Effects of Maturity and Drying Method on the Nutritive Value of Tropical Grasses in Nicaragua

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Key words: tropical forages, warm-season grasses, nutritive value, maturity, bunch grass

Abstract
Tropical grasses are key components for both grazing and conserved forages in sustainable livestock systems (beef and dairy) in Central America. The objective of the study was to evaluate grasses used in Nicaragua and their nutritive value contribution as preserved forage during the dry season under different drying methods. Five tropical bunch grasses (*Andropogon gayanus, Hyparrheniarufa, Urochloabrizantha, Megathyrsus maximus, and Cenchruspurpureus*) were sampled across different farms in Nicaragua in 2014 and 2015 using three replications. Forage samples were collected at 2, 4, 6, and 8-wk maturity as well as season long samples. Samples drying methods included sun- and oven-dried. Sun-dried samples were air dried outdoors for five days while oven-driedused forced air at 55 ºC. Samples were analyzed for nutritive value using wet chemistry protocols for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF) and *in vitro* total digestibility (IVTD). Drying methods did not influence CP, ADF, NDF and IVTD concentrations. There were significant differences among grass species in CP levels (P=0.0003), ADF (P=0.0009), and IVTD (P=0.0083). *U.brizantha* had the greatest CP concentration (79 g/kg) while *C. purpureus* had the lowest CP (44 g/kg). *U. brizantha* had the lowest ADF (340 g/kg) concentration. Species *A. gayanus, H. rufa,* and *Megathyrsus maximus* had similar NDF concentrations. In vitro total digestibility ranged from 680 to 750 g/kg with *M. maximus* having the lowest digestibility. Significant differences in forages nutritive value were observed among maturity stages for CP (P<0.0001), ADF (P=0.0022), NDF (P=0.0006), and IVTD (P=0.0241), but *U. brizantha* maintained higher CP and IVTD concentrations compared other species, indicating that could be a more preferred species for off-season feeding.

Introduction

Tropical grasses are key components for both grazing and conserved forages in sustainable livestock systems (beef, dairy, and dual purpose) in Central America. On the other hand, livestock farming activities are more often being affected by the occurrence of extreme events, such as prolonged droughts due to climate change and variability, which affects meat and milk production, worsening the ability of smallholder farmers to preserve forages. Although tropical grasses might have high biomass production, animal production might often be depressed due to adecrease in nutritive value (Guenni et al. 2002). Poor feed options among preserved forages are major factors contributing to low livestock productivity in Central America. A major constraint to smallholder farmers is the shortage of forages in quantity and quality during the dry season as key source for supplementation increasing production per animal unit. Determining the nutritive value of different forage species can help enhance animal production by identifying feed options to increase digestibility and nutrient quality which can result in greater animal growth rate, and greater milk production (Rao et al. 2014). Selecting forages with better nutritive value could also help improve calving rate, reduce mortality, and improve overall herd performance (Burns et al. 2010).

There are many factors that affect the nutritive value of preserved forages such as fertilization, species, stage of maturity and methods of preservation. The nutritive value of forage depends on its leaf:stem ratio, digestibility, and the nature of digested products. These characteristics affect the amount of forage consumed by the animal and their utilization. Tropical forage grasses contain different quantities of fiber, lignin, minerals and vary in the proportion of leaf and stems than can be digested by cattle (Lee, 2018). The objective of the study was to evaluate grasses used in Nicaragua for beef production and their nutritive value contribution as preserved forage during the dry season under different drying methods.

Methods

Tropical grasses were sampled across different farms in Nicaragua during the 2014 and 2015 growing seasons with three replications. There were five bunch grass species: *Andropogon gayanus, Hyparrheniarufa, Urochloa brizantha (formerly known as Brachiaria brizantha), Megathyrsus maximus (formerly known as Panicum maximum), and Cenchrus purpureus(formerly known as Pennisetum purpureum*). Forages samples were collected at 2, 4, 6, and 8-wk maturity as well as season long samples (harvested once at the end of the rainy season). Two drying methods were compared, sun-dried (air dry) and oven-dry (forced air). Sun-dried samples were air-dried outdoors for five days, and oven-dried samples were processed in air force drier at 55 ^{o}C to a constant weight. Samples were processed to pass through a 2.0 mm screen and then reground with a UDY cyclone mill to pass through a 1.0 mm screen before nutritive value analysis. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were analyzed sequentially by the batch procedures outlined by the ANKOM Technology Corporation (Macedon, NY, USA) with an ANKOM 200 fiber analyzer and addition of heat-stable-amylase and sodium sulfite to the neutral detergent solution (Hintz et al. 1996).A modified Goering and Van Soest (Goering and Van Soest 1970) procedure was used to determine 48 h in vitro true digestibility (IVTD)with buffered rumen fluid followed by a neutral detergent wash of post-digestive residues. The rumenfluid incubation was performed with ANKOM F57 filter bags and an ANKOM Daisy II incubatorusing the batch incubation procedure (ANKOM Technology, Macedon, New York, NY, USA). Total N was determined by the Dumas combustion method with a LECO modelFP-528 (LECO Corporation, St. Joseph, MI, USA) and crude protein (CP) was calculated as N x 6.25.

