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Utilisation of *Gliricidia sepium* and Maize Bran or Their Mixtures with *Leucaena leucocephala* as Supplements to Growing Indigenous Goats (Mubende Type) Fed Elephant Grass (*Pennisetum purpureum*)

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Abstract: A study was conducted to evaluate the nutrient intake, N-utilization and growth performance of growing indigenous goats (Mubende type) fed elephant grass and supplemented with gliricidia leaves alone or in mixtures of leucaena and maize bran. The experimental diets comprised of a basal diet of elephant grass offered alone *ad libitum* (E); supplemented with either 300g DM/head/day maize bran (EB); 300g DM/head/day gliricidia (EG); a mixture of gliricidia and leucaena in equal proportions of 150g DM/head/day (EGL); and a mixture (100g DM/head/day each) of gliricidia, Leucaena and maize bran (EGLB). Thirty young goats 12-16 weeks old and averaging 12.28 ± 2.1 kg were arranged in a randomized complete block design with five treatments and six animals per treatment. The results indicated strong substitution of elephant grass with the supplements which resulted in significant decreased elephant grass dry matter intake. However, supplementation did not affect ($p>0.05$) total dry matter intake and digestibility but both tended to be higher for the maize bran supplemented treatment (EB) than in the other supplemented diets. Total DM intake was lowest for the goats supplemented with diets containing leucaena especially where leucaena formed a high proportion in the mixture (EGL). Crude protein intake was significantly ($p<0.05$) improved by supplementation but there was no significant differences among the supplemented diets. However, CPI tended to be higher with the gliricidia supplemented treatments and was highest where gliricidia was supplemented alone (EG). Legume supplementation improved nitrogen absorbed and retained and was significantly higher than the maize bran supplemented diets but there was no significant differences among the legume supplemented diets. However, the highest N absorbed and N retained was obtained in the gliricidia (EG) and the leucaena-gliricidia-maize bran (EGLB) treatments, respectively. Average daily gain (ADG) was greater in the supplemented diets than the control but there were no significant differences among the supplemented diets. Body weight changes revealed that goats supplemented with a mixture of gliricidia, leucaena and maize bran had higher body weights than other supplemented treatments. The study revealed that the productivity of indeginous goats offered elephant grass containing moderate levels of CP may be limited by inadequate energy intake and the inefficient utilisation of N and this can be enhanced by gliricidia supplementation alone or in mixtures with leucaena and maize bran which will improve nitrogen utilisation in the animal body. It was therefore concluded that tree legumes especially gliricidia which is being promoted for use in the smallholder crop-livestock farming systems and maize bran which is a by-product from the major stable food in Uganda can play an important role in maximising utilisation of grass forages hence improving goat production.

Key words: elephant grass, gliricidia, indigenous goats, leucaena and maize bran

Introduction

Goats are widely distributed in the tropics and are of great economic importance in the arid and semiarid rangelands of Eastern Africa. The meat goat is of particular importance and has made a greater contribution to the welfare of rural people than cows generally because each person can manage to keep a goat unlike cows, which are kept by the rich. They can be easily looked after by children and the elderly and hence utilising the labour which would have been idle. Goats are easy to sell and buy and hence are often regarded as the first step out of poverty and an insurance against crop failure. Goats naturally prefer to browse; and when left by themselves, goats are able to find a diet of reasonable quality by selecting the plants and parts of plants which they eat preferring shrubs and short trees (Peacock, 1996). Unlike cattle, goats are rarely supplemented with concentrates since most of them are kept under extensive or semi-intensive systems. However, population pressures on land, have led to confinement of goats at home in many smallholder crop-livestock production systems. Supplementation under intensive or tethering production systems is of paramount necessity since the animals' free choice is limited when confined. A number of studies have shown that using tree legumes as protein supplements gives better results than when used as a sole feed (Carew, 1983; Ash, 1990; Girdhar *et al.*, 1991; Richards, 1994a, b).

