Nigerian Veterinary Journal Vol. 25 (1), 14-20 (2004)

RUMEN DEGRADABILITY CHARACTERISTICS OF *STYLOSANTHES GRACILIS, PANICUM MAXIMUM, PENNISETUM PURPUREUM* AND *CENTROSEMA PUBESCENS* IN SHEEP

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SUMMARY

The rumen degradability of four common Nigeria forages namely, *Stylosanthes gracilis, Panicum maximum, Pennisetum purpureum, Centrosema pubescens* were studied. The rumen degradability of the crude protein (CP), dry matter (DM) and organic matter (OM) contents of these forages were measured in four rumen-fistulated sheep weighing 9.6±0.07kg and using the nylon bag technique. A 4 x 4 latin square experimental design was used where four replicates of each forage were put in nylon bags measuring 7.5 x 10cm and incubated in the rumen of four sheep. The percentage disappearance of crude protein, dry matter and organic matter were monitored by withdrawing each bag at different time internals of 4, 8, 24 and 48hrs. The percent potential degradability of the forages at 48hrs were as follows: *S. gracilis,* CP (67%); DM (75%); OM (63%-); *P. maximum,* CP (57%), DM (50.12%), OM (40.36%); *P. purpureum,* CP (66%), DM (62.13%), OM (58.36%); *C. pubescens,* CP (50.7%), DM(51.1%), OM(51.06%). The DM and OM potential degradability for *S. gracilis* was significantly ($p<0.05$) higher than *C. pubescens* and *P. maximum.* There was however no significant ($p>0.05$) difference in the OM degradability of *S. gracilis* and *P. purpureum.* There was an inverse relationship between the crude fiber content of forages (Legumes and Grasses) and their rumen degradability. The data obtained in this study will help in formulating forage based diets that provide adequate rumen degradable and by pass proteins for optimum growth and productivity

KEY WORDS: Rumen, sheep, degradability

INTRODUCTION

Proteins can be evaluated (and rated) for monogastric species on the basis of digestibility, of the protein and its ability to supply specific amino acids for the animals needs (Neurath and Hill, 1982). With ruminant animals, if optimal utilization is desired, the needs can be more complex because of microbial fermentation taking place in the fore-stomach. For optimal protein efficiency, it would be desirable to be able to quantify and express in feeding standards the needs for rumen microorganisms and for the host animal separately for all the likely production situations (Czerkawski, 1986). Proteins provided by rumen micro-organisms provide an adequate supply to the tissues in most instances for animals producing at moderate levels (Hungate, 1966). For high-producing dairy cows, this does not appear to be the case. That is, these two classes of ruminants probably require a great supply of amino acids than are supplied by the microorganisms.

Proteins that are digestible yet not degraded in the rumen are referred to as by-pass proteins (rumen inert) or non-degradable intake protein or intestinally digested protein (AFRC, 1992). Proteins that are degraded in the rumen are referred to as rumen degradable protein. They have

fractions as quickly and slowly rumen degradable proteins (Ørskov and McDonalds, 1976). Proteins escape degradation in the rumen if; (1) they pass out rapidly or (2) rumen microorganisms cannot metabolize them. Information on protein utilization by ruminants, from the standpoint of rumen degradability is vital as it is the newer method of assessing protein requirement and utilization in ruminants (Nissen, 1992). Forages contain proteins that have varied degradability characteristics which may be influenced by various factors namely, solubility, treatment, age, climate, soil fertility, cutting rate (Stritzler. *et al.,* 1996). These proteins may be as amino acids (simple or conjugate) or non-protein nitrogen forms which are metabolized very rapidly by rumen micro-organisms. Legumes and grasses are major foods *consumed* by ruminants and thus serve as good protein sources. An evaluation of the nutritive value of common forages in terms of protein quality is usually based on the assessment of the proportion of forage protein that is rumen degradable and non-degradable (Mohammed and Smith, 1977). In ruminants therefore, solubility and rumen degradability of proteins are important factors in efficient nitrogen utilization hence the need to investigate the rumen degradability of certain forage proteins and other forage fractions such as dry matter and organic matter, as a means of establishing their nutritive value in forming forage based rations.

