Digestibility of Diets Based On Napier Grass, *Tithonia Diversifolia* and *Sapium Ellipticum*,

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Citation:

Maragara, E.N., Wahome, R.G., Badamana, M.S., Musalia, L.M., Njoka, E.N and Bundi, R.M.(2014). Digestibility of Diets Based On Napier Grass, *Tithonia Diversifolia* and *Sapium Ellipticum.* In: Isutsa, D.K. and Githae, E.W. *Proceedings of the First International Research Conference held from 29th to 31st October, 2014 in Chuka University, Chuka, Kenya.36-40pp.*

ABSTRACT

Tithonia diversifolia and *Sapium ellipticum* fodder species are widespread in Central, Western Province and the wetter areas of the coastal and Rift Valley regions. They could be used to supplement Napier grass fodder. However, there is little documentation on digestibility of diets that include varying proportions of either *Tithonia* or *Sapium*. This study compared the digestibility of diets consisting of varying proportions of *Tithonia* and *Sapium* forages with Napier grass fodder. Fourteen Corriedale rams aged 18 months selected for uniformity of live weight at 20±3kg were used in the experiment. The weight of the sheep was determined at the start and at the end of each feeding period. The sheep were fed seven different experimental diets comprising of varied proportions of Napier grass, *Tithonia diversifolia* and *Sapium ellipticum*. The dry matter content varied with diet one having the lowest percentages 136 g/kg, diet four highest dry matter 639 g/kg. Napier grass fodder (control diet) lowest CP of (43 g/kg), while 75% *Tithonia* mixture had CP of 189g/kg. *Tithonia* based diets had lower NDF-ADF proportion of 276 g/kg, 282 g/kg and 229.5 g/kg than those of *Sapium* based diets with 296 g/kg, 258 g/kg and 256 g/kg. Diets 1, 5 and 7 reflected a negative N balance. These were the Napier grass control diet and the 25% and 75% supplementation of *Sapium* diets. *Tithonia* based diets yielded positive

nitrogen balance. Inclusion of both *Tithonia* and *Sapium* forages decreased feed intake, total faecal and urine output for all the diets, although proportionately to intake, the faecal and urine output increased.

Keywords: Ruminant animals, Nitrogen Balance, Neutral and Acid Detergent fiber.

INTRODUCTION

Ruminant animals are usually fed on napier grass as a basal diet. Napier grass is the most widely grown and popular fodder plant for the small- scale farmers in Kenya. Overdependence on napier grass for fodder needs is risky and alternative fodder species need to be sought. In Kenya both *Tithonia diversifolia* and *Sapium ellipticum*are widespread in Central, Western Province and the wetter areas of the Coastal and Rift Valley regions.*Tithonia diversifolia*is a robust shrub with fast growth to a height of three meters, while*Sapium ellipticum* is an evergreen indigenous tree growing to fifteen meters tall with drooping branches. There is very little documentation on digestibility of diets that include varying proportions of either Tithonia or Sapium. This study compared the digestibility of diets consisting of varying proportions of Tithonia and Sapiumforages with napier grass fodder.

MATERIALS AND METHODS

Study Site

The study was carried out at the KALRO Embu Research Centre, Embu district, Eastern Province of Kenya. The center is in a sub-humid agro ecological zone and is located 1490 meters above sea level at 0°30'S and 37°27'E. The deep, well weathered with friable clay texture soils in the area are humid Nitosol derived from basic volcanic rocks and classified by USDA under humid patehumult. The rainfall is moderate, an average of 1200-1500 mm (Jaetzold and Schmidt, 1983). It follows a bimodal pattern with long rainy season from March to June amounting to an average of 750mm. The short rain comes from October to December and average 350 mm and month temperature averages 18-21°C.

Study design

Experimental animals and housing

Fourteen (14) Corriedale rams aged 14 months selected for uniformity of live weight at 20±3kg were used in the experiment. The weight of the sheep was determined at the start and at the end of each feeding period. The 14 male Corriedale sheep were housed in individual wooden slatted pens. The metabolic units was wooden with raised and slatted floor subdivided into individual pens measuring approximately 1.5m by 1.5m by 2m mounted above a cemented floor.