Despite the fact that tree legume species especially, gliricidia and leucaena together with maize bran have been known to be potential suppliers of protein and digestible energy respectively, well designed studies need to be carried out to establish their optimum levels of supplementation to grass based diets specifically for goat production. Since under natural conditions, goats select and mix forages when feeding, there is need to evaluate these browse species when fed as mixtures together with other energy sources like maize bran, and establish their effects on animal performance. This is aimed at diversifying the energy and protein sources especially from locally available feed resources. The main objective of this study was therefore to evaluate the nutrient utilisation and the performance of growing indigenous goats fed elephant grass and supplemented with gliricidia leaves alone or in mixtures of leucaena and maize bran.

Materials and Methods

Study area: The study was conducted at Makerere University Agricultural Research Institute, Kabanyolo (MUARIK) located about 19km, north of Kampala city (0° 28'N, 32° 37'E, altitude 1,204m a.s.l.). Part 1 of the study, assessed the intake and growth of thirty growing indigenous goats (Mubende type) which were selected and bought from farmers in Nyabushozi county, Mbarara District. The goats initial weight averaged 12.28 + 2.1kg and were 12 - 16 weeks old. Before the start of the experiment, all animals were treated against internal helminths and external parasites.

Experimental diets and design: The experimental diets comprised of a basal diet of elephant grass offered alone *ad libitum* (E); or supplemented with either 300g DM/head/day maize bran (EB); 300g DM/head/day gliricidia (EG); a mixture of gliricidia and leucaena in equal proportions of 150g DM/head/day (EGL); and a mixture (100g DM/head/day each) of gliricidia, Leucaena and maize bran (EGLB). The animals in their respective treatments were allotted to group-fed wooden pens with slatted bottom and raised about 2 ft from the ground floor. The experimental design was a randomized complete block design of five treatment diets with six animals per treatment.

Elephant grass was harvested daily from the farm, chopped using a panga to about 5cm length to minimize wastage; packed in a bags and kept for feeding the whole day. *Leucaena leucocephala* and *Gliricidia sepium* leaf meal was got from 4 months re-growth shoots harvested from trees already established on the farm. The shoots were cut and wilted for a day in the field and later carried to a drying shed. After 2 days, the wilted leaves along with the rachis were removed from the stems and allowed to air dry to approximately 88% dry matter into hay for two weeks under shade and stored for use in the experiment. Maize bran was purchased from a commercial maize meal.

The supplements were offered daily in the morning before the basal forage. Elephant grass was offered three times daily to ensure availability of the basal ration at all times. Refusals were collected and weighed in the morning before giving fresh feed. The feeds offered were sampled every two weeks, bulked and later analysed for chemical composition. Water was offered to the goats at all times. The animals' body weights were monitored every week throughout the experimental period, which lasted 10 weeks.

Digestion trial: Part 2 of the trial, involved four goats selected from each of the above treatments (E, EB, EG, EGLB, EGL) and used in the digestion trial during the 9th and 10th week. Each goat was housed in an individual digestion crate and adapted to the crate for 7 days. Total daily faecal and urine output of each goat was collected during the last 7 days of the trial. After recording the fresh weight, the daily individual goat's faeces were oven dried at 60°C to constant dry weight to determine faecal dry matter. At the end of the seven days collection period, the faeces for each goat were bulked and sampled after thorough mixing. The samples were then milled to pass a 1 mm screen and stored in plastic sample cups for later chemical composition analysis. Total daily 24 hour urine output from each goat was collected over the same period into buckets containing 10mls of 0.1N Sulphuric (H_2SO_4) acid. After measuring the urine output, aliquot samples were taken daily and put into sample bottle and stored in deep freezer until analysed for nitrogen.

Sample analysis: Dry matter (DM) in the feed and faeces was obtained by oven drying of the samples at 100°C for 24 hrs. Nitrogen content of the feeds, faeces and urine was determined by the standard micro Kjedahl method (AOAC, 1990). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined by the method of Van Soest and Robertson (1985).