MATERIALS AND METHODS

The degradability characteristics of forages were carried in four rumen-fistulated sheep using the nylon bag technique as described by; Bhargara and Ørskov, (1987); Arigbede *et al.,* (2002). The animals were housed in a pen measuring $8ft^2$. They were acclimatized for two weeks during which they were fed forage based diets with grain supplementation. Salt lick was provided at 5 days intervals. The four forages are; *Stylosanthes gracilis, Panicum maximum, Pennisetum purpureum* and *Centrosema pubescens.*

Sixty four (64) nylon bags of polyamid cloth, measuring 7.5cm x 10cm, with pore size of 36μ and an apeture area of 30% were used. This was determined using a graticle. The forages were oven dried, milled to pass through a 2.5mm sieve screen. The rumen fistulas were implanted using the surgical technique as described by Dougherty (1955).

The chemical compositions of the forages were determined by the proximate analysis method (AOAC, 1980). A 4 x 4 latin square experimental design of 4 forages and 4 animals was adopted (Steel and Torrier 1980). Degradation characteristics for crude protein (CP), dry matter (DM), and organic matter (OM) were monitored in sheep by incubating, milled 1 gram of each forage put in four nylon bags, in the rumen of each rumen-fistulated sheep (Ørskov and McDonald, 1976). The disappearance of the various feed fractions from the bags within the rumen were evaluated at time intervals of 4, 8, 24 and 48hrs (Carro *et al.,* 1991). Disappearance from the bags was fitted to the equation of Ørskov and McDonald (1976)

$$P = a + b\,(1 - e^{-ct})$$

Pa = Level of degradation

a = Immediate soluble fraction of feed (CP, DM, OM)

b = represents potentially degradable feed fraction other than water soluble fraction of feed

c = Stands for the fractional rate of degradation of feed.

t =Time of exposure or incubation within the rumen.

Potential degradability = a + b
(Arigbede *et al.*, 2002).

The immediate soluble fraction or zero time solubility or washing losses of the forages were determined by heating in water bath at 37^0c for 1hr and washing under tap water until the rinsing water was colorless (Arigbede *et al.*, 2002). The sample was analyzed for crude protein, dry matter and organic matter according to the AOAC (1980). The difference between the values of these forage fraction before and after washing represents their 'a' fractions (Arigbede *et al.*, 2002) .

The rumen degradable fractions of CP, DM, and OM were determined as the difference in composition of forages before and after incubation in the rumen (Nocek *et al.*, 1979).

The statistical relationships of degradability characteristics of the forages were determined using a 4 x 4 latin square ANOVA model, and the least significant difference method (LSD) of mean comparison (Steel and Torrier, 1980).

RESULTS

The results of the experiment are as presented in the Tables I, II, III and IV.

TABLE I: **Chemical composition of S. *gracilis, P. maximum, P. purpureum and C. pubescens* (% of dry matter)**

Forage	EE (%)	CF (%)	Ash (%)	CP (%)	H_2O %	NFE (%)
S. gracilis	1	2.3	11	19.27	7	40.57
P. maximum	1.3	6.5	10	13.84	10	41.64
P. purpureum	4	6.2	10	14.63	9	43.83
C. pubescens	2	6.5	8	28.03	8	52.53

TABLE II: **Crude protein, dry matter and organic matter composition of *S. gracilis, P. maximum, P. purpureum, C. pubescens***

Forages	Crude protein (%)	Dry matter (%)	Organic matter (%)
S. gracilis	19.27	93	82
P. maximum	1.3.84	90	80
P. purpureum	14.63	90	81
C. pubescens	28.03	92	84

TABLE III: **Parameters of crude protein, dry matter and organic matter degradability of *S. gracilis, P. maximum, P. purpureum and C. pubescens* at 48hrs incubation**

Forage	Forage fractions								
	Crude protein			*Dry matter*			*Organic matter*		
	'a'(%)	*'b'(%)*	*C*	*'a'(%)*	*'b'(%)*	*C*	*'a'(%)*	*'b'(%)*	*C*
S. gracilis	4.82	8	0.007	13	62	0.023	13	50	0.021
P. maximum	1.2	6.8	0.007	8	42	0.014	1	39	0.012
P. purpureum	0.25	9.45	0.012	1	61	0.016	11	47	0.021
C. pubescens	0.87	13.33	0.007	8	42	0.009	8	43	0.013

TABLE IV: **Average disappearance of crude protein, dry matter and organic matter of *S. gracilis*, *P. maximum; P. purpureum* and *C. pubescens* at 48hrs incubation in sheep (%) (X ± E, n = 4)**

Forage	Potential degradability (%) at 48hrs incubation		
	Crude protein	*Dry matter*	*Organic matter*
S. gracilis	67.0±0.27*	75.0±3.0	63.10±1.0
P. maximum	57.4±0.27*	50.12±0.6	40.36±1.0
P. purpureum	66.0±0.97*	62.13±5.0	58.36±8.6
C. pubescens	50.7±3.5*	50.1±2.5	51.06±6.0

* = Obtained as: 'a' + ' b' percentage of total crude protein content of forage.

