COMPARATIVE RUMEN DRY MATTER DEGRADABILITY OF SELECTED PARTS OF DIFFERENT LOCAL NAPIER (*PENNISETUM PURPUREUM*) GRASS CULTIVARS IN SHEEP AND GOATS

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SUMMARY

A degradability experiment was conducted to evaluate the feeding value of four selected local Napier (*Pennisetum purpureum*) grass cultivars namely Madizini (L8), Kilakala (L11), Kigurunyembe (L12) and Mlimakola (L13). The four selected genotypes were among the severally growing naturally local Napier accessions within the peri-urban and urban areas of Morogoro municipality. Dry Matter (DM) degradation characteristics were determined using nylon bags to incubate the four ground cultivars of the Napier into rumens of three fistulated Black Head Persian (BHP) rams as well as three cross-bred bucks. Incubation was carried out for 12, 24, 48, 72, 96 and 120 hours. To determine the degradability trend, the data were fitted to the exponential model: $Y = a+b(1 - e^{-ct})$. Potential degradability (a+b) ranged from 78.5 for Kilakala cultivar to 81.1 for Madizini and the degradation constant (c) ranged from 0.0481 for Madizini to 0.0687 fractions per hour for Kilakala. Effective degradability at 1% passage rate significantly ($P<0.05$) varied from 69.7 for Mlimakola to 71.2 for both Kilakala and Kigurunyembe cultivars. DM degradation means for sheep and goats were not significantly ($P>0.05$) different. The results demonstrated a possible trend for the Kilakala and Kigurunyembe cultivars to be nutritionally superior to others.

INTRODUCTION

Forages are cheapest sources of feeds for ruminants in the tropics. However, there has been a concern over the ability of the different forages to support animal production. Attempts have been made to explore the different nutritive values of forages through digestibility studies. The widely used digestibility methods include *in vivo, in vitro and in sacco,* all collectively referred to as biological techniques (Mehrez and Ørskov, 1977).

Significant interest has recently developed in the use of the *in sacco* (a degradability technique) which uses rumen fistulated animals. The reason for its popularity is that the technique efficiently predicts both the potential digestibility and rate of digestion of nutrients in the rumen (Preston and Leng, 1987). Moreover, it has been found that Voluntary Feed Intake (VFI) can be explained from degradation profiles of DM or Neutral Detergent Fibre (Weisbjerg and Hvelplund, 1993).

Napier grass (*Pennisetum purpureum)* also known as Elephant grass or Uganda grass in East Africa, is one of the widely used forage grass particularly under the stall fed, zero-grazing production systems (Skerman and Riveros, 1990; Muinga *et al.* 1992). The grass is a thick stemmed, tall erect perennial of up to 4.5m high (GØhl, 1981). The plant is robust with vigorous and deep root system which enables it to survive drought quite well (Skerman and Riveros, 1990). However, there is extensive variation within Napier germplasm in terms of forage yield, growth and maturity rates, leaf to stem ratio and the degree of hairy cover of the stem which varies from location to location. The later characteristic not only makes handling difficult, but it also causes irritation in livestock (Mtengeti *et al.* 1993; Ndemanisho, 1996). The grass is however, highly digestible when young decreasing with increasing maturity, as a result of rising fibre content (Ademosun, 1970). The protein content has been reported to be relatively low (4 - 5%) but adequately meeting the requirements of animals in Vitamin A and minerals such as Selenium and Calcium (Abour-Ashour *et al.* 1984).

Considerable work on degradability studies to compare forage utilization by sheep, cattle and goats has confined itself to low quality roughages, such as straw and banana tissues (Sundstøl *et al.* 1978 and Shem *et al.*, 1993). Without supplementation these low quality materials have poor degradability to the extent that they require treatment before they can contribute to animal nutrition (Kilongozi, 1992 and Ndemanisho, 1996). Napier grass which grows and fed widely to ruminants in the tropics, may have better potential compared to the low quality roughages (Muinga *et al.*, 1992). However, there is little information on the degradability characteristics of Napier grass, particularly on comparative basis of different native cultivars. It is quite essential that degradability of feed nutrients be known to meet the animals nutritional requirements (Poos-Floyd *et al.* 1985). This study was therefore designed to evaluate dry matter (DM) degradability characteristics of different local Napier grass cultivars in comparison between goats and sheep.