Statistical analysis: Data from the two trials (growth and digestion) were subjected to analysis of variance using General Linear models of Statistical Analysis Systems (SAS, 1987). Treatment means were separated and ranked using Duncans Multiple range test.

Results and Discussion

The chemical composition of the experimental feeds is presented in Table 1. The level of cell wall contents in elephant grass was higher (64%) and its crude protein content lower than that of the supplements. Gliricidia contained relatively more NDF than leucaena (36 vs 29% DM). Maize bran had the lowest percentage of ash, NDF and ADF when compared to the legume supplements, but the CP concentration was much higher in the forage legumes. Although, the NDF of the elephant grass used in this study was at the upper limit (45-65%) of the medium quality feed (Singh and Oosting, 1992), the level of CP was lower than the level (11-12%) required for moderate ruminant production (ARC, 1980). Thus the elephant grass used in the present study necessitated supplementation to meet the nutrient requirements of growing goats. The high CP and low NDF concentrations in gliricidia and leucaena forages in addition to the high energy content in maize bran made them good supplements that would supply the nutrient requirements of the growing goats especially when offered as mixtures. This could result into synchronization of protein and energy that would result into increased rumen microbial populations and increased the efficiency of fibre break down due to increased efficiency of microbial protein synthesis and hence a higher DM intake (Sinclair *et al.,* 1995).

Table 2 presents results of daily dry matter intake (DMI), diet apparent digestibility and live weight changes. Low acceptability of gliricidia and maize bran was recorded during the first week of the experiment. However, during the subsequent weeks, the animals got used to the two feeds though they could not finish the whole amount given. Supplementation significantly ($p<0.001$) decreased elephant grass dry matter intake (g day $^{-1}$) and intake per metabolic body weight. The significant basal diet DM intake decrease for the supplemented treatments indicated strong substitution of elephant grass with the supplements.

Supplements did not affect ($p>0.05$) the total dry matter intake but tended to be higher for the maize bran supplemented treatment (EB) than in the other supplemented diets. Total DM intake was lowest in the supplement diets containing leucaena especially where leucaena formed a high proportion in the mixture (EGL). Similarly, total dry matter digestibility was not significantly ($p>0.05$) affected by supplementation but the highest DMD was recorded in the maize bran supplemented group. The tendency for higher total dry matter intake and digestibility for the maize bran supplemented goats was possibly due to better rumen environment due to a high supply of dietary energy from the maize bran which probably increased microbial protein synthesis efficiency.

Crude protein intake (CPI) was significantly ($p<0.05$) improved by supplementation but there were no significant differences among the supplemented diets. However, total CPI tended to be higher with the gliricidia supplemented treatments and was highest where gliricidia was supplemented alone (EG). Crude protein digestibility was highest in the control and gliricidia supplemented diets while supplementation with maize bran (EB) and leucaena based mixtures supplements significantly ($p<0.05$) reduced CP digestibility. Richards *et al.* (1994a, b) reported that the high nitrogen solubility of gliricidia when fed together with napier grass which has a slower energy release, led to a synchronous supply of nitrogen and energy in the rumen of goats which is utilised by the rumen microbes resulting into an increase in CP digestibility. The results also show that supplementation with high levels of leucaena significantly ($p<0.05$) reduced CP digestibility. The low DMI and CP digestibility in the leucaena supplemented diets was attributed to the effect of anti-nutritional factors in leucaena especially mimosine and tannins which are known to reduce the efficient utilization of the diet because of mimosine toxicity and complexing with protein respectively. The goats used in the present study were from an area mainly dominated by Acacia species and they were not used to leucaena forage. It is likely that they did not have Dihydroxy Pyridine (DHP) degrading bacteria to degrade the mimosine in leucaena, which is toxic to the animal and to the rumen microbes (Hegarty *et al.*, 1976; Jones and Megarity, 1986).

NDF digestibility treatment differences were not significant ($p>0.05$) but tended to be higher in the control group than the supplemented.

