Nutritive Value and Utilization of Three Grass Species by Crossbred Anglo-Nubian Goats in Samoa

Eroarome Martin Aregheore*
The University of the South Pacific, School of Agriculture, Alafua Campus, Apia, Samoa

ABSTRACT : A study was carried out to investigate the nutritive value and utilization of three grass species, batiki grass (*Ischaemum aristatum* var. *indicum*), guinea grass (*Panicum maximum*) and signal grass (*Bracharia decumbens*) by growing goats. Eighteen growing crossbred goats (Anglo-Nubian × Fiji local) of between 9-11 months of age and pre-trial average live weight of 9.50±1.60 kg were divided on the basis of weight to three treatment groups in a completely randomized design. The grasses constituted the diets and they were harvested fresh and chopped into pieces before they were offered to the goats. Chemical composition of the grasses, DMI, body weight gain (BWG) and apparent nutrient digestibility coefficients were measured. The grasses had similar DM content. The CP content of the grasses was in the range of 8.3-11.2%. Crude fiber (CF) content was between 30.9-35.2%. Ether extract (EE) was low with a range of 1.2-1.8%. Nitrogen free extract (NFE) was similar (40.9%) for batiki and guinea grasses, while signal grass had more NFE content (51.1%). The grasses are good sources of minerals (ash). OM content was higher in signal grass while guinea and batiki grasses had similar OM content. The goats on signal grass had higher DMI than those on batiki and guinea grasses ($p<0.05$). The goats on batiki grass had lower average BWG ($p<0.05$) than those on guinea and signal grasses. Nutrients digestibility were significantly ($p<0.05$) higher in the goats on signal grass compared to those on guinea and batiki grasses. The goats on guinea grass were better ($p<0.05$) in the digestibility of CP, OM, NFE and ME than those on batiki grass. However, goats on batiki were significantly better ($p<0.05$) in digestibility of CF than those on guinea grass. Signal and guinea grasses had more DCP than batiki grass. DE was lower in batiki grass ($p<0.05$) than in guinea and signal grasses. There was no significant difference ($p>0.05$) between batiki and guinea grasses in TDN. Data obtained in this experiment demonstrated that signal grass is better than guinea and signal in the nutrition of growing goats in the tropical environment of Samoa. It had the highest nutritive value, better apparent digestibility coefficients which have better growth rate and feed efficiency. In ranking, signal grass was better than guinea and batiki grasses, while guinea grass was better than batiki in nutritive value in the parameters measured. For future pasture establishment in Samoa, signal grass is recommended for consideration because of its higher nutritive value as a replacement for batiki, the most predominant grass. ***(Asian-Aust. J. Anim. Sci. 2001. Vol 14, No. 10 : 1389-1393)***

Key Words : Grass, Batiki, Guinea, Signal, Chemical Composition, DMI, Growth Rate, FE, Digestibility

INTRODUCTION

For the production of animal protein from ruminant animals over the years, humans have utilized grasslands, either as a sole component of the diet or as a supplement to feeds of vegetable and animal origin. In most parts of the tropical and subtropical countries, the grazing of available native pastures largely supports the production of ruminants. In the Pacific Island countries (PICs), especially the large raised Island countries where many ruminants are reared, natural pasture has for ages been the source of nutrients for grazing animals. The importance of natural pasture in tropical ruminant livestock production has been stressed by several researchers (Mannetje, 1978; Olubajo and Oyenuga, 1971; Reynolds, 1978; Adu and Adamu, 1982; Adjei, 1995; Michiels et al., 2000).

In most tropical environments, growth and performance of goats are largely limited by forage quality and this is reflected in low voluntary intake and digestibility (Minson, 1990). Thus, it has been emphasized that most tropical grass species have low dry matter digestibility and intakes (Minson, 1971; Humphreys, 1987). The supply of natural pasture is subject to seasonal variation in quantity and quality. Adu and Adamu (1982) opined that the low productivity of animals reflects poor yields and low quality of pasture from available grasslands. The season of the year and grass species have been observed to influence intake, nutritive value and digestibility of herbage (Aregheore, 2000a).

Pasture and animal improvement in the Pacific Island countries are a recent development. However, livestock improvement programs in the PICs now lays strong emphasis on the production of better yielding pasture species with high nutritive value when either grazed or conserved.

