EFFECT OF FRESH LEUCAENA(*LEUCAENA LEUCOCAPHALA*) LEAF SUPPLEMENTATION ON THE GROWTH OF YOUNG ANGLO-NUBIAN CROSSBRED GOATS FEEDING EITHER BATIKI (*ISCHAEMUM ARISTATUM* VAR. *INDICUM*) AND GUINEA GRASS (*PANICUM MAXIMUM*)

Eroarome M. Aregheore[1] and Yahaya, M.S.[2]

ABSTRACT

A feeding trial was conducted at the University of the South Pacific, School of Agriculture in Samoa, to investigate the effect of leucaena fresh leaf supplementation on the growth of 7 – 9 months old Anglo-Nubian x Local Fiji goats stall fed with either batiki or guinea grass as basal diet. Leucaena leaves were supplemented at 0, 10, 30 and 50 % levels of the total daily forage allowances. 16 goats were divided into two groups of 8 each. Each group was further divided into 4 sub groups of two each while receiving the respective diets. The experimental design was a change-over with two feeding periods, each of 24 days separated by 7-day adaptation period. The parameters measured were voluntary feed intake and apparent nutrient digestibility and estimates of live weight changes. CP content of the two grass diets increased linearly with increase in the level of leucaena in the diet, which ranged from 5.3 -18.2 % for batiki and 7-19.1 % for guinea. DMI of grass only diets were significantly (P<0.05) lower than those supplemented with leucaena leaves, but there was no significant (P>0.05) difference between levels of supplementation. DM, CP and OM digestibilities improved with increasing levels of leucaena. LWG of goats without leucaena was significantly lower (P<0.05). Batiki at 10 % level of leucaena supplementation was significantly (P<0.05) lower than the two higher levels but in the case of guinea grass there was no significant (P>0.05) difference between levels of leucaena supplementation. At the same level of leucaena supplementation guinea grass consistently gave significantly (P<0.05) higher LWG. Maximum growth was attained at 30 % leucaena supplementation for batiki, while for guinea grass it was at 10 % level.

Keywords: *Leucaena, batiki, guinea grass, goats, DMI, growth, digestibility*

INTRODUCTION

In most Pacific Island countries (PICs) natural or unimproved pasture is the main source of feed for grazing ruminant livestock. The importance of natural pasture for ruminant livestock production in the tropics has been stressed by several researchers, (Olubajo and Oyenuga 1971; t'Mannetje 1978; Reynolds 1978; Gutteridge and Whiteman 1978; Adjei 1995; Aregheore 2001a). Batiki grass (*Ischaemum aristatum* var. *indicum*) which was introduced into Samoa from Fiji initially to compliment existing natural or unimproved pastures has now become the most commonly propagated pasture grass for ruminant livestock. However, other grass species such as guinea grass, (*Panicum maximum*) signal grass (*Brachiaria decumbens*) and elephant grass (*Pennisetum purpureum*) are also used. In Samoa, guinea and signal grass rank second and third in terms of availability of grass species for ruminant livestock grazing. In most cases they are used in zero grazing through the cut-and-carry system.

In the tropics, growth and performance of ruminant livestock are largely limited by forage quality, which results in low voluntary intake and digestibility (Minson 1971; Humphreys 1987; Aregheore 2001b). Adu and Adamu (1982) reported that the low productivity of ruminant animals in the tropics is a reflection of poor yields and low quality of natural grasslands. Season and species of grass have been observed to influence the nutritive value which in turn affects voluntary intake and digestibility of the herbage, (Aregheore 2001a,b).

Leaves, shoots and twigs of browse plants are cheap protein sources that can help to overcome the nutritional deficiencies of low quality feeds (roughage). Leaves from browse and fodder trees form major parts of livestock feed in many tropical countries (Woods *et al.* 1994; Mandal 1997) and play an important role in improving dietary protein (Kaitho *et al.* 1998).

