Performance of Growing Goats Fed *Panicum maximum* and Leaves of *Gliricidia sepium*

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ABSTRACT : Thirty female goats of local breed (mature weight 28 kg), weighing 11 to 18 kg, were used in a growth experiment with the objectives to evaluate the effect of different levels of *Gliricidia sepium* leaves in a diet of Guinea grass (*Panicum maximum*) on feed intake, weight gain and apparent digestibility. The goats were allotted to five treatments, consisting of 5 levels, 0 (GL-0), 20 (GL-20), 30 (GL-30), 40 (GL-40) and 50% (GL-50) of *Gliricidia sepium* leaves in the diet based on the energy requirements of the goats. Another six female goats were used to study the digestibility of three dietary treatments, GL-0, GL-30 and GL-50, according to a double 3×3 Latin square arrangement. The crude protein (CP) content in Gliricidia was higher and the neutral detergent fibre (NDF) and acid detergent fibre (ADF) lower than in the Guinea grass. Increasing the amount of Gliricidia leaves resulted in similar intake of total dry matter (DM), organic matter (OM), NDF and ADF among treatments, but CP intake increased with increasing Gliricidia in the diet. The highest total DM intake was 3.0% of body weight in the GL-20 diet. The highest daily live weight gain was 43 g/day in the GL-30 diet. Inclusion of 30% of Gliricidia leaves improved the apparent DM, OM and CP digestibility compared to 0% or 50% inclusion. NDF and ADF digestibility declined with increasing levels of Gliricidia leaves in the diet. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 11 : 1585-1590)***

Key Words : Goats, Gliricidia Sepium, Panicum Maximum, Intake, Digestibility, Growth

INTRODUCTION

The most important livestock species in Lao are ruminants, which are predominantly kept free ranging on non-agricultural land. The local market for live goats and goat meat is expanding due to increasing population and a higher income per capita as a result of development efforts. The market value of live goats for meat or reproduction in Lao depends upon the size, weight and general appearance of the animals. A major constraint to the performance of the goats is the inadequacy of feeds, particularly during the dry season, when the quality and quantity of natural pasture declines, resulting in lower intakes and reduced animal productivity.

The prevailing level of production from local goats is generally low which is primarily due to poor feeding practices and lack of intensification of the production systems (Devendra, 1991). Poor quality forages and roughages, such as mature grass, straw, stover, and many other plants and agro-industrial by-products may be improved by physical, chemical or biological treatment. Procedures for improving nutritive value by chemical methods have, however, not been adopted by farmers because of lack of information and the cost of inputs. A more appropriate method of utilising fibrous feeds, may be to supplement with leguminous leaves.

There are many shrubs and tree species in the tropics and subtropics that can supply fodder. Most of them have high nutritive values, high levels of minerals and vitamins, are nitrogen fixing and relatively persistent with deep root systems, giving drought tolerance (NFTA, 1987). Supplementation of fibrous feeds with legume leaves is common in villages of many tropical countries. *Gliricidia sepium*, one of the best known species, has been widely promoted in Lao. Gliricidia is a fast growing tropical leguminous tree, 10-15 m high. The spread of *Gliricidia sepium* around the world and its inclusion in a wide range of farming systems is due in large part to its quality and its truly multipurpose nature. One of the most important properties is the ability to re-sprout vigorously and repeatedly after cutting. Another is the ease with which *Gliricidia sepium* can be established vegetatively from cuttings (Stewart, 1997). The yield of leaves is high and the nutrient content varies with age, season, part of the plant and physiological state (before and after flowering). The content of crude protein (CP) varies between 28 and 30% and *in vitro* digestibility of dry matter (DM) is between 48 and 77% (Glover, 1989). *Gliricidia sepium* is also low in extractable tannin, and there is little evidence of toxic effects on ruminants fed either fresh or wilted leaves. Toxicity problems have, however, been encountered when Gliricidia is fed to non-ruminants (Simons and Stewart, 1994). When using Gliricidia as a supplement to low quality tropical forages and by-products for ruminants, there is some

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evidence of poor palatability and reduced intake of the basal diet (Stewart, 1997) and it is believed that wilting improves the acceptability (Stewart et al., 1998). The DM digestibility is increased by the addition of energy sources such as cassava to the diet (Ademosun et al., 1985) and supplementing with Gliricidia improved the digestibility of poor quality feeds (Ivory, 1990).