* Corresponding Author: Eroarome Martin Aregheore. Tel: +685 21 671 X 229, Fax: +685 22 933, Email: aregheore_m@samoa.usp.ac.fj
Received November 7, 2000; Accepted May 3, 2001

Several species of grasses, including batiki grass (*Ischaemum aristatum* var. *indicum*), were introduced over the years to Samoa to complement other existing natural or unimproved ones. However, because of competitive nature of batiki grass, its has over the years overshadowed other pasture species such as guinea grass (*Panicum maximum*), elephant grass (*Pennisetum purpureum*) and signal grass (*Bracharia decumbens*). At present, batiki grass is the most common propagated pasture grass species for ruminant livestock in Samoa and in other small island countries in the South Pacific region.

Except for the reports of Reynolds (1978), Gutteridge and Whiteman (1978), and Aregheore and Hunter (2000), there is scant information on the chemical composition and nutritive value of grasses in the PICs. The challenge in using pasture as a sole source of forage for animals is to determine whether or not the pasture can supply adequate nutrients for maintenance, growth and production (Aregheore, 1997). The objective of this paper therefore was to evaluate batiki grass with two other grass species, namely guinea grass (*Panicum maximum*) and signal grass (*Bracharia decumbens*) in diets of growing goats.

MATERIALS AND METHODS

Site of the experiment

The experiment was conducted at the Goat Unit of the School of Agriculture, The University of the South Pacific, Alafua Campus, Apia, Samoa (Latitude-13.5 °S, Longitude-172.5 °W) during the dry season. The climate was characterized by a mean annual temperature of 27°C (range 23-30°C), a mean annual rainfall of 3,500 mm and 65% humidity. The dry season period in Samoa is between April to November. This experiment was conducted between late April and early July 1999.

Diets

The diets were from batiki grass (*Ischaemum aristatum* var. *indicum*), guinea grass (*Panicum maximum*) and signal grass (*Bracharia decumbens*). The grasses were harvested fresh around the goat unit and fed to the animals *ad libitum* to allow about 10-20% refusal. An adaptation period of 7 days was allowed for the goats to get used to the experimental diets before data collection started. Diets offered and refused were recorded on a daily basis to estimate voluntary dry matter intake. Cleaning of the pens and removal of refusals from the previous day was done daily before supplying each day's diet. All the goats were allowed free access to mineral blocks. The mineral block contained salt, calcium, magnesium, copper, cobalt, iodine, phosphorus, manganese, iron, zinc, selenium (3 ppm), Vits. A, D and E, with copra meal and molasses added. To express growth rate and voluntary DMI for 10 weeks (70 days) only average weights at the beginning and end of experiment were used.

Animals and experimental design

Eighteen growing crossbred goats (Anglo-Nubian × Fiji local) between 9-11 months of age and pre-trial average live weight of 9.50±1.60 kg were divided on the basis of weight to three treatment groups in a completely randomized design experiment. In each treatment there were six goats. The goats were housed in individual pens that had previously been disinfected. The pens had concrete floors covered with wood shavings as litter. They were drenched with a dewormer (Levicare, Anoare, Birkenhead, Auckland) prior to the start of the experiment.

Digestibility study

At the end of the growth trial, the goats in each group were used for metabolic studies. Since the goats were on the same diet and environment, a digestibility study started 2 days after the end of the growth phase. The total daily fecal output for each goat was weighed before a 25% sample was removed for dry matter determination in a forced draught oven at 70°C for 48 h. The daily samples of feces and diets were then bulked separately, milled, and stored in air tight bottles until required for analysis. Digestibility was calculated by difference.

Analytical procedures

The forages were oven-dried at 70°C for 24 h. All dried products were ground using a Christy and Norris hammer mill to pass through a 1.7 mm sieve. Dry matter was determined by drying at 102°C for 24 hours, ash by firing at 600°C for 24 hours, protein by the micro-Kjeldahl procedure (N × 6.25) following the procedure of AOAC (1995). Minerals were determined using atomic absorption spectrophotometer (GBC 908 AA, Scientific Equipment Pty Ltd, Dandenog, Victoria, Australia), while Na and K were determined using a flame photometer (Ciba-Corning Flame Photometer 410) as described by AOAC (1995).

Statistical analysis

Analysis of variance (ANOVA) was used to analyze the data on voluntary feed intake, growth rate and apparent nutrient digestibility coefficients (Steel and Torrie, 1980), and where significant differences were observed the treatment means were compared by Duncan's multiple range test

RESULTS

Mean of dry matter (DM) contents and chemical composition of the grasses fed to the goats are presented in table 1. The grasses had similar DM content. The crude protein (CP) contents were within the range of 8.3-11.2%, while crude fiber (CF) content was between 30.9-35.2%.

