The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

CARIBBEAN FOOD CROPS SOCIETY

41

Forty First
Annual Meeting 2005

GUADELOUPE

Vol. XXXXI - Number 2

Proceedings of the Caribbean Food Crops Society. 41(2): 504-509. 2005

CHEMICAL COMPOSITION AND RUMINAL FERMENTATION CHARACTERISTICS OF TROPICAL FODDER TREES (*CRATYLIA ARGENTEA*, *CALLIANDRA CALOTHYRUS* AND *MORUS ALBA*)

Suzika Pagán Riestra Department of Animal Industry, University of Puerto Rico, Mayagüez Campus.
Elide Valencia, Department of Agronomy and Soil Sciences, University of Puerto Rico, Mayagüez Campus.
Abner Rodríguez Carías, Department of Animal Industry, University of Puerto Rico, Mayagüez Campus.
Rafael Ramos Santana, Department of Agronomy and Soil Sciences, University of Puerto Rico, Mayagüez Campus.

ABSTRACT: Goat production in the tropics relies on both native and or improved grass pastures. Experiences in Puerto Rico, however, indicate that nutritional constraints to improved goat production are due to a scarcity of feed supply, low feeding value of tropical grasses and reduced efficiency of utilization of available feed resources. Exploitation of fodder trees as browse plants can be an effective strategy to improve goat nutrition. Little information, however, is available on the use of fodder trees in goat feeding. The objectives of this study were to determine the chemical composition, *in situ* dry matter degradability (ISDMD), forage degradability rates (kd) and protein solubility fraction of three fodder trees [*Calliandra calothyrus* (Powderpuff; CC); *Cratylia argentea* (Cratylia; CA); *Morus alba* (Mulberry; MA)] and a tropical grass hay mixture (TGHM). Twigs of each fodder tree were clipped, oven-dried and ground in a Wiley mill to pass a 1-mm screen. Samples were analyzed for crude protein (CP), organic and inorganic matter (OM and IM), and cell wall components [NDF, ADF and hemicellulose (HC)]. Data were analyzed using the GLM procedure of SAS. The ISDMD study was conducted in a fistulated Holstein cow maintained on a grass diet utilizing the suspended nylon bag technique. Triplicates samples (5g) were incubated for 0, 6, 12, 24, and 48 hrs and analyzed for degradation rates and dry matter disappearance. Data were analyzed using a non linear regression procedure, $y = a + b\ (1- e^{-c*t})$, where a = soluble fraction, b= degradable fraction, and c= rate of degradation, and t = incubation period. Protein solubility percentages were estimated by protein content difference after placing samples in nylon bags in fistulated cow. Crude protein was higher ($P<0.05$) for MA (21.0%) than for CC (16.27%), CA (14.65%), and TGHM (4.69%). There were a difference ($P<0.05$) for OM among the studied forages (CC 91.89; CA 88.49; MA 86.66 and TGHM 93.51%). The TGHM had high NDF and ADF values (74.31 and 55.59, respectively) compared to the others forages species. The NDF and ADF values were: 52.66, 40.67 (CA); 47.51, 37.26 (CC) and 28.50, 15.38 (MA). Protein solubility percentages were 25.79, 35.52, 47.72, and 19.85 % for CA, MA, CC and TGHM, respectively. After 48 hrs of ruminal fermentation *in situ* dry matter disappearance values were 41.85, 45.52, 91.75, and 36.56 % for CA, CC, MA and TGHM, respectively. Ruminal kd values of DM degradability were calculated for CA (.005), CC (.011), MA (.003) and TGHM (.01). The higher protein solubility was observed for MA (47.72%), and as expected the lower for TGHM (19.85). The higher CP % and ISDMD for the fodder trees evaluated compared to the TGHM indicates its potential use as supplement for small ruminants diets based on tropical grasses.

INTRODUCTION

In tropical areas, small ruminant production has been identified as an alternative for meat and milk production for small-holders. In Puerto Rico, urban development spawned by rising land value has resulted in high grazing pressure in the beef industry that has forced livestock farmers to diversifying to sheep or goats as they require less land area. Nutrition in Puerto Rico relies on naturalized or improved grass pastures as the main sources of feed. Experiences in Puerto Rico and elsewhere, however, indicate that major nutritional constraints to improved sheep and goat production are both scarcity and low feed value of forages during drought periods as well as reduced efficiency of utilization of available feed resources (Johnson and McGowan, 1998). Feed resources in the tropics are characterized by low crude protein and high fiber concentration in grasses.

Legumes and legume shrubs have long been recognized as an important component of the fodder resources for livestock and wildlife (Baumer, 1991). Legumes contribute in terms of higher nutritive value and increase in quantity of forage (Diaz et al. 2005; this conference), and, depending on management and climatic conditions, may extend grazing beyond what is possible with grass pastures. Legume species from different genera (e.g., *Leucaena*, *Acacia* and *Gliricidia*) have been evaluated as supplement for sheep and goats and with positives results. Preston and Leng (1987) indicated that leguminous trees (e.g., *Gliricidia* and *Erythrina*) are sources of fodder particularly as they are high-yielding perennials and possess deep-rooted systems that may access ground water and nutrients unavailable to short-rooted grass plants. Recent research by Anbarasu (2004) demonstrated an improvement in animal performance with supplementation of legume leaf meals (e.g., *Leucaena*) to the diet of goats.

