concentrate mixture increased from 20 to 80%. The fact that with an increases in the browse from 10 to 30% in the mixture there were no increase in the criteria measured may be attributed to the anti-nutritional components of the browse. They are known to contain tannins and saponins (Onwuka, 1992) which may form complexes with feed protein thereby rendering them unavailable to the rumen microbes (Barry and Reid, 1984). Thus, increasing the proportion of browse in the mixtures as a way of enhancing

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nitrogen availability and utilization would not have much impact on the degradation characteristics. It is suggested (Lu, 1988) that

the formation of polyphenol-protein complexes is a way of protecting feed protein from ruminal degradation. However, to benefit

TABLE 3: RUMEN DEGRADATION CHARACTERISTICS OF DRY MATTER OF RICE STOVER (R), *Alchonea cordifolia* (A), AND MIXTURES OF R AND A IN BUNAJI CATTLE (C), WEST AFRICAN DWARF SHEEP(S) AND GOATS (G)

Feed	Degradation characteristics ¹ (g/kg DM)									
	a	b				ED		c (%h ⁻¹)		
		G	S	C	G	S	C	G	S	C
R	239	372	350	367	327	372	371	2.4	3.7	3.3
A	285	255	312	261	361	360	360	2.5	2.7	2.4
R90: A10	201	357	400	421	320	358	369	2.5	2.5	2.8
R80: A20	210	328	391	495	324	359	364	2.7	3.3	3.1
R70: A30	229	347	345	377	314	357	367	2.3	3.5	2.9
Significance										
Among the five feeds	*	NS	NS	*	*	NS	NS	NS	NS	NS
Among the three mixtures	NS	NS	NS	NS	*	NS	NS	NS	NS	NS

¹a = Soluble fraction, b = Degradable fraction, ED = Effective degradability
c = Rate of degradation, NS = Not significant (P>0.05), * = significant (P<0.05).

TABLE 4: RUMEN DEGRADATION CHARACTERISTICS OF DRY MATTER IN RICE STOVER (R), *Ficus Capensis* (F) AND MIXTURES OF R AND F IN BUNAJI CATTLE (C), WEST AFRICAN DWARF SHEEP(S) AND GOATS (G)

Feed	Degradation characteristics ¹ (g/kg DM)									
	a	b				ED		c (%h ⁻¹)		
		G	S	C	G	S	C	G	S	C
R	239	372	350	367	327	372	371	2.4	3.7	3.3
A	228	488	280	409	291	294	303	1.0	1.0	1.6
R90: A10	181	398	443	358	320	350	373	2.5	3.1	2.8
R80: A20	190	385	406	421	318	357	358	2.4	3.3	3.1
R70: A30	205	414	349	384	316	360	360	1.8	4.5	3.3
Significance										
Among the five feeds	*	NS	*	NS	*	*	*	NS	*	*
Among the three mixtures	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

¹a = Soluble fraction, b = Degradable fraction, ED = Effective degradability
c = Rate of degradation, NS = Not significant (P>0.05), * = significant (P<0.05).

the animals, the protein has to be actually digested and absorbed in the lower digestive tract (Kamatali *et al.*, 1992).

Rice stover had the highest rate of degradation (c) of the sole feeds. Some other workers (Adebawale and Nakashima, 1992) have reported that rice stover had higher c than maize stover. This suggests that rice stover could support animal performance better than the other feeds, all other factors being constant. The importance of c was demonstrated in a study (Reid *et al.*, 1988) with two varieties of spring barley; Corgi and Golden Promise. Both varieties had similar degradable fraction (b) 484g/kg DM) but differed with respect to c values (4.83 and 3.03% h⁻¹ respectively). Thus, Corgi variety with higher c value supported better animal performance than Golden Promise in terms of dry matter intake: 5.16, 4.43kg/day, and growth rate: 400, 198 g/day respectively) when fed as part of diet to steers. The low c value for Ficus implied that the rate of breakdown of indigestible particles to sizes small enough to transverse the reticulo-omasal orifice would be slow (Orskov, 1980). This would result in rumen fill and consequently limit feed intake.

Cattle had higher ED than sheep and goats probably due to increased ruminal microbial activities leading to better utilization of neutral detergent fibre (Playne, 1978). This may also be attributed to the positive correlation between species, size and retention time of digesta in the digestive tract (Van Soest, 1982). In addition, cattle digest feed better than sheep and goats when offered more of a roughage diet (Tolkamp and Brouwer, 1993).

CONCLUSION

The feeds and their mixtures had low effective degradability. Degradation was better in cattle than in sheep and goats. Increasing the proportion of browse in the mixtures did not influence degradation. This suggests that the

use of *Alchornea cordifolia* and *Ficus capensis* as protein supplements to basal crop residue would not have much beneficial impact in enhancing animal performance. This is however, subject to *in vivo* experimentation.

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