Table 1:Chemical composition of the ingredients used in the experimental diets. (%DM)

	Dry matter	Crude protein	Ash	ADF	NDF
Elephant grass	23.0	10.5	12.3	34.0	64.0
Gliricidia	89.0	23.0	8.0	25.0	36.0
Leucaena	87.0	24.7	6.5	22.0	29.0
Maize bran	88.0	11.5	4.0	6.0	28.0

Table 2: Mean daily feed intake, apparent digestibility and body weight changes of Mubende goats fed elephant grass supplemented with dried gliricidia leaves and maize bran or their mixtures with *L. leucocephala*.

	Diets						
Parameter	E	EB	EG	EGL	EGLB	SED	Significance
Dry matter intake (g)							
Elephant grass	591[a]	343[b]	401[b]	373[b]	380[b]	34.0	***
Supplement	-	266[a]	181[b]	167[b]	180[b]	15.1	***
Total	591	620	578	540	567	38.5	ns
Dry matter intake (g/kg BW $^{0.75}$)							
Elephant grass	83.0[a]	48.3[b]	50.2[b]	48.8[b]	51.7[b]	4.5	***
Supplement	-	35.4[a]	25.6[b]	22.7[b]	24.7[b]	2.3	***
Total	83.1	83.7	75.8	71.5	76.4	5.4	ns
Crude protein (g)							
Elephant grass	72.0	36.2	42.3	39.3	40.0	-	-
Supplement	-	45.9	49.4	45.4	49.0	-	-
Total	72.1[b]	82.0[a]	91.9[a]	84.6[a]	89.1[a]	5.4	*
Total (g/kg BW$^{0.75}$)	9.4	10.6	12.0	10.9	11.7	-	-
Digestibility (%)							
Total DM	78.2	79.4	79.3	76.2	75.1	3.1	ns
Crude protein	81.2[ab]	76.6[bc]	82.9[a]	76.8[bc]	74.8[b]	3.0	*
NDF	81.4	78.8	79.5	78.5	78.5	2.9	ns
Average body weight							
Initial Bwt (kg)	12.3±1.7	12.3±2.6	12.3±2.3	12.3±2.7	12.2±1.2	-	-
Final Bwt (kg)	12.9	13.7	14.1	13.9	14.3	-	-

E = Elephant grass alone; EB = E + maize bran; EG = E + Gliricidia; EGL = E + (Gliricidia + Leucaena); EGLB = E + (Gliricidia + Leucaena + Maize bran); SED = Standard error of difference.
Means in the same row with different superscripts differ significantly ($p<0.05$).
NS = Non-significant; * = Significant ($p < 0.05$); *** = Significant ($p = 0.001$).

Table 3: Nitrogen utilisation by Mubende goats fed elephant grass *adlibitum* supplemented with dried gliricidia leaves and maizebran or their mixtures with *L. leucocephala*.

	Diets						
	E	EB	EG	EGL	EGLB	SED	Significance
Nitrogen intake							
g/day	11.54[b]	13.13[ab]	14.71[a]	13.54[a]	14.26[a]	0.86	**
g/kg BW$^{0.75}$	1.50	1.70	1.92	1.75	1.87	-	-
Nitrogen excretion							
Faecal g/day	1.99[c]	2.92[ab]	2.47[bc]	2.94[a]	3.26[ab]	0.28	**
Urine g/day	2.26[bc]	3.20[a]	1.89[c]	2.83[abc]	2.45[ab]	0.46	**
Total g/day	4.25	6.12	4.36	5.77	5.71	-	-
% of intake (faecal)	17.2	22.2	16.8	21.7	22.9	-	-
% of intake (urine)	19.6	24.4	12.9	20.9	17.2	-	-
Nitrogen absorbed							
g/day	9.54[b]	10.21[b]	12.24[a]	10.60[ab]	11.00[ab]	0.93	*
g/kg BW$^{0.75}$/day	1.27	1.38	1.61	1.38	1.48	0.15	ns
% of intake	82.67	77.76	83.21	78.29	77.14	-	-
Nitrogen retained							
g/day	7.28[b]	7.01[b]	10.35[a]	7.78[ab]	8.56[b]	1.06	**
% of nitrogen intake	63.08	53.39	70.36	57.46	60.02	-	-
% of N absorbed	76.31	68.66	84.56	73.40	77.82	-	-

