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Performance of Growing Goats Fed Urea Sprayed Maize Stover and Supplemented with Graded Levels of *Tithonia Diversifolia*

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ABSTRACT : A study was carried out to examine the effect of supplementing urea-sprayed maize stover with incremental levels of *Tithonia diversifolia* (Tithonia) forage on dry matter (DM) intake, digestibility and live weight changes. Fifteen crossbred bucks were used in a completely randomised design for a duration of 7 weeks. The treatments comprised of a control: the basal diet (maize stover sprayed with 1% urea) plus 100 g maize germ offered alone or supplemented with: 10 (T1), 20 (T2), 30 (T3) or 40% (T4) Tithonia on a dry matter basis. All animals were allowed *ad libitum* access to water and mineral lick. Supplementing maize stover with Tithonia resulted in increased total DM intake (p<0.05) from 376.7 (control), to 444.1 (T1), 533.1 (T2), 519.7 (T3) and 578.9 g/day (T4) but did not significantly (p>0.05) influence the intake of stover. Diet DM digestibility increased with supplementation with T3 recording the highest value of 66.5% which was 10.6% higher than the control. Supplementation significantly increased daily weight gains (p<0.05). T4 had the highest ADG (43.7 g/day), even though there was no difference between T4 and T3 (35.7 g/day). In goats, Tithonia should be included up to 30% of ration on a DM basis for optimum production. The higher level of inclusion (40%) may be used for higher total output in terms of meat and milk but with few animals. (**Key Words :** *Tithonia diversifolia,* Maize Stover, Intake, Digestibility, Live Weight)

INTRODUCTION

Tree legumes and shrubs that persist during the dry season when pasture is either scarce or of poor quality have been extensively used to provide protein rich forage for ruminant production in Asia, Africa and pacific Islands (Norton, 1994). There exists extensive and diverse literature on the effects of leguminous tree supplementation on the productivity of cattle, sheep and goats. Forage tree leaves, particularly of Leucaena and Gliricidia, have been used as supplements to a wide range of forages and agricultural by-products (Norton, 1994).

Utilisation of tree legumes and shrubs has, however, not been without some constraints for example; Psyllid infestation (*Heteropsylla cubana*) on Leucaena and its poor performance in acidic soils has reduced its herbage production while the astringent smell of Gliricidia leaves makes it unpalatable. Others like Calliandra are associated with high tannin levels and Sesbania is unable to withstand intensive cutting management (Roothaert and Paterson, 1997).

Foliage from tree legumes and shrubs still offers a cheaper alternative to supplementation of poor quality roughage's. This is because commercial concentrates are expensive and sometimes unavailable to the small-scale resource poor farmers, while improving the roughage's by physical, chemical or biological treatment on the other hand has been hindered by lack of information and the cost of inputs to the farmers (Phimphachanhvongsod and Ledin, 2002).

This calls for identification and screening of alternative tree legumes and shrubs as a strategy towards overcoming setbacks experienced by these common tree legumes hence broadening the feed resource base for utilisation by ruminant animals. Supplementation of straw based diet is often necessary as these are low in protein and energy so as to meet the nutrient requirements even for maintenance.

Tithonia diversifolia commonly known as Mexican sunflower is a shrub belonging to the family Asteraceae. Tithonia originated from Mexico and is now widely distributed throughout the humid and sub humid tropics in Central and South America, Southeast Asia and Africa (Wanjau et al., 1998; Jama et al., 2000). In Kenya it is found in the Rift valley, Central, Western and some parts of

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Table 1. Chemical composition as (% DM) of the feeds used in the experiment

	DM	Ash	OM	CP	EE	NDF	ADF	ADL	TEPH	TET
M.stover	45.68	6.28	93.72	5.09	2.15	75.29	44.58	5.75	Nd	Nd
Tithonia	88.23	12.38	87.62	22.15	3.25	26.63	23.97	7.32	1.055	0.56
M. germ	90	5.264	94.74	10.33	9.70	28.3	8.2	Nd	Nd	Nd
Urea				46%N						

M = maize, DM = dry matter, OM = organic matter, CP = crude protein, EE = ether extract, NDF = neutral detergent fibre, ADF = acid detergent fibre, ADL = acid detergent lignin, TEPH = total extractable phenolics, TET = total extractable tannins, Nd = not determined.

Coast Provinces. The most important attributes of Tithonia are its ability to re-sprout vigorously and repeatedly after cutting, ease of establishment vegetatively from cuttings and high leaf yield. The Nitrogen contents are between 3 to 4.5%, depending on the age, season, part of the plant and physiological state (before and after flowering). Various authors have mentioned its consumption by livestock (Roothaert and Paterson, 1997; Wanjau et al., 1998) but little study has been done to evaluate scientifically, it's potential in a feeding trial. This is despite having been used widely in Western Kenya as green manure for improved maize production (Gachengo, 1996; Wanjau et al., 1998). The objective of the study was to evaluate the effect of feeding incremental levels of *Tithonia diversifolia* forage on intake, digestibility and live weight changes of growing goats offered a basal diet of urea sprayed maize stover.

