Research Note

CHEMICAL COMPOSITION, IN VITRO DEGRADABILITY, AND INTAKE AND DIGESTIBILITY BY GOATS OF PIGEON PEA (CAJANUS CAJAN CV. GUERRERO) AND GUINEA-GRASS HAY MIXTURES[1,2]

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Tropical grasses (TG) are widely used as basal diet in small ruminant enterprises However, it is well known that the quality and quantity of TG decrease during prolonged dry seasons which affect forage availability and nutritive value. In previous research, tropical legumes (TL) ha ve been evaluated as supplements in TG-based diets for small ruminants with promising results (Hernández, 2007; Acero, 2007; Crespo, 2007; Rivera, 2003). Pigeon pea (PP) (*Cajanus cajan* cv. Guerrero) is a TL that requires less agronomic management than TG, adapts well to low fertility soils, and its nutrient profile is similar to that of *Arachis glabrata* and *Stylosanthes guiannensis*. However, information about the inclusion of PP hay as an integral part of small ruminant diets is limited. This experiment was designed to determine the chemical composition, in vitro degradability, and intake and digestibility by goats of PP and guinea-grass (GG) (*Panicum maximum*) hay mixtures. Pigeon pea and GG were harvested at 105 and 45 d of growth and regrowth, respectively, at the Agricultural Experiment Station of the University of Puerto Rico in Lajas Both forages were made into hay by sun-drying for three to four days. Samples of the ha ys were taken and ground through a 2.5-mm screen, then manually mixed at five different proportions: 100:0; 75:25; 50:50; 25:75; 0:100 w/w. Triplicate samples from each combination were analyzed to determine contents of organic matter (OM), inorganic matter (IM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), lignin, hemicellulose (as the difference NDF-ADF), and cellulose (as the difference ADF-lignin-IM), using standard procedures (AOAC , 1990; Van Soest et al., 1991). Samples from each combination were analyzed in a commercial laboratory (Dairy One Forage Lab., Ithaca, N.Y.)[7] to determine in vitro dry matter degradability (IVDMD), crude protein degradability (CPD) as percentage of DM, and NDF degradability (NDFD) as percentage of total cell-wall content after 48 h of in-

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cubation. Data were analyzed as a completely randomized design with five experimental treatments using the General Lineal Procedure of SAS (1990). Tukey t-test was used for mean separation. To determine consumption and DM, CP and NDF digestibility of two PP and GG hay mixtures, a 2 by 2 Latin Square experiment was conducted using four castrated mature native goats (average BW, 43.18 kg) as experimental units The experiment was conducted at the Small Ruminant Research facilities located on the University of Puerto Rico Mayagüez Campus. A feces collection bag was placed on each animal and the animals were individually housed in 3.66- x 2.44-m feeding pens provided with feeders and automatic waterers. To reduce vegetative material selectivity, both forages were chopped into pieces of approximately 2.5-inch length by using a commercial machine (Craftsman). Goats were assigned to two diets: 100% GG, and GG mixed with PP in 60:40 proportions. Diets were provided daily at 4% of animal BW on a dry basis. The experiment consisted of a 7-d diet adjustment period and 5 d of data collection. Samples of forages offered, orts, and feces were collected and composited for analysis of DM, CP, and NDF contents (AOAC, 1990; Van Soest et al., 1991) to determine DM and nutrient intake and digestibility.

For all five forage mixtures, OM and IM contents were similar (Table 1). As expected, as the percentage of PP increased in the mixtures, CP content increased ($P < 0.05$) whereas NDF and ADF percentages decreased ($P < 0.05$). Lignin content did not differ significantly between mixtures containing none or 25% PP, but continued to increase progressively in those containing 50, 75 and 100% PP. As shown in Figure 1, ruminal CPD increased directly ($P < 0.05$) with the proportion of PP in the mixtures. The IVDMD was similar in mixtures containing 100:0, 75:25 and 50:50 GG:PP, but was higher ($P < 0.05$) in those mixed at 25:75 and 0:100 proportions. The NDFD content was higher ($P < 0.05$) in the 100:0 and 75:25 GG:PP mixtures than in those containing 50, 75, or 100% of the TL (Figure 1).

