Research Note

MORUS ALBA *AND* HIBISCUS ROSA-SINENSIS *FED AS WHOLE-PLANT SUPPLEMENTS TO GROWING LAMBS GRAZING ON GUINEA GRASS*[1,2]

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The introduction and utilization of woody species, such as *Morus alba* (Morera) and *Hibiscus rosa-sinensis*, in livestock production systems is a possible alternative to reduce the high cost of using imported concentrate feeds in Puerto Rico. Studies with lactating goats at the Tropical Agricultural Research and Higher Education Center (C ATIE) in Turrialba, Costa Rica, indicated a high digestibility for the Morera shrub. An in vivo digestibility of 79% was found for Morera, and 64.2% for Amapola (*Malvabiscus arboreus*). Morera also showed the highest in vitro digestibility (89%) in relation to seven other shrub species native to Costa Rica (Jegou et al., 1994).

In other studies with dairy goats, high levels of milk production were sustained with a mixed diet of chopped Morera and the grass species *Pennisetum purpureum*. A linear increment (r = 0.99) in milk production was observed when Morera was fed at four levels of daily dry matter [1.0, 1.8, 2.6, and 3.5% of live weight (LW)]. From the low-producing group to the high producing group the significant increment in daily milk production per head was from 1.64 to 2.12 kg as Morera intake increased from 1.0 to 3.5% of L W, respectively (Rojas and Bena vides, 1994). Esquivel and Waelput (1994) studied the effect of replacing concentrate feeds with *Morus alba* foliage in the diet of lactating Holstein cows grazing Kikuyo grass (*Pennisetum clandestinum* Hochst, ex Chiov). The Morera replacement rate was 0, 40 and 75% of the dietary dry matter, and no significant ($P < 0.05$) differences were observed in daily milk production of the groups under evaluation (14.2,13.2 and 13.8 kg respectively). García et al. (2006) showed that it was possible to reduce the level of concentrate feed by 50% by increasing the dietary level of Morera from 1.8% to 2.8% of LW in young heifers grazing Guinea grass (*Panicum maximum* Jacq.). These studies showed the great potential of the *Morus alba* shrub for use in livestock production systems with either small or large ruminants.

Low variation was found in the chemical composition and dry matter yield of *Morus alba* and *Hibiscus rosa-sinensis* varieties when evaluated in different agro-ecosystems (Espinosa, 1996). Doney et al. (2006) studied the effect of adding *Hibiscus rosa-sinensis* hay to basal diets of star grass (*Cynodon nlemfuensis*) hay at substitution rates of 40, 60 and 80% for feeding young lambs in confinement; these researchers measured animal response as average on-line weight gain (ALWG). A significant ($P<0.05$) 2.7-fold increase in

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ALWG, accompanied by a significant increment in dry matter intake (DMI), was observed when going from a control diet of star grass ha y only to one of 60% hibiscus and 40% star grass hays.

The objective of the present study was to evaluate the effect of adding chopped whole plant forage of *Morus alba*, *Hibiscus rosa-sinensis*, or *Panicum maximum* Jacq. as supplements to the diet of young lambs grazing Guinea grass in terms of rate of weight gain and dry matter consumption. Also assessed was the quality of these forages as indicated by chemical composition.

The study was conducted at the Corozal Agricultural Experiment Station of the University of Puerto Rico in a small ruminant shed divided into six cages, each with provision for supplying salt, and a feeder for forage offerings. Next to these facilities, an area of 0.61 ha with nine fenced plots was available for the grazing of Guinea grass. Additional 0.18-ha and 0.14-ha areas of *Morus alba* (MA) and *Hibiscus rosa-sinensis* (HR), respectively, were used to supply harvested forage for use as dietary supplements during daily stable confinement after the hours of grazing. The Guinea grass pasture was fertilized at the rate of 200 kg/ha of a 15-5-10 fertilizer at the beginning of the experiment.