The objective of this study was to evaluate the effect of feeding different levels of *Gliricidia sepium* leaves on intake, daily weight gain and apparent digestibility of the diet in a Guinea grass (*Panicum maximum*) based diet for growing goats.

MATERIAL AND METHODS

Location and climate of study area

The experiments were conducted at the Livestock Research Centre, Agriculture and Forestry Research Institute, 45 km north of Vientiane, Laos, between August and December 2000. The climate of this area is tropical monsoon with an average rainfall of about 1,500 mm/year, and with a wet season from May to October, and a dry cool season from November to February. The remainder of the year is hot and humid. The temperature varies from maximum 38.5°C in April, the warmest month, to minimum 13.5°C in December.

Experimental feeds

The feeds used in the experiments were Guinea grass (*Panicum maximum TD 58*) and leaves from Gliricidia (*Gliricidia sepium*). A 1.2 ha plot of Guinea grass was established in the beginning of March 2000 by planting cuttings on a sandy-loam soil (pH 5.5) with good drainage. Three weeks after planting, the plot was fertilised with urea at a level of 100 kg nitrogen (N) /ha. Prior to the start of the experiment, at 60 days of growth, the plot was divided into six sub plots of 2,000 m^2 each. Each sub plot provided grasses for a period of one week, and 6 rotations provided forages of 42 days regrowth throughout the experiment, with a cutting height of 10 to 20 cm above ground. The grass was then about 60 cm high and in a vegetative stage. The Gliricidia leaves were cut from a forestry research plot about 4 km from the experimental site. The plot was established in 1995.

The Guinea grass was harvested daily in the morning and chopped to a length of 10-20 cm and fed fresh in the trials. The Gliricidia foliage was harvested in the late afternoon. The foliage was at an early vegetative stage and included the leaves with 30 cm of green twigs, not more than 10 mm in diameter at the base. The twigs with leaves were air-dried for approximately 15 h. The harvesting and air-drying was done partly to have the foliage available in the morning at feeding time but also to possibly improve intake. Leaves including the petioles were used as a feed in the experiment. The leaves were separated manually from the twigs after air-drying.

The grass was offered twice a day at 08:00 h and 14:00 h with half of the daily ration at each occasion, while the Gliricidia leaves were offered once per day in the morning. The two feeds were fed in the same feeding troughs. The feeds were weighed every day for individual feeding adjusted to actual DM content of the feeds. Drinking water and mineral lick blocks which contained 50% $CaHPO_4$, 18% NaCl, 15% $CaCO_3$, 13% KCl, 2% S, and 1.8% trace elements ($ZnSO_4$, Fe_2O_3, $CuSO_4$, KI, MnO, $CoSO_4$, $NaSeO_3$), were on offer at all times.

Experimental animals

The goats in the experiments were selected and bought from smallholder farms with free grazing systems in nearby provinces. Thirty female goats of local breed (mature weight 28 kg) with live weights of 11.4 kg to 18 kg were used in the growth trial and another six female goats of local breed with live weights of 14.8 to15.0 kg for the digestibility trial. Before commencement of the experiment all animals were treated with Pyrantel and Artocarpine against internal parasites, and Asuntol against external parasites and were vaccinated against foot and mouth disease. The goats were adapted to the conditions of the experiment for 15 days before being allocated to the experimental groups.

The goats were housed individually in 1.5×1 m pens. For the digestibility trial the goats were confined in individual metabolism cages.