Many indigenous and introduced browse species are found in Samoa, which include *Erythrina* spp.,

[1]Department of Animal Science, School of Agriculture,The University of the South Pacific, Alafua Campus,Private Mailbag, Apia, Samoa
[2]Department of Animal Science, Obihiro University of Agriculture and Veterinary Medicine, Obihiro, Hakkaido 080-8555, JAPAN

Calliandra calothyrsus; *Gliricidia sepium*, *Sesbania grandiflora*, *Leucaena leucocephala* and *Spondias mombin*. Among these *Gliricidia sepium* and *Leucaena leucocephala* are widely used by smallholder farmers. It has been observed however, that animals take some time in accepting *Gliricidia sepium*, compared to *Leucaena leucocephala* which is often accepted immediately (Abdulrazak *et al.* 1996); Smith *et al.* 1995; Aregheore *et al.* 2001c). Based on this rejection factor most farmers prefer to supplement their grazing animals with *Leucaena leucocephala*. The objective of this trial, was to investigate the effect of *Leucaena* as a protein supplement, fed either with batiki grass or guinea grass based diet at 0, 10, 30 and 50 % levels, on performance of goats fed in the tropical environment of Samoa.

MATERIALS AND METHODS

Site

The experiment was conducted at the Goat Unit, School of Agriculture, The University of the South Pacific, Alafua Campus, Samoa (Latitude ~13.5° S, Longitude ~172.5° W).

Animals, Experimental procedure and design

Sixteen growing goats (Anglo-Nubian x Local Fiji) were used to measure voluntary feed intake, apparent nutrient digestibility, and growth rate and weight gain. The goats were 7-9 months old with the mean weight of 9.5 ± 0.42 kg. The goats were divided into two groups of eight animals each and each group was further sub-divided into four sub-groups of two goats per diet. Each group represented either batiki grass or guinea grass while the sub-groups differ in treatments. The design of the experiment was a change-over with two periods, each of 24 days in length, separated by a 7-day adaptation period (Gill and Magee, 1976). The treatment groups were balanced for body weight gain and age.

The goats were drenched with an anthelminthic (Albendazole) at the start of the experiment at a rate of 1 ml/10 kg bodyweight. All the goats were allowed access to mineral blocks and ample drinking water. The mineral/vitamin block contained salt (NaCl), 120 g/kg calcium, 60 g/kg phosphorus, 60 g/kg manganese, 150 mg/kg copper, 1.5 mg/kg colbalt, 7.5 mg/kg iodine, 600 mg/kg manganese, 750 m/kg iron, 600 mg/kg zinc, 1.5 mg/kg selenium; Vit. A, D and E with copra meal and molasses added.

Diets, Feeding and management

Batiki and guinea grasses were harvested daily and chopped with a bush knife into pieces (6-8 mm) in order to limit preferential selection of forage components. *Leucaena* was harvested in the morning for feeding in the afternoon, with some allowed to wilt overnight for feeding in the morning. Stems were removed to ensure that the fodder composition was uniform. An adaptation period of 7 days was allowed for the goats to get used to the diets.

Basal diets of either batiki or guinea were supplemented at 0, 10, 30 and 50 % of the total daily forage allowance levels with fresh *Leucaena* leaves and fed to the goats. The basal and supplementary components of the diets were mixed thoroughly to avoid selection, and offered as a whole diet. There were a total of eight diets; and batiki or guinea grasses only diets were used as controls. The level of supplementation used was calculated as percentage of total *ad libitum* daily forage allowance of the growing goats. The diets were fed on an *ad libitum* basis to allow about 10 – 20 % refusal.

The diets were offered three to four times daily to ensure constant availability. Batiki and guinea grass and *leucaena* were sampled once a week for dry matter determination. Feeds offered and refused were recorded on a daily basis to estimate voluntary dry matter intake. The pens were cleaned and leftovers from the previous day removed, weighed and sampled daily before supplying each day's diet. The live weights recorded at the end of each week of the experiment were used to calculate the amount of the feed to be offered during the subsequent week.

Digestibility study

At the end of the growth trial, all the animals in each diet group were used for metabolic studies. The total daily faecal output from each animal was collected, weighed and a 25 % sample removed for nutrient content analysis. The samples were later dried in a forced-air oven at 70° C for 24 hours. The daily samples of faeces and diets were then bulked separately and milled with a simple laboratory mill, and stored in air tight bottles until required for analysis.

Analytical Methods

The nutrient contents were analyzed following AOAC (1995) method. All analyses were done in triplicate. Dry matter was determined by drying at constant weight at 70° C for 24 hours in a forced-air oven, ash by incineration at 600° C for 4 hours, protein by the micro-Kjeldahl procedure (N x 6.25). Neutral detergent fibre (NDF) analysis was according to Goering and Van Soest (1970).