E = Elephant grass alone; EB = E + 300g maize bran; EG = E + Gliricidia; EGL = E + (Gliricidia + Leucaena); EGLB = E + (Gliricidia + Leucaena + Maize bran); SED = Standard error of difference.
Means in the same row with different superscripts differ significantly ($p<0.05$).
NS = Non-significant; * = Significant ($p < 0.05$); ** = Significant ($p < 0.01$).

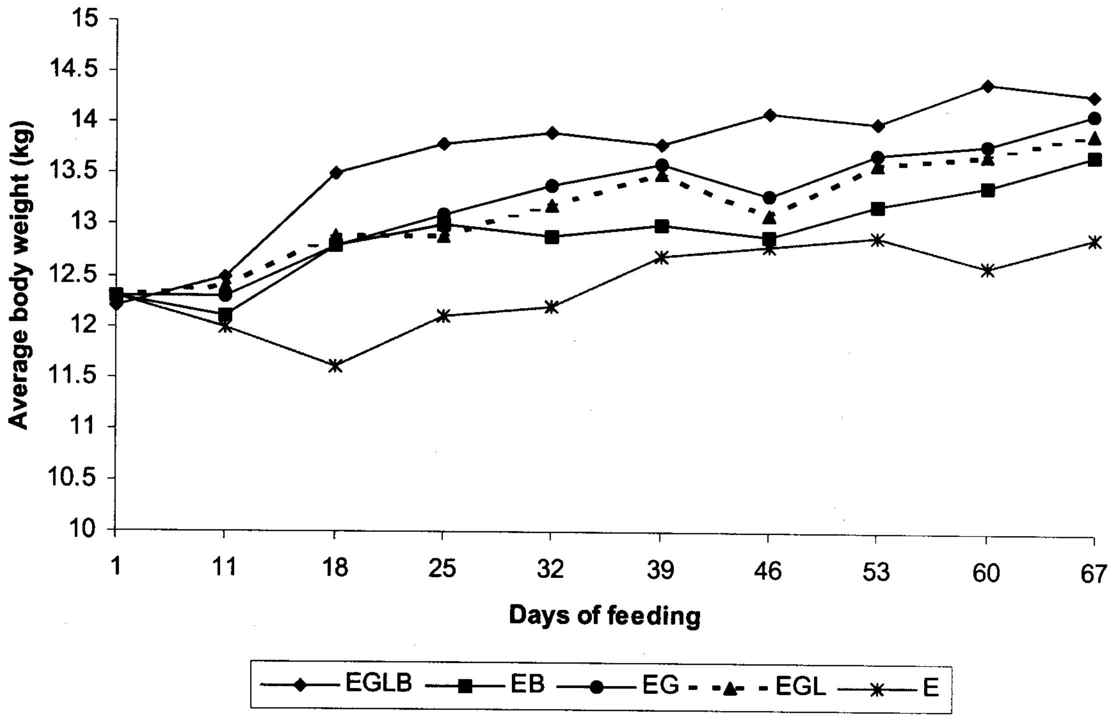

Fig. 1: Body weight changes of Mubende goats fed elephant grass *ad libitum* supplemented with gliricidia and maize bran or their mixtures with *L. Leucocephala*.

Similarly, Dharia *et al.* (1987) who used crossbred heifers did not also observe any significant improvement in NDF digestibility of elephant grass based diet supplemented with gliricidia leaves. This indicated that probably the energy and CP content of the elephant grass was adequate and provided the nutrient requirements for the rumen microbes to break down the fibre.

