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Influence of grass species and stage of maturity at ensiling on intake and partial digestibility by sheep

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Abstract

The aim of this study was to compare intake and partial digestibility of organic matter (OM) and nitrogen (N) of two ensiled tropical grass species, *P. maximum* and *D. eriantha*, made either at the boot or full bloom stage of growth. Intake and digestibility were determined by the double marker technique where Yb and Cr were infused continuously into the rumen with a peristaltic pump. Except for OM disappearance in the digestive tract, neither species nor stage of harvesting had an effect on intake, digesta flow and OM disappearance within the rumen and small intestine. For *P. maximum* silage, N intake (g/d) was higher at the full bloom than at the boot stage. Total abomasum N flow (g/d), non-ammonia nitrogen (NAN) flow (g/d), NAN flow per N intake and NAN disappearance as % of N intake in the gastrointestinal tract (GIT) were higher for sheep fed on *D. eriantha* than *P. maximum* silage made at full bloom. In *D. eriantha* silage NAN disappearance was higher for silage at full bloom than *D. eriantha* silage at boot stage. The true N-digested (%), however, did not differ significantly between the species or stage of maturity. In terms of NAN disappearance in the lower GIT it is evident that silage made from *D. eriantha* at the full bloom stage is superior to silage made at the boot stage, as well as to silage made from *P. maximum*.

Keywords: Boot stage, *Digitaria eriantha*, non-ammonia nitrogen, organic matter disappearance, *Panicum maximum*
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Introduction

Panicum maximum (Guinea grass) and *Digitaria eriantha* (Smuts finger) grass are adapted to a wide range of climatic and soil conditions (Aganga & Tshwenyane, 2004). The silage made from these grasses could supply quality roughages during the late winter and early spring periods when natural pasture has a poor nutritive value (Tainton, 2000). The objective of this study was to compare intake and partial digestibility of organic matter (OM) and nitrogen (N) of two ensiled tropical grass species (*P. maximum* and *D. eriantha*) either at the boot or full bloom stage of growth.

Materials and Methods

Panicum maximum and *D. eriantha* pastures were harvested each from an area of 0.4 ha at two stages (boot and full bloom) of growth. Each of these grasses were separately wilted to a dry matter (DM) concentration of 30% and ensiled with the addition of 8 kg sugar/ton DM in airtight plastic bags (3.1 m x 2.75 m).

Four silage diets were studied in a 2 x 2 factorial experimental design. The treatments consisted of two grass species (*P. maximum* or *D. eriantha*) and two growth stages (boot or full bloom) at harvest. Four multi-cannulated sheep fitted with ruminal, abomasal and ileal cannulas were randomly allocated to one of the four silage diets for the partial digestibility study. The animals were fitted with faecal collection bags. The sheep were housed in individual metabolism crates and fed *ad libitum*. The animals had free access to a 50 : 50 dicalcium phosphate/salt lick and fresh water was available.

The double marker technique, with continuous infusion and sampling at pre-determined times, as described by Faichney (1975), was used to determine the partial digestibility of the silage. Chromium (Cr)-EDTA (220 mg Cr per day) (liquid phase marker) and ytterbium (Yb)-acetate (90 mg Yb per day) (solid phase marker) were infused continuously with a peristaltic pump into the rumen for 24 h per day over a period of eight days. The exact sampling times of ruminal and abomasal fluid were: day 1 at 09:00 and 21:00; day 2 at 12:00 and 24:00; day 3 at 15:00 and 03:00; and day 4 at 18:00 and 06:00.

Ruminal and abomasal fluid were collected, thawed and the supernatants were used for determination of rumen ammonia nitrogen (NH_3-N). Total faecal excretion was measured twice daily at 08:00 and 18:00 and a 10% subsample of the faeces was pooled and frozen pending analysis. Abomasal fluid samples were thawed and a portion of the sample was centrifuged to determine concentrations of NH_3-N, Yb and Cr (Morgan *et al.*, 1976). Feed intake was estimated by recording the amount of silage offered and refused.

Dry matter, ash and N concentrations were determined according to AOAC (2000) methods and neutral detergent fibre (NDF) concentration according to Robertson & Van Soest (1981).