Statistical analysis

The observations from the feeding trial (voluntary feed intake, growth rate, feed efficiency and apparent nutrient digestibility coefficients) were analyzed using ANOVA procedures with individual goat as a replicate, period and treatment as mean effects.

RESULTS AND DISCUSSION

Chemical composition

Chemical composition of Leucaena, batiki and guinea grasses, and supplemented diets is presented in table 1. Nutrient composition (DM, CP, NDF and OM) of the Leucaena used in this study are 43.8 %; 31.2 %; 38.6 % and 85 % respectively and are consistent with values reported by Abdulrazak *et al.* (1997); Kaitho *et al.* (1998); Tjandraatmadja *et al.* (1993). Nutrient contents of batiki and guinea grasses are comparable to values reported earlier by Kumar (2000) and Aregheore and Cawa (2000).

The mean value of DM and NDF of batiki grass were significantly ($P<0.05$) higher than those of guinea grass while the opposite was true for OM. There was no significant difference ($P>0.05$) between CP of both grasses that increases linearly with increase in the levels of leucaena leaves in the diets (Table 1). The increase ranged from 5.3 – 18.2 % CP (mean 11.3±4.9) and 7 – 19.1 % CP (mean 12.5±4.7) for batiki and guinea grass based diets, respectively. Inclusion of leucaena in both batiki and guinea grass at the various supplementary levels (0-50 %) had effects on the nitrogen content of the diets offered to the goats. The data obtained are consistent with the findings of Bamualim *et al.* (1984); Tjandraatmadja *et al.* (1993); Abdulrazak *et al.* (1997) and Aregheore *et al.* (2002). They reported that the usage of the leaves of browses and multipurpose trees as supplements contribute to improve the nutrient quality of diets based on low quality roughage or tropical grasses.

Dry matter intake

Dry matter intake (DMI) by goats on the batiki (378 g/day) and guinea (385 g/day) sole diets were both lower ($p<0.05$) than those goats on the diets supplemented with *leucaena* leaves (Table 2). However, the goats on guinea grass had higher ($p<0.05$) DMI than the goats on batiki grass and the result obtained confirmed the earlier report of Aregheore (2001b).

The inclusion of *leucaena* leaves increased DMI in both batiki and guinea grass based diets (Table 2), which demonstrates the relevance and importance of supplementation of low quality forages with leaves of browses as means of improving their nutritive values. It has been reported that the leaves of browses play an important role in improving dietary protein (Woods *et al.* 1994; Mandal 1997; Kaitho *et al.* 1998). The inclusion of *leucaena* leaves improved

Table 1. Proximate chemical composition of grass and *Leucaena*-grass mixtures (analysis of DM, %)

		Diets					
Nutrients (%)	Grass	Grass + 0 % Leu.	Grass + 10% Leu.	Grass + 30% Leu.	Grass + 50% Leu.	Mean	± SEM
DM	Batiki	37.3[1]	37.3[1]	39.3	40.6	38.6	1.4
	Guinea	44.2[2]	44.2[2]	44.1	44.0	44.1	0.08
CP	Batiki	5.3[a]	8.4[a]	13.1[b]	18.2[c]	11.3	4.9
	Guinea	7.0[a]	9.4[a]	14.3[b]	19.1[c]	12.5	4.7
NDF	Batiki	39.7	39.6	39.4	39.2	39.5	0.2
	Guinea	36.0	36.3	36.8	37.3	36.6	0.5
OM	Batiki	82.4[1]	82.7[1]	83.2	83.7	83.0	0.5
	Guinea	89.0[2]	88.7[2]	86.2	86.0	87.7	1.2

* Four (4) diets four each grass species
+ % Leu. - *Leucaena*, DM, dry matter; CP, crude protein; NDF, Neutral detergent fibre; OM, organic matter.
± SEM, standard error of mean
[a,b,c] Means within row with different superscript differ ($p<0.05$)
[1,2] Means within each treatment (% of *Leucaena*) for each variable of different superscript differ ($p<0.05$).