Average daily gain (ADG) was greater in the supplemented diets than the control but there were no significant differences among the supplemented diets Table 2. However, the results revealed that the goats supplemented with maize bran exhibited the highest weight gain. Body weight changes (Fig. 1) revealed that goats supplemented with a mixture of gliricidia, leucaena and maize bran had higher body weights than other supplemented treatments. The results in this study thus indicated that energy was the limiting factor in the performance of the goats fed grass alone. Similar results were reported by Yates and Panggabean (1998) who fed goats with elephant grass plus increasing amounts of concentrate or leucaena.

The high body weights exhibited by goats in the gliricidia-leucaena-maize bran mixture supplemented group was attributed to the high nitrogen intake, retention and utilisation as observed in Table 3. This together with the dietary energy from maize bran could have provided adequate nutrients for microbial protein synthesis and bypass nitrogen, which was reflected in N-absorbed. The maize bran would be expected to provide adequate dietary energy. As such, the lowest growth rate exhibited by the unsupplemented goats was attributed to poor utilization of the feed. Therefore the tendency for high weight gains observed with the maize bran supplemented diets especially in the mixtures with the forage legumes may have been due to a high supply of dietary energy from the maize bran coupled with the high diet nitrogen concentration which increased microbial protein synthesis efficiency and resulted into increased dry matter intake and digestibility. The improved body weight gains of the diets containing maize bran could also be attributed to the bran providing rumen undegradable carbohydrates that is digested post-rumen to produce glucose.

Such glucose has a sparing effect on glucogenic amino acids that are partitioned towards growth.

Nitrogen intake by goats fed elephant grass was significantly ($p < 0.05$) improved by supplementation but there were no significant differences between the supplemented treatments Table 3. However, the supplemented diets, which had forage legumes tended to have higher N-intake than the maize bran treatments and the control diet. Similarly, goats fed the legume supplemented diets especially gliricidia had the highest percentage of both absorbed and retained N. When retained N was expressed as a percentage of N absorbed and N-intake, the greatest efficiency of nitrogen retention by goats was obtained in the gliricidia-supplemented diet (85 and 70 %, respectively). This was attributed to the crude protein digestibility and nitrogen retention of the gliricidia supplemented diets which were significantly higher than that of the elephant grass alone and decreased when it was mixed with leucaena and / or maize bran.

The differences observed in the goats response to supplementation especially where leucaena was used alone as a supplement was explained by the effects of anti-nutritional factors (ANFs) in leucaena possibly mimosine and tannins. Leucaena has appreciable amounts of tannins (ICRAF,1992) these normally complex with protein and hence could have complexed with the protein and hence made it unavailable for digestion and absorption in the small intestines. This was evidenced by the nitrogen excreted in the faeces which was higher in the diets containing leucaena indicating that the complexed protein was not digested but excreted in faeces. However, these tannins are on the other hand useful in animal nutrition in that they protect proteins from being degraded in the rumen by the rumen microbes and make them available in the small intestines for digestion and absorption. However, this was not the case with the leucaena supplementation. Since the goats used in the study were got from the rangelands of Nyabushozi Mbarara where leucaena has not been introduced and therefore not exposed to it before, it is likely that they were not used to leucaena and therefore lacked the DHP degrading bacteria that degrades the protein mimosine in the rumen. Mimosine toxicity to the rumen microbes and the animal especially goats has been reported by Jones (1979) and Jones *et al.* (1985). Therefore the mimosine could have contributed to the reduction of the nitrogen absorbed and CP digestibility of the goats that were on leucaena treatments.

Conclusion

This study revealed that the productivity of goats given elephant grass containing moderate levels of CP might be limited by inadequate energy and the inefficient utilisation of N. This can be enhanced by gliricidia supplementation alone or in mixtures with leucaena and maize bran to low quality roughages, which will improve nitrogen utilisation in the animal body. It was therefore concluded that tree legumes especially gliricidia which is being promoted among smallholder crop-livestock farming systems and maize bran which is a by-product from the major staple food in Uganda can play an important role in maximising utilisation of grass forages hence improving animal production.

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