Batiki grass had higher CF content while signal grass had a low value of 30.9% CF. Ether extract (EE) was low with a range of 1.2-1.8%. Nitrogen free extracts (NFE) content was similar for batiki and guinea grasses, while signal grass had more NFE (51.1%). The grasses are good sources of minerals, however, the ash content was lowest in signal grass with a value of 8.5% compared to 13.0% and 12.5% obtained for batiki and guinea grasses, respectively.

Table 2 shows the mineral concentrations in the grasses. They contained similar levels of macro-minerals (P, K, Ca, Na and Mg); Mg was lower than Ca and, with the exception of the low Mn content in signal grass, Fe and Mn were higher than other micro-minerals.

Data on voluntary dry matter intake (DMI), growth rate and feed efficiency (FE) of the goats during the ten weeks experimental period are presented in table 3. Average DMI was significantly higher in the goats on signal than those on guinea and batiki grasses ($p<0.05$). Also, treatment effects on average body weight gain (BWG) were significantly different ($p<0.05$). The goats on batiki had lower average BWG than those on guinea and signal grasses. Feed efficiency was better in the goats on signal grass, and those on guinea grass followed.

Table 4 presents data on apparent digestibility coefficients of nutrients available in the grasses by the goats. Nutrients digestibility were significantly ($p<0.05$) higher in the goats on signal grass compared to those on guinea and batiki grasses. The goats on guinea grass were better ($p<0.05$) in the digestibility of CP, OM, NFE and ME than those on batiki grass. However, goats on batiki were significantly better ($p<0.05$) in digestibility of CF than those on guinea grass.

The nutritive values of the grasses as expressed by digestible crude protein DCP, digestible energy (DE) and total digestible nutrients (TDN) are shown in table 5. Guinea and signal grasses contained more DCP than batiki grass. Also, DE was lower in batiki grass ($p<0.05$) than in guinea and signal grasses. There was no statistical significant difference ($p>0.05$) between batiki and guinea grasses in TDN. However, the TDN value of signal grass was significantly ($p>0.05$) higher than that of batiki and guinea. Signal grass had the highest nutritive value index (Crampton et al., 1960) and this was followed by guinea grass, whereas batiki grass had the lowest nutritive value index.

Table 1. Mean chemical composition of the grasses

Nutrients (%)	Grasses		
	Batiki	Guinea	Signal
Dry matter	34.7	35.2	35.6
Crude protein	9.4	11.2	8.3
Crude fiber	35.2	33.6	30.9
Ether extract	1.5	1.8	1.2
Nitrogen free extract	40.9	40.9	51.1
Organic matter	87.0	87.5	91.5
Metabolizable energy (MJ/kg DM)	9.5	9.4	9.4

Table 2. Mineral concentrations in the grasses

	Grasses		
Macro-minerals (g/kg)	Batiki	Guinea	Signal
Phosphorus (P)	0.29	0.29	0.25
Potassium (K)	2.76	3.90	2.18
Calcium (Ca)	0.45	0.49	0.44
Sodium (Na)	0.24	0.22	0.22
Magnesium (Mg)	0.25	0.25	0.22
Micro-minerals (mg/kg)			
Iron (Fe)	75.00	66.67	66.67
Manganese (Mn)	40.60	43.89	29.57
Copper (Cu)	5.36	6.43	6.96
Zinc (Zn)	34.18	25.68	27.57

DISCUSSION

Nutrient composition of signal grass was better comparatively. However, the nutrient composition of batiki and guinea grass followed reasonably uniform trends except for CP and CF. The CP content of the grasses ranged between 8.3-11.2% and this was within the CP concentration reported by Reynolds (1978) for pasture grasses in Samoa. The CP content of the batiki (9.4%) used in this experiment was lower than the value of 11.1% reported for batiki by Aregheore and Hunter (1999) and Aregheore (2000b); the period of the year, forage age and maturity stage may be implicated in the difference.

It was observed that the CP contents of batiki and signal are below the 11-12% suggested by NRC (1981) as being adequate to meet requirements for moderate weight gains in goats. However, the mean CP content of forage was more than 8%, below which it could be considered deficient (Norton, 1994). The low EE content of the grasses is a characteristic of forages (Adu and Adamu, 1982). The forages had high OM content suggesting that they can support overall animal performance. The ME values of the grasses are consistent with published estimates for forages fed to ruminants in other tropical countries (Butterworth, 1964).