Table 2. **Effects of *Leucaena* supplementation on voluntary feed intake and growth of goats**

		Diets: + Leucaena (%)					
Parameter	**Grass**	**0**	**10**	**30**	**50**	**Mean**	**± SEM**
Av. Daily DMI (g)	Batiki	378[1]	412	419	412	405.3	15.9
	Guinea	385[2]	416	415	410	406.5	12.6
Initial live-weight (kg)	Batiki	12.3	12.3	12.3	12.2	12.3	0.04
	Guinea	12.3	12.3	12.3	12.3	12.3	0.00
Final live-weight (kg)	Batiki	15.2	16.4	17.1	16.8	16.4	0.7
	Guinea	15.6	16.7	17.8	17.1	16.5	0.8
Body weight gain/loss (kg)	Batiki	2.9	4.1	4.8	4.6	4.1	0.7
	Guinea	3.3	4.4	5.5	4.8	4.5	0.8
Ave. daily LWG (g/d)	Batiki	60[c]	86[b1]	100[a1]	96[a]	86	0.02
	Guinea	69[b]	92[a2]	115[a2]	100[a]	94	0.02
Feed efficiency (feed/gain)	Batiki	6.3	4.8	4.2	4.3	4.9	0.8
	Guinea	5.6	4.5	3.6	4.1	4.4	0.8
Dry matter intake (g/kg $BW^{0.75}$)	Batiki	40.9[1]	44.6	43.3	39.4	42.1[1]	2.0
	Guinea	47.1[2]	48.7	48.8	46.1	47.7[2]	1.1

+ Leu. (%), with *Leucaena*
± SEM, standard error of mean
[a,b,c] Means within row with different superscript differ ($p<0.05$)
[1,2] Means within each treatment (% of *Leucaena*) for each variable of different superscript differ ($p<0.05$)

the nutritive value of the diets and subsequently increased DMI by the goats.

Another possible reason for the improved total DMI in the *leucaena* diets might be associated with faster outflow rate of particulate matter due to reduction in retention time of particulate matter (Bamualim *et al.* 1984) and/or the nature of the legume protein (Abdulrazak *et al.* 1996).

Live weight gains

There was no significant ($P>0.05$) difference between goats that received sole grass diets. Average daily live weight gain (LWG) of goats on grass only diet was significantly ($P<0.05$) lower than those of goats on diets supplemented with *leucaena*. Supplementation with leucaena leaves significantly ($P<0.05$) increased LWG reaching the maximum growth rate at 30 % supplementation for batiki, least at 10 % for guinea grass. At the same level of supplementation, LWG of guinea grass based diet was significantly ($P<0.05$) higher than that of batiki based diet except at the 50 % level. However, LWG of the goats supplemented with *leucaena* leaves at the 10 % and 50 % levels were significantly better ($p<0.05$) than those on the of batiki and guinea sole diets (no supplementation with *leucaena*). The improvement in LWG was reflected by a similar improvement in feed efficiency with increasing level of *leucaena* in the diets in both grasses.

One important aspect of legume supplementation is to identify the optimum level of its inclusion in the diet. It has been suggested that the optimum level of shrub and tree leaf supplements are in the range of 30 – 50 % of the diet on a dry matter basis. Kaitho (1997) suggested that the optimum level of browse supplements to low-quality diets fed to sheep was 45 % for *Leuceana leucocephala*. In this experiment *Leucaena* leaves were included up to 50 % of the total daily forage allowance of the goats and there were observed improvements in LWG.

Apparent nutrient digestibility coefficients

Table 3 presents data on apparent nutrient digestibility coefficients by the goats fed the batiki or guinea grass and diets with *leucaena* leaves supplementation. DM, CP and OM digestibilities improved with increase in the levels of *leucaena* supplementation. The goats on batiki or guinea sole diets were significantly lower ($p<0.05$) in the digestibility of DM, CP, NDF and OM than those of the goats on diets supplemented with *leucaena*.

However, the goats on guinea grass with *leucaena* leaves at the 10 – 50 % levels of supplementation were better ($p<0.05$) in the digestion of CP, NDF and OM than the goats on batiki grass at similar levels of supplementation with *leucaena*. The implication of these data is that the goats on guinea grass had better response than those goats on batiki grass even when supplemented with *leucaena* leaves at the same levels (10 – 50 %).