Experimental design

The growth trial : The goats in the growth experiment were stratified based on weight and allotted to five treatments, consisting of 5 levels of Gliricidia leaves in the diet in a completely randomised block design. The diets were based on the energy requirements for goats of 11 to 18 kg weight growing 50 g/day according to Peacock (1996). The ration was adjusted individually every 15 days in relation to the increasing weight of the animals. For diet composition table values from Devendra and McLeroy (1982) were used. The experiment lasted for 90 days and the percentage of *Panicum maximum* and Gliricidia leaves in the treatments based on the energy requirements were as follows: GL-0: 100/0, GL-20: 80/20, GL-30: 70/30, GL-40: 60/40 and GL-50: 50/50.

The digestibility trial : Six female goats were allocated to three dietary treatments, consisting of 3 levels of Gliricidia leaves in the diet according to a double 3×3 Latin square arrangement. The diets were the same as three of the diets in the growth trial GL-0, GL-30 and GL-50. The level of feeding was based on the energy requirements at the actual weight of the animal (Peacock, 1996) at the start of the period and was the same during each period. The animals were confined in individual metabolism cages allowing collection of faeces but not urine. The goats were adapted to the cages during a 15 days period. The experiment lasted 51 days in total, with 3 periods consisting of 17 days (7 days of adaptation, 7 days of collection and 3 days for releasing the animals on an open ground for exercise). During the days of exercise the animals grazed freely.

Data collection and analyses

The goats in the growth trial were weighed at the start and every 15 days in the morning at 07:00 h before feeding. Feed consumption was calculated as the difference between the amount of feed offered and the amount of feed refused. The botanical composition of the feed refusals was determined and a sub sample was taken for DM determination once every second week. A sample of feed offered was taken for DM determination every third day, and 5 times for chemical analyses during the experiment.

During the collection period in the digestibility trial, the refused feed and faeces were collected from each animal. The refusals were classified according to botanical composition and weighed every morning. Sub samples of faeces and refusals were collected every morning, weighed and kept in a deep freezer and were later pooled for the whole collection period. Chemical analyses of feed offered, refusals and faeces were made for DM, ash, organic matter (OM) and CP according to AOAC (1990). The neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined by the methods of Van Soest et al. (1991).

Statistical analysis

The data from the experiment were statistically analysed by ANOVA using the General Linear Model of Minitab software version 12.0 (Minitab, 1999). Treatment means which showed significant differences at the probability level of $p<0.05$ were compared using Tukey's pairwise comparison procedures. The following statistical models were used:

$Y_{ij}=\mu+A_i+B_j+e_{ij}$ (growth experiment) where Y_{ij}=growth or feed consumption, μ=overall mean, A_i =effect of diet; B_j =effect of block, e_{ij}=random error and

$Y_{ijk}=\mu+A_i+B_j+C_{k(ij)}+e_{ijk}$ (digestibility experiment) where Y_{ijk}=dependent variable, μ=overall mean, A_i=effect of period, B_j=effect of animals, $C_{k(i,j)}$=effect of diets, e_{ijk}= random error .

RESULTS

The chemical composition of the diet components used in the experiment is shown in Table 1. Gliricidia leaves had a higher DM, OM and CP content, while Guinea grass had higher content of ADF and NDF.

Table 1. Chemical composition of the dietary components[1]

	Gliricidia leaves	Guinea grass
DM, g/kg	264±11	245±15
g/kg DM		
Ash	70±6	83±13
OM	930±6	917±13
CP	244±14	96±12
ADF	230±26	438±26
NDF	405±13	770±19
ME (MJ/kg)[2]	10.76	9.42
No. of samples	5	5

[1]Means and standard error, [2] from Devendra and McLeroy, 1982.

In the growth trial (Table 2), there were no significant differences among treatments in the total intake of DM, OM, NDF and ADF, but the CP intake of the two feed stuffs was different between treatments. The CP intake increased with increasing level of Gliricidia leaves in the diet and was highest in the diet consisting of 50% Gliricidia. The total DM and OM intake tended to be highest in the GL-20 diet, on which DM intake was 3% of body weight and 60 g per kg/$W^{0.75}$. The NDF and ADF intake decreased when inclusion of Gliricidia leaves increased (Table 2). The effect of level of Gliricidia leaves in the diet on daily live weight gain was significantly different ($p<0.01$) between the GL-0 diet and the GL-30 diet (Table 3). Daily live weight gain was highest in the treatment with 30% Gliricidia and lowest in the diet with no Gliricidia. The feed conversion ratio tended to improve with the addition of Gliricidia and the pattern of the response matched the live weight responses.