MATERIALS AND METHODS

Animals and feeds

Three Black Head Persian (BHP) rams (S_1- S_3) and three cross-bred (Norwegian x Tanzanian local) bucks (G_1-G_3), with mean initial liveweights of 36.7±8.18 and 33.3±2.11kg respectively, were used in this study. They were all fistulated in the rumen and each fitted with a rumen cannula whose internal diameter was 35mm for sheep and 30mm for goats. The animals were put in individual cages. The basal ration consisted of chopped, fresh Napier grass, collected around Morogoro town. They were named after the peri-urban and urban areas' names out of where they were collected from. The grass was harvested in its vegetative stage and was fed at 35g DM/kg$W^{0.75}$ per animal per day (Table 1).

The grass was supplemented with 30% concentrate made up of two parts of cotton seed cake (CSC) to one part maize bran (MB), plus 1% mineral mix (based on the concentrate ration). There was a 10 day adjustment period followed by 16 day of data collection. Fresh feeds were offered in two portions at 0800h and 1600h. Clean drinking water was given *ad-libitum*.

Chemical analysis

All forages and concentrates used in the experiment were analyzed for DM and ash according to Association of Official Agriculture Chemists (AOAC, 1991) procedures. The Kjedahl method was used for crude protein (CP) determination. Cell wall constituents (CWC), such as neutral detergent fibre (NDF) was determined by the method of Goering and Van Soest (1970).

Degradability experiment

Rumen degradabilities were measured using the nylon bag technique as outlined by Ørskov *et al* (1980). Prior to chopping, stems thicker than 1.5cm in diameter were removed to create uniformity. Chopped samples were dried at 60°C for 48 hrs, ground to pass through a 2.5mm screen, and stored for analysis. Two grams of each sample were weighed in duplicates and put into labelled nylon bags. The bags were tightly sealed with rubber bands and tied securely with more rubber bands onto manila string. Each string was supported with a bag containing a sinker in order to anchor the sample bags within the ventral rumen sac.

The sample bags were incubated in the rumens of the respective caged animals through their rumen cannulae. Each of the fistulated animals received a single string containing eight sample bags at any incubation.

Table 1 Composition of basal diets and concentrate ingredients (g) offered daily to experimental animals

Sheep n=3	Goat n=3	Napier grass (g/d)	CSC (g/d)	Maize bran (g/d)	Mineral premix (g/d)
S^1	-	3200	128	64	2
-	G^1	2500	97	49	1.5
S^2	-	2500	96	48	1.5
-	G^2	2500	97	49	1.5
S^3	-	2200	88	44	1.3
-	G^3	2500	97	49	1.5

Incubation was done at the same hour of each experimental day (i.e. one hour after the morning feeding) to eliminate variations. The bags were removed at 0, 12, 24, 48, 72, 96 and 120 hours (h) post incubation. The 0-h incubation was obtained by soaking the bags for 2 h in water.

All bags were washed thoroughly in tap water until the water passing through the bags was clear. This process was repeated after each incubation time. Subsequently, the bags were dried at 60°c for 48 h. DM degradability of the samples were determined according to AOAC (1990) procedures.

Calculation

DM degradability of the samples were calculated from the disappearance of DM from the bags after rumen incubation and washing as follows:-

Dry matter degradability (DMD)= Weight of DM incubated - (Weight of DM residue)/ Weight of DM incubated

Effective ruminal degradability (ERD) was calculated using the following equation according to Kristensen *et al* 1982:-

$P = a + bc/c+k$

where P is effective ruminal degradability, k is the passage rate. The percentage of the material degraded (p) after a certain time (t) was described by the equation of Ørskov and McDonald (1979):-

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

with a, b, and c being constants for

both equations 1 and 2.

where:-

p = the percentage degradation at time t

a = water soluble component (intercept of the degradation curve at time zero)

b = not water soluble, but potentially rumen degradable part

a+b= potentially rumen degradable part (asymptote)

c = the rate constant at which b is degraded

The asymptote a+b (the maximum digestibility of the feed ingredients) - cannot exceed 100. It follows that 100 - (a+b) represents the fraction which will appear to be undegradable in the rumen.