In Puerto Rico, many legumes and other fodder trees had not been evaluated in small ruminant productions systems. Recent introduction and agronomic evaluation of legume trees (e.g., *Cratylia* and *Calliandra*) indicate a fast growth and high foliage yield (R. Ramos-Santana, 2005; personal communication). Little information, however, is available on the chemical components of these fodder plants. The objective of the present study was to determine the chemical composition and assess ruminal fermentation characteristics of three fodder trees [*Calliandra calothyrus* (Powderpuff; CC); *Cratylia argentea* (Cratylia; CA); *Morus alba* (non-leguminous Mulberry; MA)] and a tropical grass hay mixture (TGHM). Results from this study can provide information that can assist us in designing feeding strategies for small ruminants in Puerto Rico.

MATERIALS AND METHODS

Experimental design

Mature (three-year-old) plants of *Calliandra calothyrus* (Powderpuff; CC); *Cratylia argentea* (Cratylia; CA); *Morus alba* (Mulberry; MA), growing on an Ultisol, Corozal series (Very-fine, parasesquic, isohyperthermic Typic hapluderts) at the Agricultural Experimental Substation, Corozal, Puerto Rico were pruned to induce new sprouts. Twigs (leaves, petioles and tender stems) of these fodder plants were harvested at 12-wk regrowth and used for this study. Tropical grass hay (guineagrass; *Panicum maximum* Jacq.) was also used as a check to establish a comparison with the fodder plants.

Harvested material (5 kg) were oven dried (65° C for 48-hr) and ground in a Wiley mill to pass a 1-mm screen. Triplicates sub-samples were analyzed for crude protein (CP), organic and inorganic matter (OM and IM) following the procedures outlined by AOAC (1990), and cell wall components [neutral fiber detergent; NDF, acid detergent fiber; ADF and hemicellulose (HC)] were determined by the method of Van Soest et al. (1991).

Ruminal fermentation characteristics were studied using a rumen fistulated Holstein cow maintained on a guineagrass hay diet utilizing the suspended nylon bag technique (Orskov, 1980). Triplicates samples (5 g) were incubated for 0, 6, 12, 24, and 48 hrs. After each incubation period, all bags were hand washed under running water and oven dry. Dried bags plus residues were weighed and analyzed for degradation rates and dry matter disappearance, measured as the difference between initial and residual material at each incubation period. Protein solubility was estimated after placing samples in nylon bags in a fistulated cow for 5-min.

Statistical Analysis

Data for the chemical component were analyzed using the General Linear Models Procedure of SAS (1990). When effects of treatments were found to be significant ($P<0.05$), the Bonferoni t- test was used to separate means. For the ruminal fermentation characteristics, data were analyzed using a non linear regression procedure, $y = a + b\ (1- e^{-c*t})$, where a = soluble fraction, b= degradable fraction, and c= degradation rate, and t = incubation period.

RESULTS

There were differences in chemical composition (Table 1) for all forages evaluated. Crude protein percentages were higher for MA (21%), followed by CA (16.3%) and CC (14.7%). There were a 3.7 and 5.3 percentage unit differences for MA compared to CA and CC, respectively. The chemical composition for MA was similar to those reported by Flores *et al.* (1998), while different for CA and CC. There was also significant differences ($P<0.05$) among forages for OM and IM. Fodder trees had higher values for IM compare to the TGHM. The tropical fodder trees had lower NDF percentage (28.50 - 52.66), than the TGHM (74.31), which indicates that these fodder trees have high soluble cell content.

In Figure 1, it can be observed that *in situ* DM degradability of MA at all incubations periods was higher than from those of CC, CA and TGHM. Dry matter degradability after 48 hrs of ruminal fermentation were 91.75, 45.52, 41.85and 36.56 % for MA, CC, CA and TGHM, respectively. Studies by Ngo Tien Dung et al. (2003) reported that rumen dry matter degradability after 96 hours incubation was for the non-leguminous *M. alba* (87%). The DM degradability of CA and CC were lower than MA. Earlier studies suggest that the low degradability of some legumes trees (for example *Calliandra calothyrus*,) is associated to the presence of high levels of condensed tannins (Anbarasu *et al*, 2004 and Salawuap *et al*, 1997), but in the present study, condensed tannins were not evaluated. A higher protein solubility was observed for MA (47.72%; Table 2), and as expected the lower for TGHM (19.85). Ruminal kd values of DM degradability (Table 2.) were calculated for CC (.006), CA (.011), MA (.003) and TGHM (.01).