In the digestibility trial, inclusion of different levels of Gliricidia leaves had no effect on total DM and OM intake, and only the CP intake was significantly increased ($p<0.001$), and was highest on the diet containing 50% Gliricidia. The NDF and ADF intake decreased with increasing level of Gliricidia in the diet, the highest content being in the diet with no Gliricidia. Apparent digestibility of DM and OM of the GL-30 diet was significantly different from the two other treatments, but the digestibility of CP was only different from the GL-0 diet. The NDF and ADF digestibility were lowest in the GL-50 diet, and were significantly lower than for the two other diets.

DISCUSSION

Goats, when left to browse *ad libitum*, will select a varied diet. Cafeteria trials have been used widely to determine relative palatability differences between species of shrubs and fodder trees. Apart from showing the animal's preferences for particular fodder species, they also show that given the opportunity, ruminants will consume more of a mixture of forages than of a single diet component

Table 2. Feed offered[1] and feed intake[2] in the growth experiment

	Treatments					SE
	GL-0	GL-20	GL-30	GL-40	GL-50	
Feed offered, g DM/day						
Gliricidia leaves	-	82	126	169	209	
Guinea grass	552	422	373	316	265	
Total	552	504	499	485	474	
Feed intake, g DM/day						
Gliricidia leaves	-	77[c]	119[b]	159[a]	180[a]	9.1
Guinea grass	441[a]	382[ab]	324[ab]	278[b]	238[b]	18.1
Total intake g/day						
DM	441	459	444	437	418	14.0
OM	405	421	409	403	385	12.8
CP	42[b]	55[ab]	60[a]	65[a]	67[a]	2.3
NDF	339	324	298	278	256	11.4
ADF	193	184	169	158	145	6.4
MJ ME/day	4.1	4.4	4.3	4.3	4.1	0.1
% of ME from Gliricidia	0	18.9[d]	30.0[c]	39.7[b]	46.3[a]	2.2
% of DM from Gliricidia	0	16.9[d]	27.4[c]	36.6[b]	43.0[a]	2.1
Intake, % of body weight	2.9	3.0	2.7	2.7	2.6	0.06
Intake, g/$W^{0.75}$	58	60	55	55	52	1.21

[a, b, c] Means within rows with different superscripts differ significantly (p<0.05).

[1] Means, [2] Least square means, SE=standard error, GL-0 to GL 50 =0 to 50% of the energy from *Gliricidia sepium* leaves, the remaining from *Panicum maximum.*

Table 3. Effect of level of Gliricidia leaves in the diet on live weight gain and feed conversion ratio[1] in the growth experiment

	Treatments					SE
	GL-0	GL-20	GL-30	GL-40	GL-50	
Initial weight, kg	13.9	13.9	14.0	14.3	14.6	0.38
Final weight, kg	15.9	16.3	17.9	17.5	17.5	0.46
LWG, g/day	22[a]	26[ab]	43[b]	35[ab]	32[ab]	2.28
FCR, kg feed/kg LWG	20.0[a]	17.6[ab]	10.3[b]	12.5[b]	13.0[b]	1.20

[a, b] Means within rows with different superscripts differ significantly (p<0.05).

[1] Least square means, SE=Standard error, FCR=Feed conversion ratio=kg feed/kg live weight gain, LWG=Live weight gain, GL-0 to GL-50 =0 to 50% of the energy from *Gliricidia sepium* leaves, the remaining from *Panicum maximum.*

(Rosales and Gill, 1997).