The values of both equations (1) and (2) were calculated in a computer using a special program called NAWAY, developed by Ørskov *et al* (1980) and Ørskov (1982).

Statistics

Parameters for the rate of degradability were subjected to a T -test and the General Linear Models (GLM) procedure using the SAS computer program (SAS, 1990).

RESULTS

Chemical Composition

Results for chemical composition of the various Napier cultivars are as shown in Table 2. The four cultivars demonstrated similar values of DM. Values for CP were lowest for Mlimakola and highest for Madizini and Kilakala cultivars. The NDF were significantly higher for Madizini and Mlimakola.

Degradability

The potential degradabilities or asymptotes (a+b) and the degradation rate constants of the four Napier grass cultivars are summarized in Table 3 and Figure 1. Sheep and goats in this study did not show significant ($P>0.05$) difference in their capabilities to degrade DM of the four cultivars at each of the incubation times, thus necessitated the data to be pooled together into one graph (Fig. 1) for both species. Figure 1 indicates that the constants for the four cultivars were most rapid between 12 and 48 hours of incubation. It illustrated that cultivar Kilakala had the most rapid rate of degradability which differed significantly ($p<0.05$) from that of Madizini, but not ($p>0.05$) from of Kigurunyembe and Mlimakola.

Table 2 Chemical composition of the different Napier cultivars on DM basis

	Napier grass cultivars			
Nutrient	Madizini (L8)	Kilakala (L11)	Kigurunyembe (L12)	Mlimakola (L13)
DM	94.6±0.1	93.8±0.2	93.3±0.01	93.8±0.01
CP	9.4±0.01	9.4±0.01	9.0±0.1	8.4±0.1
NDF	72.9±1.7[a]	65.4±0.3[b]	65.2±0.3[b]	74.6±4.3[a]

High mean DM degradability (70%) was exhibited after 48 hours of incubation by all cultivars in both sheep and goats (Figure 1).

Degradability rates (c) were significantly higher (P< 0.05) for the Kilakala and Kigurunyembe, followed by Mlimakola and Madizini. The highest water soluble component (a) was recorded for Mlimakola and Kigurunyembe and their values differed significantly (P<0.05) from that of Madizini and Kilakala, but did not differ significantly (P>0.05) from that of Kigurunyembe (Table 3). The component insoluble in water, but potentially rumen degradable (b) ranged from 53.3 for Kigurunyembe to 59.2 for Madizini and the latter was statistically significantly (P<0.05) highest of all the cultivars.

Effective DM degradability

Table 4 presents the effective dry matter degradabilities (DMD) with standard error (SE) values for the four cultivars at different fractional passage rates (% per hour). At 1% fractional passage rate, cultivars Kilakala and Kigurunyembe had highest effective degradability which differed significantly (P<0.05%) from that of Mlimakola, but not (P>0.05) from that of Madizini. The effective degradabilities for all the four cultivars in the present experiment decreased as the rate of passage increased from 1% to 4%. The table shows that there is a close relationship between the degradation rate at 1% fractional passage rate and the effective degradability at 48h.