The goats that had higher OM digestibility had higher LWG. The goats that had 30 % and 50 % *leucaena* leaves diets had higher OM digestibility. It has been observed that the higher the OM digestibility, the

Table 3. **Apparent nutrient digestibility coefficients of mixtures of *Leucaena* leaves with either batiki or guinea grasses at four levels (0, 10, 30 and 50 %) of supplementation**

		Diets: % Leucaena					
Nutrients	**Grass**	**0**	**10**	**30**	**50**	**Mean**	**± SEM**
DM	Batiki	44.4^{d}	57.8^{b}	63.0^{b}	68.0^{a}	58.4	8.9
	Guinea	48.0^{c}	58.2^{b}	64.7^{a}	66.4^{a}	59.6	7.5
CP	Batiki	48.3^{c}	58.0^{ab1}	62.9^{a1}	65.8^{a1}	58.8	6.6
	Guinea	49.6^{c}	68.3^{b2}	72.0^{a2}	74.3^{a2}	66.1	9.7
NDF	Batiki	48.9^{c}	64.9^{a}	60.9^{a1}	58.6^{ab}	58.3	5.9
	Guinea	50.4^{c}	63.4^{b}	68.6^{a2}	61.8^{b}	61.1	6.6
OM	Batiki	46.7^{c}	64.5^{b}	70.0^{a1}	67.6^{ab1}	65.1	4.4
	Guinea	51.2^{c}	65.8^{b}	74.8^{a2}	70.2^{a2}	65.5	8.8

% *Leucaena*,
DM, dry matter; CP, crude protein; NDF, Neutral detergent fibre; OM, organic matter.
± SEM, standard error of mean
^{a,b,c} Means within row with different superscript differ ($p<0.05$)
^{1,2} Means within each treatment (% of *Leucaena*) for each variable of different superscript differ ($p<0.05$).

higher the expected metabolizable energy (ME); and the feed with higher OMD is expected to provide more energy and therefore more production i.e. high live weight gain. This was the trend in this experiment with respect to LWG.

CONCLUSION

This study clearly demonstrates that inclusion of fresh *leuceana* leaves, up to 50 % of total daily forage allowance in the diets of goats offered either batiki grass or guinea grass improved their DMI and growth performance. It also shows that the levels of *leucaena* used may not cause any detrimental toxicity effects if goats are feed for a short period similar to that in this study. Such practices may be more appropriate for short-term feeding as in fattening program with cut-and-carry or semi-intensive system where goats could be fed controlled levels of *leucaena*. Finally, the goats on guinea grass had better response than those goats on batiki grass even when supplemented with *leucaena* leaves at the same levels. Maximum growth was attained at 30 % leucaena supplementation for batiki, while for guinea grass it was at 10 % level. *Leucaena* supplementation is therefore recommended for cut-and-carry or semi-intensive system of production.

REFERENCES

ABDULRAZAK, S.A., R.M. MUINGA, W. THORPE and E.R. ORSKOV (1996). The effect of supplementation with *Gliricidia sepium* and *Leucaena leucocephala* forage on intake, digestibility, and live-weight gains of *Bos taurus x Bos indicus* steers offered napier grass. *Animal Science,* 63:381-388.

ABDULRAZAK, S.A., R.M. MUINGA, W. THORPE and E.R. ORSKOV (1997) Supplementation with *Gliricidia sepium* and *Leucaena leucocephala* on voluntary food intake, digestibility, rumen fermentation and live-weight of crossbred steers offered *Zea mays* stover. *Livestock Production Science*, 49:53-62.

ADJEI, M.B (1995). Component forage yield and quality of grass-legume cropping systems in the Caribbean. *Tropical grasslands,* 29:142-149.

ADU, I.F. and ADAMU, A.M. (1982). The nutritive value and utilization of three tropical grass hays by sheep. *Tropical grasslands,* 16(1):29-33.

AOAC (1995). *Official Methods of Analysis*, 16th ed. (Association of Official Analytical Chemists, Arlington, VA).

AREGHEORE, E.M (2001a). The effect of supplements of crop residues based diets on the performance of steers grazed on natural pasture during the dry season. *African Journal of Range and Forage Science,* 18:25-29.