In the literature it is reported that the real constraint to feeding Gliricidia to ruminants lies in the palatability. Animals seem to refuse Gliricidia leaves on the basis of smell, often rejecting it without tasting it (Lowry, 1990). Wilting the Gliricidia leaves before feeding is widely believed to improve their acceptability, presumably through the loss of an aversive volatile compound (Stewart et al., 1998). Palatability did not seem to be a problem in this study. Wilting of the foliage, training, prior learning and level of secondary compounds may all have contributed to the success of Gliricidia addition.

The chemical composition of the Guinea grass and Gliricidia in this study is in agreement with that found by Duke (1983) and Roger et al. (1999). Including Gliricidia leaves in a diet based on Guinea grass resulted in increased CP intake and reduced NDF and ADF intake due to the chemical composition of the feed stuffs. The intake of DM from the diets offered was not significantly different when Gliricidia leaves were included. Van Eys et al. (1986) supplemented Napier grass (*Pennisetum purpureum* Schum) (11.9% CP in DM) with Gliricidia and found no effect on total DM intake, although the weight gains were improved. Mpairwe et al. (1998) also reported that when rams were fed elephant grass (*Pennisetum purpureum*) (10.25% CP in DM) *ad libitum* supplemented with Gliricidia leaves the effect of the supplementation on total DM intake of the rations was not significant. Veeresvara Rao et al. (1993) reported that when sheep were fed Napier grass (7.1% CP in DM) *ad libitum,* or grass and leaves from *Gliricidia sepium*, the supplementation with tree leaves decreased total DM intake, though the effect was not significant. These results are in contrast with those of Sujatha et al. (1997) who showed that supplementation of rice straw (6.9% CP in DM) with Gliricidia to sheep resulted in an increase in total feed intake. Alayon et al. (1998) also reported that when sheep were fed Star grass (*Cynodon nlemfuensis*) hay (4.3% CP and 6.5 MJ/kg DM) with increasing levels of Gliricidia foliage (0-30% on DM basis) DM, OM and CP intake was linearly increased. Based on the literature it seems that supplementation with Gliricidia to a low quality roughage diet will result in increased intake of the roughage

Table 4. Intake and apparent digestibility (%) of the different diets[1] in the digestibility experiment

	Treatment			SE
	GL-10	GL-30	GL-50	
Feed offered, g DM/day				
Gliricidia leaves	0	126	196	
Guinea grass	525	362	262	
Total	525	488	458	
Feed intake, g DM/day				
Gliricidia leaves	-	114[b]	186[a]	
Guinea grass	418[a]	336[ab]	252[b]	
Total intake, g/day				
DM	418	450	438	
OM	383	414	403	
CP	38[c]	58b	68[a]	
NDF	321[a]	294[ab]	270[b]	5.9
ADF	182[a]	173[a]	152[b]	3.5
Digestibility, %				
DM	47.1[b]	53.3[a]	48.8[b]	1.1
OM	48.6[b]	54.6[a]	50.5[b]	2.2
CP	46.9[b]	57.6[a]	51.6[ab]	2.6
NDF	49.4[a]	49.0[a]	40.7[b]	0.8
ADF	41.9[a]	35.2[a]	23.5[b]	0.7

[a,b] Means within rows with different superscripts differ significantly ($p<0.05$)

[1] Least square means, SE=standard error , GL-0, GL-30, GL-50 =0, 30 or 50% of the energy from *Gliricidia sepium* leaves, the remaining from *Panicum maximum.*

and of DM in total. Substitution of a grass diet of better quality is not likely to give the same response. This is consistent with the results of van Eys et al. (1986), Sujatha et al. (1997), Alayon et al. (1998) and Mpairwe et al. (1998). In this study the animals were not able to express an increased intake since the feed offered was limited and it is not possible to make any conclusion on total DM intake. However, there were around 10% feed residues that was not consumed. When the experimental design was discussed it became clear that it was not possible to formulate a diet balanced for both protein and energy requirements and expected DM intake based on Guinea grass and Gliricidia only. Diets formulated on expected DM intake resulted in overfeeding of protein and underfeeding of energy. It was not either interesting to feed Gliricidia *ad lib.* since Gliricidia was a limited resource and could possibly also result in very high CP intake. To feed the grass *ad lib*. could have resulted in much lower intake of Gliricidia than was anticipated. Since energy seemed to be the limiting factor is was decided to formulate diets that would cover the energy requirements at an expected intake of 3% of body weight and accept the moderate CP surplus that was obtained.