The grasses have relatively high total mineral content (ash) and the contents of the macro and micro minerals are a true reflection of the ash contents obtained in the grasses. Ca and P are very important minerals and, generally, Ca is not usually deficient and range forages often contain high levels of Ca in relation to P (Norton, 1994). The P requirement in forage for sheep is 0.16-0.38% of DM (NRC, 1984), thus the P content of the three grasses used in this experiment seemed clearly to satisfy the P requirements of

Table 3. Performance characteristics of the goats fed the grasses

Parameters	Grasses			
	Batiki	Guinea	Signal	SEM
Initial average live -weight (kg)	9.5	9.5	9.5	
Final average live -weight (kg)	13.2	14.8	15.9	1.11
Metabolic mass (kg 0.75)	2.7^{b}	4.0^{a}	4.8^{a}	0.87
Daily live-weight gain (g/d)	52^{c}	76^{b}	91^{a}	0.16
Voluntary dry matter intake (kg)	0.35^{c}	0.39^{b}	0.43^{a}	0.33
Feed efficiency (feed/gain)	6.7	5.1	4.7	0.86

$^{a,b,c.}$ Means on the same row having unlike superscripts differ significantly ($p<0.05$)

Tabled 4. Mean apparent nutrient digestibility coefficients by the goats fed the grasses

Nutrients (%)	Grasses			
	Batiki	Guinea	Signal	±SEM
Dry matter	37.8^{a}	40.0^{a}	49.1^{b}	4.89
Crude protein	35.0^{bc}	39.0^{ab}	41.2^{a}	2.57
Crude fiber	47.0^{a}	41.0^{b}	66.7^{c}	10.98
Organic matter	35.4^{a}	36.9^{a}	54.8^{b}	8.81
Ether extract	28.1^{b}	28.0^{b}	36.7^{a}	4.08
Nitrogen free extract	47.8^{a}	51.5^{b}	56.6^{c}	3.61
Metabolizable energy	42.6^{c}	48.2^{b}	59.0^{a}	6.81

^{a,b,c} Means on the same row having unlike superscripts differ significantly ($p<0.05$)

Table 5. Nutritive value of the grasses

Nutrients (%)	Grasses			
	Batiki	Guinea	Signal	±SEM
Digestible crude protein (%DM)	0.11	0.15	0.18	0.03
Digestible energy (MJ/kg DM)	14.4^{c}	18.7^{b}	25.4^{a}	4.53
Total digestible nutrients (%DM)	40.3^{a}	40.3^{a}	53.8^{b}	6.36
Nutritive value index*	24.7^{c}	31.8^{b}	42.3^{a}	7.23

^{a,b,c} Means on the same row having unlike superscripts differ significantly ($p<0.05$).

* Nutritive value index=Relative intake × percent energy digestibility (Crampton et al., 1960).

the goats. The P values obtained for the grasses are similar to the values reported by Fujihara et al. (1992) for forages in the Phillipines. Also the Ca concentrations in the grasses are within the values reported by Kumagai et al. (1990) and Little et al. (1989) for native grasses in Indonesia and by Fujihara et al. (1992) for forages grazed by goats in the Philippines.

Micro-mineral concentrations were within the values reported by Little et al. (1989) for native grasses in Indonesia. Fijihara et al. (1992) reported that the relationship between mineral content of forages and mineral nutrition of goats is extremely limited. Comparatively, the concentration of minerals in the grasses used in this experiment seems to indicate that the minerals meet the requirements of the size of goats used in this experiment.

Voluntary intake is the most important factor that determines the level and efficiency of ruminant productivity (Van Soest, 1994). The body size of an animal has a major effect on voluntary DMI and the normal voluntary intake is 1-2.8% of body weight. The values for voluntary DMI of the grasses were within this range; therefore it could be assumed that the DMI of the goats with the different grasses was adequate to meet their requirements for growth. Based on the above it would appear that the DMI obtained should support adequate energy (TDN) intake to meet the requirements of the size of goats used in the present experiment.

The higher the organic matter digestibility (OMD) the higher the expected value of ME, thus the feed with the higher OMD is expected to provide more energy and therefore better growth rate and productivity. The goats on signal grass that had a higher OMD had a higher corresponding live-weight gain, showing that signal grass is better forage than batiki and guinea grasses. In the ranking of some available pasture grasses in Samoa, with respect to nutrient availability, signal grass was better in ranking than guinea and batiki grasses (Aregheore, unpublished data). Among the several grasses, batiki grass ranked lowest, therefore the low live-weight gain of goats on batiki grass was expected.

The high CF content of batiki grass affected DMI and subsequently its utilization by the goats for growth. Plants with high CF content occupy a large volume in the rumen; therefore limiting gut capacity and the rate of break down of these materials determines their potential intake and utilization. The apparent digestibility coefficients of the grasses are a reflection of the ability of the goats to utilize the available nutrients for growth. Signal grass was better in all the parameters measured (table 3), followed by guinea grass, while the least was batiki grass. However, batiki grass although lower in nutrients than most grasses found in Samoa, still remains the most cultivated grass compared to others because of the reason given earlier.