Experimental Diets

Seven different experimental diets comprising of varied proportions of napier grass, *Tithonia diversifolia* (Tithonia) and *Sapium ellipticum* (Muthatha) were fed. Feeding was done over four, fifteen (15) day periods. The sheep were adapted to the diets in question during the first ten (10) days of each feeding period for the adaptation, and samples were collected in the last five (5) days. The seven diets were randomly allocated to two sheep at the beginning of each period resulting in a completely randomized design (CRD). Each diet was assessed with eight (8) animals during the feeding trail. During the five day collection period, daily feeds intakes and leftovers were measured and samples of feed on offer and refusals for each sheep were taken.

Laboratory Analysis

The feed and refusal samples taken were dried at 60^{o}c for 48 hours and milled to pass a 1mm screen and stored in clean grass containers for future analysis. Total daily faecal output was measured for each sheep, pooled, mixed thoroughly and a 10% sample taken and stored as separate samples in a freezer (-20°C) for each experimental period. The five days samples for each sheep were pooled at the end of the experiment and a composite sample taken for each experimental period. Sub-samples of the faeces were taken, oven dried at 60^{o}c to constant weight and ground (1mm mesh) for later chemical analysis.

The 24 hours urine output from each sheep was measured, recorded, mixed and a 10% sample taken and stored as separate samples in a freezer for each experimental period. The DM for feed offered, refusals and faeces were obtained by oven dying at 105°C to constant weight. Ash of the feed offered was determined by igniting samples in the muffle furnace at 600°C for 5 hours (AOAC, 1990). The feed, faecal and urine nitrogen contents were determined by the standard micro Kjeldal method (AOAC, 1990). Neutral detergent fiber (NDF) and Acid detergent fiber (ADF) were determined by the procedures described by Goering and Van Soest (1970).

Data management and analysis

Intake, faecal and urine outputs were recorded daily during the five day sampling period. The DM and the CP contents of the seven diets were established using proximate analysis. The DM of the dried samples was calculated after further drying the samples in the oven at 60°C and 105°C. NDF, ADF and ADL levels of the seven diets was established using the Van Soest analysis. Ash content was calculated by drying sample in the oven set at105°C and burning the samples in the muffle furnace at 600°C.

Apparent digestibility was calculated using the equation formula below:

$$\text{Apparent digestibility\%} = \frac{100*\text{Nutrient intake-Nutrient in feaces}}{\text{Nutrient intake}}$$

RESULTS

Chemical composition of the diets.

The dry matter content of the seven diets varied; with diet one having the lowest percentages 136g/kg while diet four had the highest dry matter 639g/kg. The DM content depended largely on the proportion of napier grass fodder fed. The dry matter content of the substitute diets increased with the level of inclusion of other feedstuffs. *Tithonia diversifolia* forage produced diets that had greater dry matter content than *Sapium ellipticum*.Napier grass fodder (control diet) had the lowest CP percentages of (43g/kg) while 75%Tithonia mixture (diet 4) had the highest CP of 189g/kg. The CP levels for the diets increased with increase of either Tithonia or Sapium forages as the hay had higher levels of CP than napier grass. Leaves and twigs from trees and shrubs have crude protein content ranging from 12-30% which is usually higher than that of mature grasses 3-10% (Le Houerou, 1980). Crude protein value of 8% is considered absolute minimum needed to maintain rumen function. The nutritive value of browse trees and shrubs varies with soil type, location, plant part (leaf and stem), age of leaf and season. The latter factors influence the forage chemical composition, palatability, intake, the extent and the rate of degradation, digestibility and the nutrient utilization by ruminants (Kaitho, 1997).

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RESULTS AND DISCUSSION.

Chemical composition of the diets

The dry matter content of the seven diets varied; with diet one having the lowest percentages 136g/kg while diet four had the highest dry matter 639g/kg(table 1). The DM content depended largely on the proportion of napier grass fodder fed. The dry matter content of the substitute diets increased with the level of inclusion of other feedstuffs. *Tithonia diversifolia* forage produced diets that had greater dry matter content than *Sapium ellipticum*.Napier grass fodder (control diet) had the lowest CP percentages of (43g/kg) while 75%Tithonia mixture (diet 4) had the highest CP of 189g/kg(table 9).

The CP levels for the diets increased with increase of either Tithonia or Sapium forages as the hay had higher levels of CP than napier grass. Leaves and twigs from trees and shrubs have crude protein content ranging from 12-30% which is usually higher than that of mature grasses 3-10% (Le Houerou, 1980). Crude protein value of 8% is considered absolute minimum needed to maintain rumen function. The nutritive value of browse trees and shrubs varies with soil type, location, plant part (leaf and stem), age of leaf and season. The latter factors influence the forage chemical composition, palatability, intake, the extent and the rate of degradation, digestibility and the nutrient utilization by ruminants (Kaitho, 1997).