In this experiment IVDMD was higher in mixtures containing 75 and 100% PP than in GG alone, and CPD increased as PP was increasingly included in the grass-legume mixtures. However, the reverse effect was observed in NDFD. The latter result might be associated with the differences in cell wall structure and in components between those of TL and GG in general, and with the easily observed high stems:leaves ratio of the PP cut at 105 d. The high lignin content and low proportion of leaves of the PP might have de-

TABLE 1.—*Chemical composition of pigeon pea (*Cajanus cajan *cv. Guerrero) and guinea grass (*Panicum maximum*) hay mixed at different proportions.*

	GG: PP proportion (w/w)				
Component[1], %	100:0	75:25	50:50	25:75	0:100
OM[2]	93.90	94.10	94.15	94.32	94.50
IM[2]	6.10	5.90	5.85	5.68	5.50
CP[2]	9.1 e[3]	11.0 d	12.3 c	15.2 b	18.4 a
NDF[2]	65.0 a	64.3 b	55.3 c	52.4 d	43.1 e
ADF[2]	49.2 a	46.7 b	43.2 c	38.4 d	34.8 e
Lignin[2]	6.5 b	7.7 b	9.0 ab	10.1 a	11.5 a

[1]Means are values of three replicates.
[2]Dry Matter Basis
[3]Means within each component followed by different letters are significantly different ($P < 0.05$).

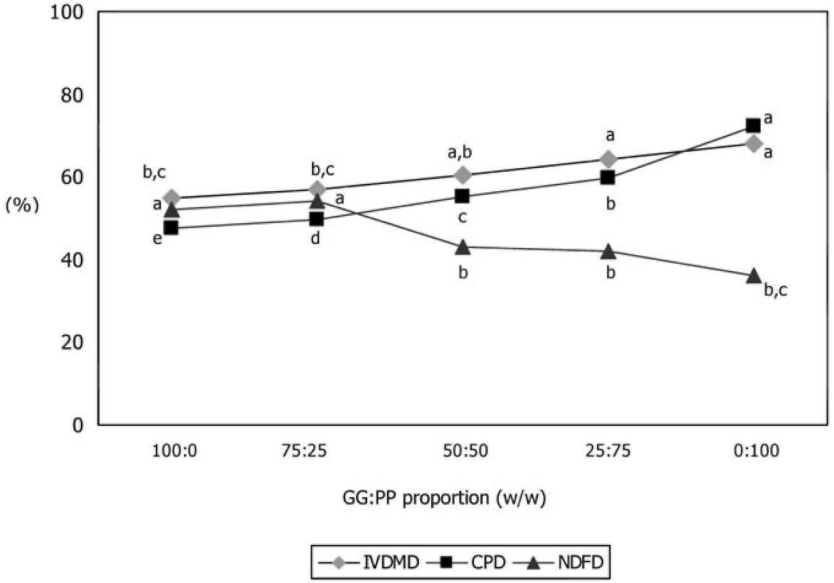

FIGURE 1. In vitro dry matter (IVDMD),crude protein (CPD) and NDF degradability (NDFD) of GG:PP mixed at different proportions Means with unlike letters within a line differ ($P < 0.05$).

creased NDF degradation, and thus decreased utilization by rumen microbes as its percentage increased in the mixtures.