Nutritive value composition among specieswas analyzedusing the two-way analysis of variance. The first factor was maturity stage, and the second factor was the drying method. General Linear Mixed (GLIMMIX) and regression (REG) Models of SAS (SAS Institute Inc. 2019) were used to determine differences at α = 0.05.

Results and Discussion

Present study focused variation in nutritive values among drying methods, grasses species and sampling dates. Drying methods (sun- vs oven-dried) did not differ in the assessment of nutritive value parameters. Nutritive values were very similar among drying methods for CP (58 g/kg), ADF (372 g/kg), NDF (652 g/kg) and IVTD (707 g/kg).

Table 1. Influence of five different tropical bunch grasses on nutritive value constituents (CP, ADF, NDF, and IVTD). Data averaged across sampling dates.

	Nutritive Value (g/kg DM)*			
Forage Species	***CP***	***ADF***	***NDF***	***IVTD***
Urochloabrizantha	79.0 A†	340.1 B	641.0 AB	730.5 A
Hyparrheniarufa	60.7 B	365.2 A	620.7 B	736.9 A
Megathyrsus maximus	53.0 B	379.3 A	668.0 A	670.4 B
Andropogon gayanus	54.2 B	381.6 A	664.7 AB	707.0 AB
Cenchruspurpureus	43.6 B	392.8 A	665.5 AB	692.3 AB

*CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; IVTD = *in vitro* true digestibility.
†Letters are for comparison of forage species within a nutritive value parameter, values with different letters denote significant differences ($p<0.05$).

Nutritive value parameters were influenced by forage species [CP (P = 0.003), ADF (P = 0.0009), NDF (P = 0.0066), and IVTD (P = 0.083)] (Table 1). *Urochloa brizantha* had 79% greater CP concentration than *C. purpureus.* Cruder protein concentrations of *A.gayanus and M. maximus were very similar.* Greater ADF difference was observed between *B. brizantha* and *C. purpureus. Hyparrhenia rufa* had lower NDF concentration compared to the other grasses. IVTD content of*M. maximus*was 8% lower than *U.brizantha* and *H.rufa*, respectively. Our results indicate that *U. brizantha* may be the preferred speciesfor preserved forages during the dry season. Previous research (Rao et al., 2015), confirmed that palatability and animal response improved on feeding *Urochloa* grass due to better voluntary dry matter intake and less constrained gut-fill compared to other tropical grasses.

Nutritional parameters (CP, ADF, NDF, and IVTD) were affected (P < 0.01) by forage sampling date (Table 2). There was a linear decline in CP with increase sampling date [CP (g/kg DM) = -9.979w + 88.037, R^2 =

0.9829, P < 0.01]. Season-long biomass production had greater NDF concentration while no differences were observed between 4 to8-week intervals. The two-week and season long (SL) sampling dates had greater NDF concentrations while values among the rest of the sampling dates were very similar. Sampling at 4 weeks had greater IVTD compared to the rest of sampling dates while SL had the lowest IVTD concentration. This indicates that harvest management is an important tool to manipulate the nutritive value of forage species. Changes in nutritive value suggests that cutting at 4 weeks might provide a better option for preserving the nutritive value of these tropical grasses.

Table 2. Influence of sampling date on nutritive value of tropical forages. Data averaged across forage species.

	Nutritive Value (g/kg DM)*			
Sampling Date (weeks)	***CP***	***ADF***	***NDF***	***IVTD***
2	78.7 A†	375.5 B	651.4 B	722.1 AB
4	69.3 AB	351.9 C	622.9 C	743.5 A
6	54.4 B	335.8 C	613.7 C	723.2 AB
8	49.2 B	358.9 BC	637.0 BC	695.8 B
Season Long	38.9 B	437.0 A	734.9 A	652.4 B

*CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; IVTD = *in vitro* true digestibility.
†Letters are for comparison of forage species within a nutritive value parameter, values with different letters denote significant differences ($p<0.05$).

Conclusions

The findings of this study suggest that changes in nutritive value was not affected by drying method, but rather influenced by forage species and stage of maturity. Towards the onset of flowering there was a rapid decline in overall nutritive value (CP, ADF, NDF, and IVTD). In vitro true digestibility was highest at 2 and 4-week regrowth, compared to 6-week, 8-week, and season long regrowth. Our results suggest that the grasses do not meet even maintenance requirement and supplementation is needed if using 6-week regrowth or season long forage. *U. brizantha* maintained greater CP and IVTD concentrations indicating that this could be a more preferred species for off-season feeding.

Acknowledgements

This project was funded by United Stated Agency for International Development (USAID) in collaboration with the Consultative Group on International Agricultural Research (CGIAR) Research Program on Livestock and Fish.

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