Data obtained in this experiment demonstrated that signal grass is better than other grasses in the tropical environment of Samoa for the nutrition of growing goats. It had the highest nutritive value, better apparent nutrient digestibility coefficients and subsequently better animal performance in terms of growth rate and feed efficiency. In ranking, signal grass was better than guinea and batiki grasses, while guinea grass was better than batiki in nutritive value, apparent nutrient digestibility coefficients, growth rate and feed efficiency. For future pasture establishment in Samoa, signal grass is recommended for consideration because of its higher nutritive value as a replacement for batiki, the most predominant grass.

REFERENCES

Adjei, M. B. (1995). Component forage yield and quality of grass-legume cropping systems in the Caribbean. Trop. Grass L. 29:142-149.

Adu, I. F. and A. M. Adamu. (1982). The nutritive value and utilization of three tropical grass hays by sheep. Trop. Grass L. 16(1):29-33.

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

Aregheore, E. M (2000a). The effect of supplements of crop residues based diets on the performance of steers grazed on natural pasture during the dry season. Afric. J. Range For. Sci. 18:26-29.

Aregheore, E. M. (2000b). Intake and digestibility of mixtures of batiki grass (*Ischaemum aristatum* var. *indicum*) and dadap (*Erythrina variegata* var. *oriental*) by Anglo-Nubian goats in Samoa. Trop. Grass L. (In press).

Aregheore, E. M. and D. Hunter. (1999). Crude protein and mineral composition of Samoan ruminant forages. J. South Pac. Agric. 6(1):34-39.

Butterworth, M. H. (1964). The digestible energy content of some tropical forages. J. Agric. Sci. Cambridge, 64:319-321.

Crampton, E. W., E. Donnefer and L. E. Lloyd.. (1960). A nutritive value index of forages. J. Anim. Sci. 19:538-544.

Fujihara, T., T. Matsui, S. Hayashi, A. Y Robles, A. B Serra, Cruz, L. C. and H. Shimizu. (1992). Mineral status of grazing Philippine goats: I. Nutrition of Calcium, Magnesium and Phosphorus of goats in Luzon Island. Asian-Aus. J. Anim. Sci. 5(2):383-388.

Gutteridge, R. C. and P. C. Whiteman. (1978). Pasture species evaluation in the Solomon Islands. Trop. Grass L. 12(2):113-126.

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.

Kumagai, H., N, Ishida, M. Katsumata, H. Yano, R. Kawashima and J. Jachja. (1990). A study of nutritional status of macro minerals of cattle in Java Indonesia. Asian-Aus. J. Anim. Sci. 3:7-13.

Little, D. A., Supriati Kompiang and R. J. Petheram. (1989). Mineral composition of Indonesian Ruminant forages. Trop. Agric. (Trinidad) 66(1):33-37.

Mannetje, L. T. (1978). The role of improved pastures for beef production in the tropics. Trop. Grass L. 12(2):1-9.

Minson, D. J. (1971). The nutritive value of tropical pastures. J. Aust. Inst. Agric. Sci. 37:255-263.

Minson, D. J. (1990). Forage in Ruminant Nutrition, San Diego, California 92101, Academic Press, Inc.

Norton, B. W. (1994). Tree legumes as dietary supplements for ruminants. In: R. C. Gutteridge and H. M Shelton (eds.), Forage Tree Legumes in Tropical Agriculture, CAB International, Wallingford, UK.

NRC (National Research Council) (1981). Nutrient Requirements of Domestic Animals. No. 15 Nutrient Requirements of Goats, National Academy of Sciences, Washington, D.C.

NRC (National Research Council) (1984). Nutrient Requirements of Sheep. 6th Revised Ed. (National Academy of Sciences, Washington, DC).

Olubajo, F. O. and V. A. Oyenuga. (1971). The measurement of yield, voluntary intake and animal production of tropical pasture mixtures. J. Agric. Sci. Cambridge, 77:1-7.

Reynolds, S. G. (1978). Evaluation of pasture grasses under coconuts in Western Samoa. Trop. Grass L. 12(3):146-151.

Steel, R. G. D. and J. H. Torrie. (1980). Principles and Procedures of Statistics. McGraw-Hill, New York, p. 481.

Van Soest, P. J. (1994). Nutritional Ecology of Ruminants, 2nd Ed, Cornell University Press, Ithaca, NY, USA.