All parameters were analyzed using Proc GLM of SAS (2001). The influence of grass species and growth stage was investigated and where the F ratio showed significance differences ($P < 0.05$), the means were tested using Bonferroni's test according to Samuels (1989).

Results and Discussion

Table 1: Partial digestibility of organic matter by sheep fed *P. maximum* and *D. eriantha* silages harvested at boot and full bloom stages of growth

Parameters	Stage of growth at harvest	Pasture species	
		Panicum maximum	*Digitaria eriantha*
Intake			
OMI (g/d)	Boot	977_1^a (± 12.4)	978_1^a (± 12.4)
	Full bloom	1086_1^a (± 12.4)	1194_1^a (± 12.4)
DOMI (g/kg $W^{0.75}$/d)	Boot	33.2_1^a (± 2.2)	32.2_1^a (± 2.2)
	Full bloom	33.9_1^a (± 2.2)	38.9_1^a (± 2.2)
Digesta flow (L/d)			
Abomasum	Boot	24.3_1^a (± 2.2)	19.4_1^a (± 2.2)
	Full bloom	19.2_1^a (± 2.2)	19.1_1^a (± 2.2)
Ileum	Boot	7.1_1^a (± 1.2)	6.7_1^a (± 1.2)
	Full bloom	5.8_1^a (± 1.2)	5.6_1^a (± 1.2)
OM disappearance in the rumen			
Disappearance in the rumen (g/d)	Boot	475_1^a (± 11.6)	499_1^a (± 11.6)
	Full bloom	599_1^a (± 11.6)	615_1^a (± 11.6)
Disappearance as % of OMI	Boot	48_1^a (± 3.2)	51_1^a (± 3.2)
	Full bloom	55_1^a (± 3.2)	51_1^a (± 3.2)
OM disappearance in the small intestine	Boot	107_1^a (± 9.1)	107_1^a (± 9.1)
	Full bloom	158_1^a (± 9.1)	204_1^a (± 9.1)
OM disappearance in small intestine as % of OMI	Boot	11_1^a (± 2.8)	11_1^a (± 2.8)
	Full bloom	15_1^a (± 2.8)	17_1^a (± 2.8)
OM disappearance in GIT as % of OMI	Boot	74_1^a (± 2.4)	74_1^a (± 2.4)
	Full bloom	72_1^a (± 2.4)	75_1^a (± 2.4)

Means within columns (a,b) and rows (1,2) with different superscripts differ significantly at $P < 0.05$.

Grass species had no significant effect on intake, digesta flow and OM disappearance, both in the abomasum and ileum of sheep fed on the silages (Table 1). Generally the level of digestible OM intake per kg $W^{0.75}$ ranged from 32.2 to 38.9 g/kg $W^{0.75}$/d and, according to Engels (1972), this is sufficient to meet the maintenance requirement of grazing sheep. The digesta flow both in the abomasum and ileum as well as OM disappearance in the rumen and GIT recorded in our study is within the range reported by Relling *et al.* (2001) while the OM disappearance values in the small intestine were generally low compared to values reported for *P. maximum* pasture during summer.

The partial digestibility of N of the two grass silages is presented in Table 2. The total N intake (g/d) of the sheep was not significantly different ($P > 0.05$) among the two grass species. However, the total N flow (g/d), non-ammonia nitrogen (NAN) flow (g/d) and NAN flow per N intake in the abomasum for *D. eriantha* were higher than *P. maximum* silage when compared at the full bloom stage. The high level of disappearance of NAN for *D. eriantha* is an indication that more amino acids (of microbial protein origin) were available for absorption from this species (Relling *et al.*, 2001). The NH_3-N flow (g/d) in the abomasum as well as the total N-flow (g/d) and NAN flow (g/d) recorded in the ileum did not differ among the two grass species. At boot stage *D. eriantha* silage had a higher NH_3-N flow (g/d) in the ileum than *P. maximum* silage, while the two grass silages didn't differ when compared at the full bloom stage.