MATERIALS AND METHODS

The experiment was conducted at the Bukura Agricultural College in Kakamega District, Western Province of Kenya. The area lies in agro ecological zone I normally described as the sugar cane zone. It has an altitude of between 1,300-1,500 m above sea level, annual temperature of 20-22°C, and annual average rainfall of 1,800-2,000 mm (Jaetzold and Schmidt, 1982).

Animals and feeds

Fifteen bucks (German Alpine×Small East Africa) aged one and a half years old were used for the experiment measuring the intake, digestibility and live weight changes. Stover from hybrid maize (614 D) planted and top dressed using diammonium phosphate and calcium ammonium nitrate respectively at the rates of 50 kg/ha was collected from the college farm and used for the experiment. Tithonia leaves were collected from farm borders normally planted as a fence to demarcate land within the farm. The foliage was air-dried for 3 to 5 days on a raised barn floor before feeding.

Experimental design and procedures

The goats were allocated to four treatment diets and a control according to a completely randomised design with three goats per treatment. The five experimental diets were as follows; urea sprayed maize stover (10 g urea/litre of water/kg stover) plus 100 g maize germ as the control. The treatments were control plus T1: 10, T2: 20, T3: 30 or T4: 40% on dry matter basis of Tithonia. Whole dry maize stover was manually chopped into sizes of about 40- 60 mm and sprayed with urea solution prior to feeding *ad libitum.* Feeding was done daily at approximately 0800 h and 1500 h. Tithonia foliage was fed in two equal portions in the morning after maize germ and in the afternoon. This was followed at both times with maize stover. Water and mineral lick were available at all times. Feed offered and refused was weighed every day to determine intake and samples taken weekly for dry matter determination, while the live weights were taken on weekly basis early in the morning before feeding.

Analytical methods

The dry matter (DM) of feed and faeces was determined by drying the samples in an oven at 55°C for 48 h, ash by ashing at 550°C, and crude protein (CP) by the official methods of the Association of Analytical Chemists (AOAC, 1990). Acid detergent fiber, (ADF) and Neutral detergent fiber (NDF) by method of Van Soest et al. (1991). Total extractable phenolics and tannins (TEPH and TET) were determined as described by Abdulrazak and Fujihara (1999).

Statistical analysis

Data from the experiment was subjected to analysis of variance using the general linear model (GLM) of the SAS computer package (Statistical Analysis Systems, 1998). Treatment means were separated using Least Significance Difference (LSD).

RESULTS

The chemical composition of the feeds is shown in Table 1. Tithonia had notably high levels of CP, ash and low concentrations of phenolic compounds. Maize stover on the other hand was characterised by the lowest CP levels but apparently the highest NDF contents reflecting less of soluble cell contents while maize germ had the highest percentage of ether extracts (fat).

The level of supplementation with Tithonia foliage did not significantly affect the intake of the basal diet ($p>0.05$)

Table 2. Mean DM intake (DMI) and Crude protein intake (CPI) of goats offered USMS and supplemented with graded levels of Tithonia

	C	T1	T2	T3	T4	SEM
DMI (g/day)						
Maize stover	286.7	308.8	347.3	276.4	283.4	44.437
Tithonia	-	45.3[d]	95.8[c]	153.3[b]	205.5[a]	12.074
Maize germ	90	90	90	90	90	
TDMI	376.7[c]	444.1[bc]	533.1[ab]	519.7[ab]	578.9[a]	51.940
CPI (g/day)						
Maize stover	14.59	15.72	17.68	14.07	14.43	2.262
Tithonia	-	10.04[d]	21.22[c]	33.95[b]	45.51[a]	2.675
Maize germ	9.30	9.30	9.30	9.30	9.30	
TCPI	23.89[e]	35.05[d]	48.20[c]	57.32[b]	69.23[a]	4.333
CPI as % of TDMI	6.36[e]	7.93[d]	9.06[c]	11.03[b]	11.96[a]	0.213

Means with different superscript letters in the same row differ significantly (p<0.05). SEM = standard error of the mean.

Table 3. Dry and organic matter digestibility (DMD and OMD) and average daily gains (ADG) g/day of goats offered USMS and supplemented with graded levels of Tithonia

Digestibility	C	T1	T2	T3	T4	SEM
DM %	60.1	60.2	60.7	66.5	65.9	3.742
OM %	63.96	64.03	63.99	68.49	67.81	3.380
ADG (g/day)	-15.1[d]	11.1[c]	23.9[bc]	35.7[ab]	43.7[a]	6.209

Means with different superscript letters in the same row differ significantly (p<0.05). SEM = standard error of the mean.

(Table 2). However the TDMI was significantly (p<0.05) influenced by supplementation with Tithonia foliage. The 10 and 20% levels of Tithonia inclusion seemed to have an additive effect on consumption of maize stover but at 30 and 40% the intake of basal diet declined marginally. Inclusion of Tithonia foliage significantly (p<0.05) increased the CPI (Table 2) where a linear relationship was evident as the level of supplementation increased.