In the growth trial the goats fed Gliricidia had a higher daily weight gain than the goats without Gliricidia, but only the diet with 30% Gliricidia was significantly different. This could be a result of the fact that the CP intake was higher for those diets than for the diet with Guinea grass alone but also that the energy intake was somewhat lower. The daily live weight gain increased as the levels of inclusion of Gliricidia increased up to 30% and then decreased slightly at higher inclusion rates. This result agrees with the study of Mpairwe et al. (1998) who supplemented 4 levels of Gliricidia leaves (0, 4, 8 and 12 g DM/kg live weigh and day) to rams fed elephant grass *ad libitum*. The body weight changes were significantly improved by Gliricidia supplementation, with the highest body weight gain obtained at 8 g. Hao et al. (2001) also carried out a study in which that goats were supplemented with 0, 30, 40, 50% of the diet DM of Gliricidia, the diet with 30% Gliricidia gave the best intake and the highest growth rate. This study showed that increasing the level of Gliricidia inclusion to more than 30% decreased total DM, OM, NDF and ADF intake, while only CP intake was increased. This could be the cause of the slightly lower live weight gain at higher inclusion rates, but an increased content of anti-nutritional substances may also be an explanation.

In the digestibility trial, increasing the level of Gliricidia up to 30% resulted in an increase in apparent DM, OM and CP digestibility, but a decrease at 50% inclusion compared to Guinea grass as the sole feed. This is consistent with Alayon et al. (1998), who reported that when increasing the levels of Gliricidia foliage from 0 to 30% on DM basis to sheep fed Star grass hay, there was a linear increase in apparent digestibility of DM, OM and CP. Mpairwe et al. (1998) also reported that when supplementing with 4 levels of Gliricidia leaves (0, 4, 8 and 12 g DM/kg live weigh/day) the highest DM digestibility was obtained at 8 g. A higher level of Gliricidia inclusion than 30% did not seem to affect the DM, OM and CP digestibility in this study, even though the CP intake increased significantly. Increasing intake of CP in the diet up to 65 to 70 g/day resulted in increasing live weight gain. Intake above 70 g/day did not increase the live weight gain further. The live weight gain was highest when the Gliricidia intake was about 25 to 35% of total DM intake. Even though the content of tannins is not high in Gliricidia the tannins may have a negative effect at high levels of intake. This is consistent with the study of Jones (1979) and Reed et al. (1990), who reported that supplement of fodder tree leaves should be about 30% of the diet, because of the secondary compounds which inhibit the digestibility and reduce the acceptability to animals at higher levels of inclusion. Also Devendra (1993) and Simons and Stewart (1994) 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 seems that the best use of Gliricidia would be to utilise the foliage in a cut and carry system. Supplementation of grazing animals would be too labour intensive since the animals often are grazing far away from the villages on the hillside. Also the increasing competition for land (Phimphachanvongsod, 2001) point towards development of a semi-intensive production system. Whether wilting is essential is not possible to conclude from the results of this study.

CONCLUSIONS

Substituting Guinea grass with *Gliricidia sepium* leaves had no effect on intake of dry matter or organic matter from the diets offered. Crude protein intake increased with increasing levels of *Gliricidia sepium*. Higher levels of intake of *Gliricidia sepium* leaves than 27% of DM did not give any increase in intake, digestibility or growth. Inclusion of 30% of Gliricidia leaves in the Guinea grass diet gave the highest live weight gain, double growth rate compared to grass only, and the best feed utilisation efficiency. *Gliricidia sepium* is consequently a species that may be used with good result in the feeding systems for goats in small holder farms.

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