Table 2: Partial digestibility of nitrogen in sheep fed *P. maximum* and *D. eriantha* at boot and full bloom stage of growth

Parameters	Stage of growth at harvest	Pasture species	
		Panicum maximum	*Digitaria eriantha*
N intake (g/d)	Boot	20.0_1^b (± 2.0)	25.5_1^a (± 2.0)
	Full bloom	28.1_1^a (± 2.0)	27.4_1^a (± 2.0)
Abomasum			
Total N-flow (g/d)	Boot	19.5_1^a (± 2.2)	21.0_1^a (± 2.2)
	Full bloom	20.5_2^a (± 2.2)	27.5_1^a (± 2.2)
NH_3-N flow (g/d)	Boot	2.1_1^a (± 0.8)	2.3_1^a (± 0.8)
	Full bloom	1.9_1^a (± 0.8)	1.9_1^a (± 0.8)
NAN flow (g/d)	Boot	17.4_1^a (± 2.2)	18.7_1^a (± 2.2)
	Full bloom	18.6_2^a (± 2.2)	25.6_1^a (± 2.2)
NAN flow/N-intake	Boot	0.87_1^a (± 0.04)	0.74_1^a (± 0.04)
	Full bloom	0.66_2^a (± 0.04)	0.95_1^a (± 0.04)
Ileum			
Total N-flow (g/d)	Boot	8.5_1^a (± 1.5)	8.9_1^a (± 1.5)
	Full bloom	7.7_1^a (± 1.5)	10.2_1^a (± 1.5)
NH_3-N flow (g/d)	Boot	0.11_2^a (± 0.20)	0.22_1^a (± 0.20)
	Full bloom	0.10_1^a (± 0.20)	0.10_1^b (± 0.20)
NAN flow (g/d)	Boot	8.4_1^a (± 1.4)	8.7_1^a (± 1.4)
	Full bloom	7.6_1^a (± 1.4)	10.1_1^a (± 1.4)
NAN disappearance (% of N intake)	Boot	45_1^b (± 3.7)	40_1^b (± 3.7)
	Full bloom	39_2^a (± 3.7)	58_1^a (± 3.7)
True N-digested (%)	Boot	88_1^a (± 1.6)	86_1^a (± 1.6)
	Full bloom	89_1^a (± 1.6)	86_1^a (± 1.6)

Means within columns (a,b) and rows (1,2) with different superscripts differ significantly at $P < 0.05$.

At full bloom stage, *D. eriantha* had a higher GIT NAN disappearance (as % of N intake) than *P. maximum* silage, while the two grass silages didn't differ when compared at boot stage. Generally the two grass silages did not differ in terms of true N digested (%) in the GIT.

Growth stage had no effect on intake, digestion and OM disappearance in the abomasum and ileum (Table 1). In contrast, Relling *et al.* (2001) reported a decrease in intake, abomasal digesta flow and OM disappearance in the small intestine with increasing maturity for *P. maximum* pasture harvested during the summer period. However, these parameters were not significantly different for the same species for autumn and winter harvest.

For *P. maximum*, higher N intake was recorded in sheep fed full bloom compared to boot stage silage (Table 2). This was due to a higher N concentration of *P. maximum* silage that was recorded at full bloom than boot stage (Hassen *et al.*, 2009). In *D. eriantha* silage, however, growth stage had no significant effect on N intake. Generally growth stage had no effect on the total N flow (g/d) and NAN flow (g/d) in both the abomasum and ileum. In contrast, Relling *et al.* (2001) found a lower abomasal N flow with increasing stage of maturity mainly associated to N, which is present in the fibre component. However, for *D. eriantha* the ileum NH_3-N flow (g/d) was higher in boot stage than full bloom stage silage. In contrast the NH_3-N flow in the abomasum generally was not affected by the growth stage. Likewise for *P. maximum* silage growth stage had no effect on ileal NH_3-N flow.

In *D. eriantha*, full bloom stage silage had higher GIT NAN disappearance (as % of N intake) than boot stage silage. In contrast, for *P. maximum* silage growth stage had no effect on GIT NAN disappearance. Growth stage had also no effect on true N digested (%) in the GIT by sheep fed the two grass silages (Table 2). In contrast, Relling *et al*. (2001) found lower total tract N disappearance with increasing stage of maturity for *P. maximum* pasture during summer and autumn, but not during the winter period.

Conclusions

No differences occurred in terms of OMI and disappearance between *P. maximum* and *D. eriantha* silage, ensilaged either at the boot or full bloom stage. The N and NAN flow as well as NAN disappearance favoured the full bloom ensiled stage of *D. eriantha* silage, resulting in a higher nutritive value for lambs compared to *P. maximum* silage.

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