This experiment took place during the eight-week period between 16 April and 11 June 2008 and had as objectives the evaluation of three supplemental forage species in terms of animal consumption, estimated quality and live weight gain of young lambs. The animals grazed daily on Guinea grass plots during the hours from 7:00 a.m. to 2:30 p.m. Thereafter, they were placed in the individual cages and fed harvested whole-plant forage according to the following treatments:

MA – Chopped *Morus alba*
HR – Chopped *Hibiscus rosa-sinensis*
GG – Chopped Guinea grass (control)

For the sampling of the grazed forage area, four clipped random samples at 15-cm height were taken from each plot before the introduction of the animals in each two-week cycle. The composite sample of each of the four grazing periods was oven-dried at 65° C for two weeks. These samples were ground to pass through a 1-mm sieve. Ground dried samples were sent to a laboratory for estimation of quality parameters. An average of the four sampled cycles was used to determine the nutritional level of the grazed forage during this evaluation.

All the chopped forages were obtained from regrowth 16 to 24 weeks after the previous harvest. The quantity of forage provided daily under each treatment was determined on a dry matter basis, and was equal to 2.0% of animal body weight. Two young lambs (each weighing 16 to 18 kg) were placed in each cage. The level of forage consumption of each treatment was determined during each of four two-week cycles of grazing. The animals remained on the same treatment throughout the experimental period. At the end of each cycle the animals were individually weighed during the morning hours.

During the first week of each cycle the animals were considered to be adapting to the new daily offerings of supplemental forages. During the second week, daily samples of the offered forage were taken to produce a seven-day composite for each treatment. The composites were air-dried in an oven at 65° C for a period of two weeks. For sample evaluation, the 30 April to 13 May, and 14 May to 28 May cycles were chosen as representative of forage quality criteria.

The mean forage consumption, expressed as a decimal proportion of the amount offered, was calculated in each of the four cycles by using the following formula:

$$\text{Mean Forage Consumption} = \frac{\text{wt. offered forage} - \text{wt. refused forage}}{\text{wt. offered forage}}$$

We analyzed the chemical fractions Crude Protein (CP), Acid Detergent Fiber (ADF), Neutral Detergent Fiber (NDF), and estimates of Relative Feed Value (RFV). The RFV is an index for ranking forage based on digestibility and intake potential, which is calculated from ADF and NDF. A RFV of 100 is considered the standard score and represents alfalfa hay containing 41% ADF and 53% NDF on a dry matter basis . Also estimates of Total Digestible Nutrients (TDN), Net energy for lactation (NEl), Net energy for maintenance (NEm), and Net energy for growth (NEg) were determined by the Dairy One Forage Evaluation Laboratory in Ithaca, New York.[5]

Data on feed consumption were analyzed by using a generalized linear model with logit link and beta distribution for criteria of forage quality , and with identity link and normal distribution for live weight gain. Means were compared by using the T Test (LSD) (SAS, 2004).

Mean chemical composition and estimated values of TDN and net energy (dry basis) of the Guinea grass available for grazing during this experiment were as follows: CP, 8.5%; ADF, 40%; NDF, 72%; RFV, 77; TDN, 59%; NEl, 0.17 Mcal/kg; NEm, 0.24 Mcal/kg; and NEg, 0.12 Mcal/kg. A lower nutritional value of this pasture grass is evident relative to that of the chopped forages of *Morus alba* and *Hibiscus rosa-sinensis* offered during the afternoon. The 8.5% CP content of the pasture forage represents marginal quality. According to Parish and Justin (2008), when dietary CP levels are below 8%, rumen bacteria cannot maintain optimum growth rates; therefore, supplemental nitrogen is needed. The ADF and NDF contents and estimated RFV also indicate that this grazable forage was of inadequate quality to support optimal growth of lambs A level five quality classification, according to the scheme of Lin et al. (1987), can be assigned to this forage.

Table 1 presents the mean proportions of the supplemental forages that were consumed, differences being significant ($P<0.05$) in cycles 2 and 3 but not in cycles 1 and 4. Higher consumption was observed for MA compared to that of HR and GG for the mean of all four experimental cycles.

TABLE 1.—*Mean proportional consumption of supplemental MA, HR and GG per grazing cycle.*[1]

	Cycle				
Treatment (Diet)	1	2	3	4	Mean
MA	0.64 a[2]	0.85 a	0.82 a	0.75 a	0.77 a
HR	0.47 a	0.69 b	0.57 b	0.74 a	0.62 b
GG	0.57 a	0.47 c	0.60 b	0.67 a	0.58 b
Mean	0.56	0.67	0.66	0.72	0.65

[1]Consumption relative to the offering of whole plant forage at 2.0% of lamb body weight daily.