CONCLUSIONS

In conclusion, this study found that the chemical composition between the fodder trees evaluated were different. But their higher CP % and ISDMD when compared to the TGHM indicates its potential use as a supplement for small ruminants diets based on tropical grasses. The wide variation in rumen degradability between *M. alba* (90%) and 40% for *C. argentea,* and *Calliandra* spp. suggest the possibility of a high tannin content that may affect rumen degradability. Additional research is needed to evaluate possible anti-nutritional factors that may affect the utilization of these feed resources.

ACKNOWLEDGMENTS

This research was funded by local state funds “Leguminous tree foliage as a supplement to roughage diets for small ruminants”

REFERENCES

Anbarasu, C., Dutta, N., Sharma, K., and Rawat, M. 2004. Response of goats to partial replacement of dietary protein by a leaf meal mixture containing *Leucaena leucocephala*, *Morus alba* and *Tectona grandis.* Small Ruminant Research 51:47–56.

AOAC. 1990. Official Methods of Analysis. 15th Ed. Association of Official Analytical Chemist. Arlington. VA.

Baumer, 1991. Trees as browse to support animal production. In: Speedy, A., and Pierre-Luc Pugliese. Proc. of the FAO Expert consultation held at the Malaysian Agricultural Research and Development Institute (MARDI) in Kuala Lumpur, Malaysia, 14-18 October 1991.

Diaz, H., J. Torres, E, Valencia and A. A. Rodriguez. 2005. Seedbed management effects on botanical composition and nutritive value of bluepea (*Clitoria ternatea*) on a guineagrass (*Panicum maximum* Jacq.) stand. In Proc. of the 2005 Caribbean Food Crops Society Meetings. Guadeloupe, 11th-16th July, 2005

Flores, O. I, Bolívar, D. M., Botero, J. A., Ibrahim, M. A. 1998. Parámetros nutricionales de algunas leguminosas arbóreas leguminosas y no leguminosas con potencial forrajera para la suplementacion de rumiantes en el trópico. Livestock Research for Rural Development. Vol 10, num.1

Johnson, D.D., and C.H. McGowan. 1998. Diet/management effects on carcass attributes and meat quality of young goats. Small Ruminant Research 28:93-98.

Ngo Tien Dung, Nguyen Thi Mui, Tran Hoang Chat and Dinh Van Binh 2003: Studies on the nutritive value of foliage from legumes and shrubs for goats; *In: Proceedings of Final National Seminar-Workshop on Sustainable Livestock Production on Local Feed Resources (Editors: Reg Preston and Brian Ogle). HUAF-SAREC, Hue City, 25 – 28 March, 2003.* Retrieved July 8, 2005, from http://www.mekarn.org/sarec03/dzungnew.htm

Orskov, E.R., Hovell, F.D. Deb and Mould, F. 1980. The use of the nylon bag technique for the evaluation of feedstuffs. Trop. Anim. Prod., 5: 195-213.

Preston, T.R., and R.A. Leng. 1987. Matching ruminant production systems with available resources in the tropics and sub-tropics. Penambul Books, Armidale, NSW, Australia.

Salawuap, M.B., Acamovic, T., Stewart, C.S. and Maasdorp, B. 1997. Assessment of the nutritive value of *Calliandra calothyrsus:* its chemical composition and the influence of tannins, pipecolic acid and polyethylene glycol on in vitro organic matter digestibility. Animal Feed Science Technology. 69:207-217.

SAS Institute. 1990. SAS/STAT® User's Guide (Release 8.1). SAS Inst. Inc., Cary, N.C.

Van Soest P J, Robertson J B and Lewis B A.1991. Methods for dietary fiber, neutral detergent fiber and non starch polysaccharides in relation to animal nutrition. Journal of Dairy Science 74:3583-3593.

Table 1. Chemical composition and cell wall components of tropical fodder trees evaluated.

Forages	CP	OM	IM	NDF	ADF	HC
	% of DM					
Calliandra calothyrus	14.65[b]	91.89[b]	8.10[c]	52.66[b]	40.67[b]	11.99[b]
Cratylia argentea	16.27[b]	88.49[c]	11.51[b]	47.51[b]	37.26[b]	20.38[a]
Morus alba	21.00[a]	86.66[d]	13.34[a]	28.50c	15.38[c]	12.31[ab]
Tropical grass hay mixture	4.69[c]	93.51[a]	6.49[d]	74.31[a]	55.59[a]	18.72[ab]

Means with the same superscript within column are not significantly different *(P>O.O5)*.

Table 2. Ruminal fermentation characteristics of tropical fodder trees.

Forages	CP solubility (%)	Soluble fraction	Degradable fraction	Degradation rate	DM degradability (%, 48hrs)
Calliandra calothyrus	25.78	0.263	0.695	0.006	41.85
Cratylia argentea	35.53	0.322	0.258	0.011	45.52
Morus alba	47.72	0.456	3.381	0.003	91.75
Tropical grass hay mixture	19.85	0.096	9.600	0.010	36.56

Figure 1. *In situ* DM degradability of three tropical fodder trees (*C. argentea* (CC), *C. Calothyrus* (CC), *M. Alba* (MA) and a tropical grass hay (TGHM).