DISCUSSION

Centrosema pubescens and *Stylosanthes gracilis* are both tropical legumes. They have relatively high crude protein contents than the grasses as shown in table I. This result agrees with the report of Polk *et al.,* (1976) who compared the crude protein contents of grasses and legumes grown together without the use of commercial fertilizers. Minson, (1990) also reported that the average crude protein content of legumes and legume-containing pastures were higher than those of grasses alone and pasture without legumes.

The dry matter and organic matter contents of the grasses (*Panicum maximum* and *Pennisetum purpureum*) and legumes (*Centrosema pubescens* and *Stylosanthes gracilis)* were slightly higher than those reported by Oyenuga, (1957). This could be as a result of differences in the leaf/stem ratio (Ramirez *et al.,* 2001a; Stritzler *et al.,* 1996); the stage of growth at cutting or grazing the soil fertility, manuring, treatment and by climatic conditions (Minson, 1990). The fertility of the soil upon which grasses and legumes are grown affects their dry matter and organic matter contents, but not on digestibility (Verbic *et al.,* 1999).

Forage plants at different stages of growth have different dry matter, organic matter and mineral contents. In table I high crude protein content of *S. gracilis* was characterized by low crude fiber content. Conversely, the relative lesser crude protein content of *P. maximum* and *P. purpureum* were characterized by higher crude fiber content. These observations agrees with the observation of Polk *et al.,* (1976) and Strizler *et al.,* (1996). These workers reported that there is a reciprocal relationship between the crude protein and crude fiber contents in a given forage specie, although this relationship can be upset by the application of nitrogenous fertilizes. This trend however contrasts the observation for *C. pubescens*, which had a high crude protein as well as high crude fiber contents.

The percent crude protein of panicum maximum (13.84%) as observed in this study agrees with that of Oyenuga (1960a) who reported that in the dry matter for 3-weekly cuts of *panicum maximum* the crude protein was (12.8%).

The observation that dry matter contents of all the forages were more than 90%, likewise the organic matter contents being more than 90% of the dry matter agrees with the observation of Arigdede *et al.,*(2002). This observation led him to conclude that any factor that affects dry matter degradability will also affect organic matter degradability.

Tropical grasses have a higher tensile strength than temperate ones, a feature which results in both decreased solubility and slow microbial degradation in the rumen (Verbic *et al.*, 2001a).

The potential dry matter degradability characteristics of *P. purpureum,* as observed in this study being 62% at 48hrs agrees totally with the finding of Smith *et al.*, (1994) who reported a dry matter degradability of 63% for *P. purpureum* at 48hrs. Conversely, his report on dry matter degradability for *S. gracilis* given as 44% at 48hrs varies considerably from the observation in this study given as 75% at 48hrs. This variation could be attributed to age of forage, seasonal effect, part of forage studied.

The maximum incubation period of 48hrs was chosen as it represents the maximum incubation period of the rumen degradability of the forages studied. It is expected that under normal rumen outflow rate of 0.0863l/hr in sheep (AOAC, 1980) most of the rumen degradable fractions of any feed within the rumen should undergo optimum degradation between 48 and 72hrs. Therefore, for tropical forages, with high crude fiber content, optimal rumen degradability is likely to be achieved within the lower range of 48hrs. The trend of the rumen degradability of these forages show that the crude fiber content of any forages determines, to a great extent, the degree of potential dry matter degradability.

Rumen degradability has been reported to have an inverse relationship to fiber content (Aye, 2002). Smith *et al.*, (1994) have demonstrated a high negative correlation coefficient ($r = 0.93$, $p < 0.05$) between dry matter rumen degradability of forages, browse, crop residues and agricultural by products and their acid-detergent fiber content. Since leaves were used for this study higher rumen degradability characteristic is expected (Ramirez *et al,* 2001a, Stritzler *et al.,* 1996).

CONCLUSION

The degradability characteristics of *S. gracilis* was found to be higher than *P. maximum P. purpureum* and *C. pubescens.* Notably, the general degradability characteristics of these forages is such that a combination of these grasses and legumes would make good forage based diets for ruminants. This is because they have well varied crude fiber contents and adequate proportions of rumen degradable and by-pass proteins, which are good indices of nutritional merits for forages used as protein sources in ruminant diets.

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