[2]Means in the same column with different letters are significantly different.

[5]Company and trade names in this publication are used only to provide specific information. Mention of a company or trade name does not constitute a warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico, nor is this mention a statement of preference over other equipment or materials.

TABLE 2.—*Least square means of nutritional criteria of the chopped MA, HR and GG forages.*[1]

Treatment[2]	CP (%)	ADF (%)	NDF (%)	RFV (%)	TDN (%)	NEl (Mcal/kg)	NEm (Mcal/kg)	NEg (Mcal/kg)
MA	14.3 a[3]	28.0 a	41 b	164 a	68 a	0.32 a	0.31 a	0.19 a
HR	10.9 b	28.0 a	43 b	134 a	66 a	0.30 b	0.29 b	0.18 b
GG	9.3 b	38.0 a	75 a	74 b	59 b	0.18 c	0.24 c	0.12 c

[1]Means from three two-week composite samples from 16 April to 30 June 2008.
[2]All forages were chopped between 16 and 24 weeks of regrowth.
[3]Means in the same column with different letters are significantly different.

Table 2 presents the quality criteria means of the supplemental forages under evaluation. Significantly ($P < 0.05$) higher CP content was observed in MA in relation to that of HR and GG (3.4 and 5.0 percentage units more, respectively). The NDF contents of MA and HR were similar and significantly ($P < 0.05$) lower than that of GG. The TDN and RFV, which are estimates of the nutritional potential of the forages, were statistically similar for MA and HR, both of which significantly ($P < 0.05$) surpassed that of GG.

In terms of the three estimated net energy contents of the forages, MA was significantly ($P < 0.05$) higher than both HR and GG. Thus MA would provide more net energy for the functions of lactation, maintenance and growth of animals consuming it. *Hibiscus rosa sinensis* was also significantly ($P < 0.01$) higher than GG in these three estimates of net energy.

Lin et al. (1987) classified the value of dairy feeds according to their contents of ADF and NDF and estimated RFV. This classification includes a range of forage quality from poor (range five) to excellent (range one). According to Undersander and Moore (2002), this criterion has been of great value in ranking forages for quality in relation to animal requirements as compiled by the National Research Council Nutrient Requirements for Dairy Cattle. As Table 3 shows, the MA forage had the highest level of quality classification in this experiment; HR was the second-ranked forage, and GG the poorest in quality.

There were no significant ($P < 0.05$) differences among live weight gain of grazing young lambs receiving supplementation with the above mentioned forages. This lack of differences was probably due to the low number of observations in this experiment and the high variability in the young lambs' growth rate. Although not significantly ($P < 0.05$) different, MA showed the highest rate of gain (60.8 g/day), which represented adequate animal performance, over the eight weeks of experimentation. This result is logical, given the better forage quality, higher consumption and higher estimated net energy potential of MA. Supplementation with HR, which was shown to be a lower quality forage than MA, resulted in a slower growth rate of 23 g/day, whereas supplementation with GG, the poorest quality forage, led to a loss of 10.12 g/day of live weight, all of which was not surprising. Given these promising results, more research is warranted on the use of the MA shrub under more extensive commercial small ruminant production systems.

Morus alba showed potential as a supplemental forage for young lambs grazing relatively poor pasture, having the highest level of forage quality in terms of chemical composition, estimated net energy level, and forage consumption. Although the differences were not significant under the conditions of this experiment, MA can be expected to outperform HR and GG in promoting live weight gain when used as supplements.

TABLE 3.—*Classification of nutritive value of the three supplemental forages according to Lin et al. (1987).*

Treatment	RFV	ADF (%)	NDF (%)
MA	Highest excellence (>151)	Highest excellence (<31)	Highest excellence (<41)
HR	Fifth class (<75)	Highest excellence (<31)	First class (40-45)
GG	Fifth class (<75)	Second class (35-40)	Fifth class (>65)

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