Total DM and NDF intakes were lower ($P < 0.05$) but CP intake w as higher ($P < 0.05$) in goats fed the 60:40 GG:PP mixture than in those receiving GG alone. Consumption of PP by goats constituted 27% of total legume offered and 16% of total forage intake (data not shown). In previous studies inclusion of other TL (*Stylosanthes guianeneis* and *Leucaena leucocephala*) at dietary levels of 20 and 40% increased DM intake ofTG-based diets (Rodríguez et al., 1998). However, in this experiment including PP at 40% resulted in lower consumption than when GG was fed alone (Table 2). The higher consumption of the latter might be related to the fa vorable chemical composition of the 45-d grass utilized in this experiment, grass which had a higher CP and lower NDF content than typical grass hay previously evaluated in small ruminant diets (Díaz, 2004; León, 2003). Likewise, the lower intake of the PP:GG mixture might be explained by the mature stage of the PP plant resulting in negative goat selection (lower acceptability of thTL). The PP was offered as chopped hay, which has a decreased leaves:stems ratio, thus affecting forage selectivity, acceptability, and intake. The inherent browsing beha vior of goats and their preference for the fresh and more digestible fractions of the plant are well documented. Previous results have shown differences in chemical composition between anatomical fractions of the plants . Rivera et al. (2007) reported that stems of leguminous species contained lower CP and higher cell-wall content than leaves. Additionally, an effect of TL physical form (i.e., grazed, fresh cut, or hay) on consumption by small ruminants has been previously reported (Crespo , 2007). These two additional factors might

TABLE 2.—*Intake and nutrient digestibility by goats of diets containing guinea grass (*Panicum maximum*) and pigeon pea (* Cajanus cajan *cv. Guerrero) hay mixtures.*

Component	GG: PP proportion (w/w)	
	100:0	60:40
Intake, g/d		
DM	1,213 a[1]	968 b
CP	110 b	124 a
NDF	788 a	544 b
Digestibility (%)		
DM	64.64 a	58.81 b
CP	67.63	67.88
NDF	47.34 a	43.33 b

[1]Means in the same row followed by different letters are significantly different ($P < 0.05$).

also explain part of the lower DM consumption of the diets containing 40% PP The diets containing 100% GG also showed higher ($P < 0.05$) DM and NDF digestibility than the 60% GG:40% PP mixture, whereas CP digestibility was similar (Table 2). These results are in contrast to those of previous experiments that have shown higher DM and nutrient digestibility in diets containing grass-legume mixtures than in a diet of 100% TG (León, 2003; Rivera, 2003; Rodríguez et al., 1998). The legumes evaluated in those experiments included *Arachis glabrata*, *Stylosanthes guianensis* and *Leucaena leucocephala* added at different proportions and in more than one physical form. These differences in chemical composition of various forage species, ratios of anatomical plant fractions, and physical forms (fresh, chopped, haylage or hay) are pertinent to the understanding of animal responses in general, and of the present negative response to intake and digestibility of PP inclusion in a TGH-based diet in particular Recent studies elsewhere have also indicated different animal responses with different legume species utilized to supplement grass hay or haylage-based diets for small ruminants . Foster et al. (2009a, b) reported that lambs fed a basal diet of bahiagrass (*Paspalum notatum* Flugge cv. Tifton 9) showed higher intake and digestibility when the diet was supplemented with hay or haylages of perennial peanut (*Arachis glabrata* Benth. cv. Florigraze), annual peanut [*Arachis hypogaea* (L.) cv. Florida], or cowpea [*Vigna unguiculata* (L.) Walp. cv. Iron Clay] than animals supplemented with pigeonpea (*Cajanus cajan* (L.) Millsp. cv. GA-2). In summary, chemical composition and CPD improved as percentage of PP increased in the mixtures with GG; however, inclusion of PP in proportions higher than 25% decreased NDFD . A diet containing 40% PP also decreased forage intake and in vivo digestibility as compared with that of GG fed alone . Further experiments to evaluate PP under browsing conditions, or harvested as hay at earlier stages of maturity and offered at various levels of inclusion, must be performed to determine the potential of PP as a forage source in small ruminant diets.

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