AREGHEORE, E.M (2001b). Nutritive value and utilization of three grass species by crossbred Anglo-Nubian goats in Samoa. *Asian-Australasian Journal of Animal Sciences*, 14(10):1389-1393.

AREGHEORE E.M. and CAWA, K. (2000). Voluntary intake by crossbred Anglo-Nubian goats of water hyacinth (*Eichhornia crassipes*) fed in two states plus guinea grass (*Panicum maximum*) in confinement. *Scientia Agriculturae Bohemica*, 31(4) 261-271.

AREGHEORE, E. M.; PERERA, D. and YAHAYA, M.S. (2002). Effect of nutritive value of batiki grass (*Ischaemum aristatum* var. *indicum*) supplemented with leaves of browses (*Gliricidia sepium* and *Leucaena leucocephala*) on performance of goats. *Scientia Agriculturae Bohemica*, Vol. 33. (2): 63-70.

BAMUALIM, A., STACHIW, S., JONES, R.J. and MURRAY, R.M. (1984). The effect of fresh leucaena leucocephala as supplement on the utilisation of pasture hay by goats. *Proceedings of the Australian Society of Aniaml Production*, 15:259-262.

GUTTERIDGE, R.C. and WHITEMAN, P.C. (1978). Pasture species evaluation in the Solomon Islands. *Tropical Grasslands*, 12(2):113-126.

GILL, J.L. and MAGEE, W.I. (1976). Balanced two-period changes over designs for several treatments. *Journal of Animal Science*, 42:775-777.

GOERING, H.K and VAN SOEST, P.J. (1970) Forage fibre analysis (Apparatus, Procedures and some applications) Agriculture Handbook No. 379. ARS, USDA, Washington, D.C. 20 pp.

HUMPHREYS, L.R. (1987). Tropical pastures and fodder crops. 2nd Ed. Intermediate Tropical Agriculture Series. Longman Scientific & Technical, John Wiley and Sons Inc: New York.

KAITHO, R.J., I.V. NSAHLAI, B.A. WILLIAMS, N.N. UMUNNA, S. TAMMINGA and VAN BRUCHEM, J. (1998). Relationship between preference, rumen degradability, gas production and chemical composition of browses. *Agroforestry Systems*, 39:129-144.

KUMAR, A. (2000) Energy and protein requirement of growing crossbred Anglo-Nubian goats in Samoa. B.Agric. Project. School of Agriculture, The University of the South Pacific, Apia, Samoa. 26 pp.

MANDAL, L. (1997) Nutritive value of tree leaves of some tropical species for goats. *Small Ruminant Research*, 24:95-105.

MANNETJE, L.t'. (1978). The role of improved pastures for beef production in the tropics. *Tropical Grasslands*, 12(2):1-9.

MINSON, D.J. (1971). The nutritive value of tropical pastures. *Journal of Australia Institute of Agricultural Science*, 37:255-263.

OLUBAJO, F.O. and OYENUGA, V.A. (1971). The measurement of yield, voluntary intake and animal production of tropical pasture mixtures. *Journal of Agricultural Science* (Cambridge), 77:1-7.

REYNOLDS, S.G. (1978). Evaluation of pasture grasses under coconuts in Western Samoa. *Tropical grasslands*, 12(3):146-151.

SMITH, J.W., LARBI, A., JABBAR, M.A. and AKINLADE, J. (1995) Voluntary intake of sheep and goats fed three states and at three levels of supplementation to a basal diet of *Panicum maximum*. *Agroforestry Systems*, 32;287-295.

TJANDRAATMADJA, M., I.C. MACRAE and NORTON, B.W. (1993). Effect of inclusion of tropical tree legumes, *Gliricidia sepium* and *Leucaena leucocephala*, on the nutritive value of silages prepared from tropical grasses. *Journal of Agricultural Science* (Cambridge), 120:394-406.

WOODS, C. D., TIWARI, B. N., PLUMB, V.E., POWELL, C. J., ROBERTS, B.T., SIRIMANE, V. D. P., ROSITER J. T., and GILL, M. (1994). Interspecies differences and variability with time of protein precipitation activity of extractable tannins, crude protein, ash and dry matter contents of leaves from 13 species of Nepalese fodder trees. *Journal of Chemistry Ecology*, 20:3149-3162.