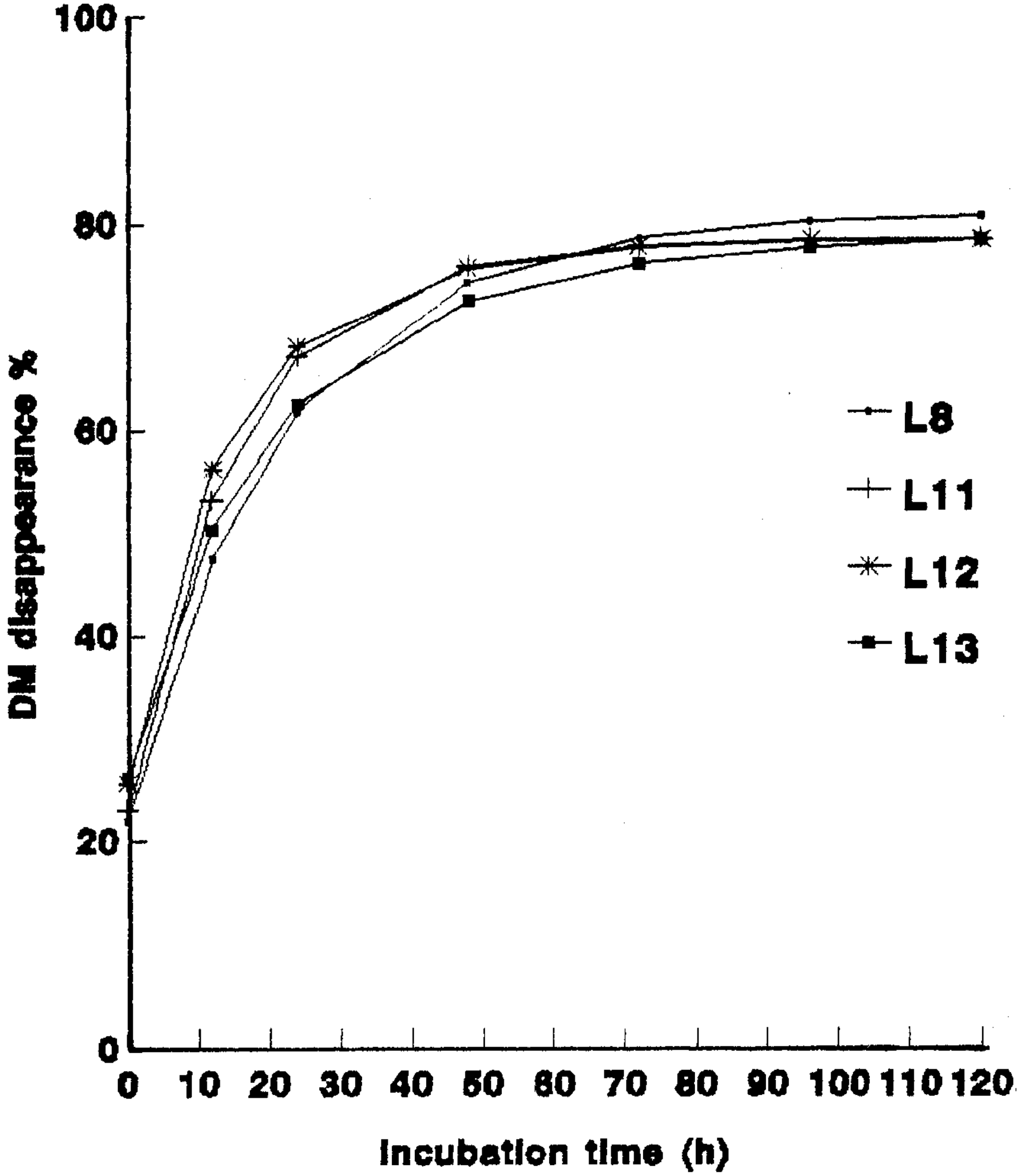

Figure 1: DM disappearance of 4 cultivars of Napier grass in rumen of 3 bucks and 3 rams fed standard diet

Table 3: DM degradability characteristics of the experimental cultivars from the equation $p = a+b(1 - e^{-ct})$

Napier grass cultivar	Madizini L8	Kilakala L11	Kigurunyembe L12	Mlimakola L13
DMD				
a	21.9[c]	23.4[b]	25.5[a]	26.1[a]
b	59.2[a]	55.1[b]	53.3[b]	53.4[b]
c	0.048[b]	0.069[a]	0.067[a]	0.055[ab]
a+b	81.1[a]	78.5[b]	78.8[b]	79.5[ab]
Residual s.d.	3.9	4.7	4.9	6.9

Table 4: Effective DM degradability at 4 different fractional passage rates

Passage rate % per h	Madizini L8	Kilakala L11	Kigurunyembe L12	Mlimakola L13	S.E.
1	70.5[ab]	71.2[a]	71.2[a]	69.7[b]	0.4
2	63.2[b]	65.6[a]	65.6[a]	63.3[b]	0.7
3	57.9[b]	61.2[a]	61.3[a]	58.7[ab]	0.9
4	53.8[b]	57.7[a]	57.9[a]	55.1[ab]	1.0
48h	73.9[a]	72.7[ab]	70.2[b]	70.7[b]	0.9