Table 1: Nutrient composition for the seven diets containing 3 three levels of Tithonia and Sapium fodder g/kg DM (Dry matter basis).

Diet Mixture	DM, g/kg	CP, g/kg	NDF g/kg	ADF g/kg	ASH g/kg
All Napier grass fodder diet (D1)	136.0	42.9	800.01	436	111.1
25% Tithonia hay-75% napier grass fodder (D2)	417.7	124.1	641.2	365.5	141.1
50% Tithonia hay-50% napier grass fodder (D3)	512.3	143.4	591.7	311.5	145.8
75% Tithonia hay-25% napier grass fodder (D4)	639.0	189.2	499.4	269.9	146.6
25% Sapium hay-75% napier grass fodder (D5)	351.0	62.9	705.7	409.4	97.7
50% Sapium hay-50% napier grass fodder (D6)	460.0	99.8	628.5	370.2	94.4
75% Sapium hay-25% napier grass fodder (D7)	522.0	100.8	541.8	285.5	80.0

Fiber and ash proportions of the diets

NDF has been shown to be negatively correlated with dry matter intake in that as it increases, animals tend to reduce their dry matter intake. NDF levels increase with the advancing maturity of the forages

(Van Soest *et al*., 1991). Grasses with content of NDF above 60% DM for grasses are classified as poor in quality (Van Soest *et al*., 1991).

Tithoniabased diets had lower NDF-ADF proportion of 276g/kg, 282g/kg and 229.5g/kg than those of Sapium based diets with 296g/kg, 258g/kg and 256g/kg. The ADF levels decreased with increase in substitution of napier grass with either Tithonia or Sapium. The ADF component has been shown to be negatively correlated with the digestibility of forages (Van Soest *et al*., 1991). Tithonia based diets had higher Ash content than the other four diets, originating from the high ash content in Tithonia and were possibly an indication of high concentrations of minerals desired by animals (Kwabiah *et al*., 2003).

Feed Intake

Diet 2 had the highest intake with 0.6kg DM while diet 7 had the least intake with 0.4kg DM per sheep per day. Intake decreased with substitution of napier grass fodder with either Tithonia and Sapium hays.

Faecal material output and urine output

The average faecal output per sheep per day decreased as the level of napier grass decreased in all the six diets (table 9). However proportionately, faecal output increased with substitution of napier grass with either Tithonia or Sapium to the effect that diets with lower intake had proportionately higher faecal output.

The differences in N intake observed between animal species and level offered are largely due to fodder species differences in N content, since animals consumed most of the leaves on offer.

Table 2: Average Dry matter feeds intake (kgs), faecal output (kgs) and urine (Litres) for sheep offered.

	Feed Intake/ sheep/day	Faecal output/sheep/ day	Faecal output / Intake %	Urine output/ sheep/ day	urine/ intake %
All Napier grass fodder diet (D1)	0.588 a	0.18 a	32.9	0.111c	18.5
25% *Tithonia* hay-75% napier grass fodder (D2)	0.594 a	0.201	32.7	0.125 bc	25.7

50% *Tithonia* hay-50% napier grass fodder (D3)	0.545 b	0.183	32.6	0.158 ab	24.7
75% *Tithonia* hay-25% napier grass fodder (D4)	0.388 d	0.174	43.4	0.139 abc	30.9
25% *Sapium* hay-75% napier grass fodder (D5)	0.567 ab	0.196	33.9	0.171 a	29.5
50% *Sapium* hay-50% napier grass fodder (D6)	0.505 c	0.191	36.9	0.122 c	23.6
75% *Sapium* hay-25% napier grass fodder (D7)	0.383 d	0.187	47.3	0.119 c	30.1
SED	0.029	0.017		0.036	

Means with different superscript in the same column differ significantly ($P<0.05$)