Though there was no statistical difference in the diet DM digestibility (p>0.05), as the level of supplementation increased the diet digestibility increased with the highest values recorded at T3 (Table 3). Similar trend was also reflected with the OM digestibility. Animals supplemented with Tithonia foliage gained weight while those on the control diet lost 15.1 g/day (Table 3). Supplementation increased (p<0.05) ADG to 11.1, 23.9, 35.7 and 43.7 g/day for T1, T2, T3 and T4 respectively (Table 3).

DISCUSSION

The CP of Tithonia was comparable to commonly used tree legume species like Gliricidia (21.4%) and Leucaena (21.8%) in Kenya (Abdulrazak et al., 1996). These values are similar to the results of the current study but differed with 28% CP reported by Premaratne et al. (1997). Jama et al. (2000) reported that nutrient composition of Tithonia varied with plant part, age, position of the leaf within the plant canopy, soil fertility and provenance. The reported CP value concurs with his results from ten locations in Western Kenya of 3.2% N which is equivalent to 20% CP.

The NDF content (26.6% DM) was considerably lower than 49.3 and 46.9% for Gliricidia and Leucaena respectively (Abdulrazak et al., 1996). The low NDF content falls within the range of 20 to 35% found to promote high digestibility of test species by Norton (1994). NDF content in maize stover was consistent with previous reports where it is characterised by high NDF contents implying that the material is high in lignocelluloses component and low in N (Abdulrazak et al., 1997; Hindrichsen et al., 2004). Though the specific minerals were not assayed, the ash content in Tithonia was relatively high reflecting high contents of minerals. Jama et al. (2000) reported P (0.37%), N (3.5%) and K (4.1%) in Tithonia and attributed the fast demineralization into the soil of the same as a factor that has greatly contributed to the utilisation of the shrub as a source of N for crops. The tannin content of Tithonia (5.6 g/kgDM) was far below 60-100 g/kg DM known to adversely depress intake and growth (Barry et al., 1984). Drying of the foliage supplement in this experiment may have acted to reduce the concentrations of TEPH (1.06% DM), which were relatively low compared to 1.6% reported by Gachengo et al. (1999).

The total dry matter intake (TDMI) increased (Table 2) with supplementation (p<0.05) though the maize stover intake was unaffected (p>0.05). Total dry matter intake may increase or decrease depending on ability of a particular diet to provide required nutrients for maintenance and other functions. Abdulrazak et al. (1996) observed a linear increase in TDMI of steers while supplementing Napier grass with increasing levels of Leucaena though the Napier grass intake was unaffected. This response was attributed to the CP content of the Napier grass (7.9%) being able to provide the rumen microbial requirements for N hence additional high quality forage of Leucaena had no further stimulating effect on the intake of the basal diet. In another study (Pathirana et al., 1992) intake of rice straw was increased with legume forage supplementation. Four levels of *Gliricidia maculata* leaves were offered to sheep on a basal diet of rice straw. The CP levels were relatively lower (3.6%) compared to those in Abdulrazak et al. (1996) but comparable to 5.1% in the current study. Legume supplementation was thus able to increase the intake of the basal diet by increasing the rumen ammonia concentration through providing ruminally fermentable N. Though the maize stover intake was not significant, numerically the intake increased with Tithonia supplementation up to the 20% level of inclusion. This reflects on the ability of Tithonia to provide both easily fermentable N and fibre which provided N and energy for the rumen microbes to grow and multiply hence colonising more of the stover leading to an increase in intake.

Premaratne et al. (1997) using Tithonia on mature sheep in Sri Lanka reported DM digestibility of 46.4 and 48% for 15 and 30% level of inclusion respectively. These levels are relatively lower compared to the current digestibility levels in this experiment. This may have been due to the differences in the basal diets used. Premaratne et al. (1997) used rice straw alone as the basal diet compared to the current study where urea in the maize stover was a source of non-protein nitrogen, which synchronised well with the energy released from the easily fermentable maize germ to promote higher microbial growth. This may have been contributed to the higher digestibility in the present study.

The ADG reflect an increasing trend with the level of supplementation. This is consistent with Phimphachanhvongsod and Ledin (2002) who reported an increasing trend in the ADG with *Gliricidia sepium* fed to growing goats on a basal diet of *Panicum maximum.* Live weight gains were highest when Gliricidia intake was about 25 to 30% of total DM intake after which no further increase was observed. Similar trend was observed in the present experiment where ADG increased with level of Tithonia supplementation. However, the ADGs at 30 and 40% levels of inclusion were not statistically different ($p>0.05$) thus 30% may be regarded as optimum. This level falls within the range of 30 and 45% DM of total ration as optimum level of browse supplementation in terms of live weight gain per gram of supplement for *C. palmensis, S. sesban, L. leucocephala, and L. pallida,* respectively Kaitho (1997). Devendra (1988) concluded that when used as supplement the optimum dietary level of fodder trees and shrubs should be about 30 to 50% of the ration on DM basis.

It is thus concluded that use of Tithonia browse foliage greatly improved the intake, diet digestibility and ADG of growing goats. Tithonia therefore has great potential as a protein supplement to poor quality roughages and can be included at 30% on DM basis in diets of goats.

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