DISCUSSION

Chemical composition

The nutrient contents of Napier grass observed in the four cultivars compare well with those reported by other workers (Gohl, 1981 and ARC, 1990). The highest values of CP content seen in Madizini and Kilakala cultivars did not show an inverse relationship to their NDF values as expected, except for the latter cultivar. It is natural that as a plant matures its CP content decreases while the NDF content increases. Mlimakola cultivar showed the expected trend in that the lower the CP the higher was the NDF content. Possible cause for higher NDF could be that the cultivars Madizini and Mlimakola were maturing faster than the Kilakala and Kigurunyembe cultivars, probably due to different soil qualities and other enviromental conditions. Furthermore, it has been stipulated that both NDF and DM tend to increase in forages with advancing maturity (Ademosun, 1970; Mgoya, 1975; Gohl, 1981 and McDonald *et al.*, 1995).

Degradability

Cultivars of Madizini and Mlimakola were degraded more slowly compared to the other two cultivars. Consequently this could be due to the higher NDF contents. A tendency for feeds high in NDF content to resist degradation by rumen microorganisms has been reported (Smith *et al.*, 1972; Ørskov *et al*, 1974; Muya, 1988). Slow degradation rate of these two cultivars imply increased retention time of the digesta in the rumen, hence decreased feed intake (Ørskov *et al*, 1974; Kimambo *et al.*, 1991; Shem *et al.*, 1992). The rates of degradation of cultivars of Kilakala and Kigurunyembe were statistically non-significant ($P>0.05$), but significantly higher ($P<0.5$) than those of Madizini and Mlimakola. The significantly ($P<0.05$) high levels of washing losses (a) for Mlimakola and Kigurunyembe cultivars were expected to follow similar trend to their degradability values, but this was not so with the Mlimakola grass, however Kigurunyembe cultivar's degradability value was high similar to its water loss (a) value. This discrepancy could have been rectified and more certain values obtained if the organic matter (OM) were measured. OM was not measured due to lack of the required facility. Usually the water soluble fraction is the major part of the OM degradation loss which occurs during the first hour of incubation without a lag phase and is correlated with the voluntary DM intake (Carro *et al.*, 1991). Generally, there has been a tendency for feeds with high levels of the soluble materials and high rates of degradation to reach maximum degradation in a relatively shorter time (Shayo, 1992).

Effective degradability (ED)

The largest drops in the effective degradability were for cultivars Madizini and Mlimakola, which also had the highest NDF contents. Similar results have been obtained by other workers (Ørskov and Ryle, 1990; Kimambo *et al* 1991 and Shem *et al* 1992). The higher ($P<0.05$) ED at 1-4% per h for cultivars Kilakala and Kigurunyembe may suggest higher intakes of these cultivars. However the trend was not the same at 48h and the reason behind this is not known. It has been reported that at higher fractional passage rates, a large proportion of the nutrients from a feed will be lost in faeces particularly for forages requiring more retention time (Mehrez and Ørskov, 1977; Ørskov and McDonald, 1979; Kimambo *et al.*, 1991 and Shem *et al.*, 1992). This was evident for the Madizini and Mlimakola cultivars, it was speculated that they had longer retention time than their counterparts. Although Madizini cultivar tended to have lower effective degradability at lower passage rates, this was not reflected in the 48h degradability value. The cultivar reflected a significantly higher ($P<0.05$) DMD at 48h incubation compared to the rest of the cultivars. It may not alter or influence the quality of the forage even if it was given ample retention time in the rumen, because the extent to which a slowly digested forage is eventually degraded could not be improved. On the contrary delayed rumen evacuation may better be avoided because it negatively influences retention times and hence limits dry matter and energy intake (Kimambo *et al.*, 1991; Shem *et al.*, 1992). In this respect Kilakala and Kigurunyembe cultivars indicated a trend of nutritional superiority over their counterparts.

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