DISCUSSION

Average digestibility coefficients for the seven diets are presented in (table 3a) and the summary ANOVA of their comparison in (table 3b). The digestibility of the dry matter for all diets decreased with an increase in the level of inclusions of the substitution diets. Diet two had the highest digestibility coefficient for dry matter (72.3%) amongst the seven diets while diet seven had the lowest (56.5%).The digestibility coefficient of the CP was lowest in diet 1 (52.6 %) while the digestibility coefficient for CP was highest in diet 2 (81.6%). A number of factors are known to influence digestibility. Among them are such feed factors as chemical composition, feed preparation and level of feeding. Among the animal factors are animal age, metabolic needs and water. The arrangements in this study strategized to minimize selection. Diets 1, 5 and 7 reflected a negative N balance (table 4). These were the napier grass control diet and the 25% and 75% supplementation of Sapiumdiets. Tithonia based diets yielded positive nitrogen balance. Loss of N through urine was low for all the treatment diets. Muia, (2000) suggested that protein supplementation improves growth and nitrogen balance in animals. Therefore the positive balance experienced in the diets of Tithoniawas occasioned by the high protein content (20.7%) of *Tithonia diversifolia* foliage.

Sapiumconstituted diets only diet six yielded a positive nitrogen balance confirming the fact that the CP level was the major factor in determining the nitrogen balance. The negative nitrogen balance experienced in the diet one could have been caused by the low CP of 4.29% that was below the limiting level of 6-8% and consequently a low apparent digestibility coefficient of 52.6%. The negative nitrogen balance experienced in Sapium diets five and seven could be as result of low CP levels (6.29% and

9.98%) respectively.These two diets had CP levels considerably lower than those of Tithonia. The drying effect of Sapium forage could have affected the Sapium diets probably more negatively than the Tithonia forages since Sapium is reported to have higher tannin levels than Tithonia forages (Sekatuba *et al*., 2004). However, Tithonia masked the effect of drying because it is very low in tannins. The implication of negative nitrogen balance is that the experimental sheep would break down tissue protein to meet demand of amino acids required for normal metabolism.

Table 3a: Mean apparent digestibility coefficients (%) and nitrogen balance (g/day) for the different components analyzed for the seven diets

Dig. Coefficients	Diets							
	1	2	3	4	5	6	7	SEM
DM	69.8	72.3	67.5	60.8	69.0	66.3	56.5	2.1
CP	52.6	81.6	77.4	74.9	80.9	78.0	55.2	3.6
NDF	69.8	70.2	65.0	58.3	67.7	62.8	49.1	2.5
ADF	67.9	68.6	58.9	52.0	66.9	62.4	38.2	2.6
ASH	60.5	69.8	64.2	50.4	54.5	58.6	28.9	3.5
N balance	-4.64	4.26	4.77	8.61	-3.82	6.48	-3.24	1.45

Table 3b: Analysis of variance for Mean apparent digestibility coefficients for the different components analyzed for the seven diets

	Df	Mean Square	F	Probability
DM	6	243.7	6.78	0.000
CP	6	1157.8	10.05	0.000
NDF	6	454.8	8.65	0.000
ADF	6	966.0	15.92	0.000
ASH	6	1397.7	11.37	0.000

Table 4: Nitrogen Balance (g/day) for sheep fed seven diets in four periods of a feeding trial

Chemical component	1	2	3	4	5	6	7	SEM
Dietary crude protein	4.29	12.41	14.34	18.92	6.29	9.98	14.32	0.000
Dietary Nitrogen	0.69	1.99	2.29	3.03	1.01	1.6	2.29	0.000
Total nitrogen in faeces and urine	11.50	15.60	18.17	21.67	13.88	16.4	19.21	1.47
Nitrogen balance	-4.64^{d}	4.26^{c}	4.77^{c}	8.61^{a}	-3.82^{d}	6.48^{b}	-3.24^{d}	1.47

Nitrogen balance Means with different superscript differ significantly (P<0.05)

CONCLUSION

Tithonia forage has a CP and ADF value of 20.7% and 27.98%, while Sapium and napier grass have 11.8% and 4.29%, and 22.35% and 43.58% respectively. Inclusion of both Tithonia and Sapium forages caused a decrease in feed intake, total faecal production and total urine output for all the diets although proportionately to intake, the faecal and urine output increased. DM, CP, NDF and ADF digestibility decreased for all the diets with increased supplement fodder. Tithoniaconstituted diets indicated positive nitrogen balance while all supplementation with Sapium caused sheep to have a negative nitrogen balance. Finally, replacing 25% of napier grass fodder in sheep diets with Tithonia and 50% with Sapium will constitute the best ratio in taking advantage of their availability for protein supplementation.

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