Warm-Season Legume Hay Or Soybean Meal Supplementation Effects On The Performance Of Lambs

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This study showed that perennial and annual peanut hays are quality forages that improve intake, digestibility, and nitrogen retention when supplemented to bahiagrass hay. Cowpea and soybean hay have lower quality, but they are also promising legume supplements.

Summary

This study determined how supplementing bahiagrass hay (Paspalum notatum Flügge cv. 'Pensacola') with soybean (Glycine max (L.) Merr.) meal or warm-season legumes affects intake, digestibility, and nitrogen (N) utilization by lambs. Forty-two Dorper x Katadhin crossbred lambs (67 ± 12 lb) were fed ad libitum amounts of bahiagrass hay alone (six-wk regrowth), or bahiagrass hay supplemented (50% dietary dry matter, DM) with hays of annual peanut (Arachis hypogaea (L.) cv. 'Florida MDR98'), cowpea (Vigna unguiculata (L.) Walp. cv. 'Iron clay'), perennial peanut (Arachis glabrata Benth. cv. 'Florigraze'), pigeonpea (Cajanus cajan (L.) Millsp. cv. 'GA-2'), or soybean (cv. 'Pioneer 97B52'), or with enough soybean meal (4.25% of dietary DM) to match the average dietary crude protein (CP; 10.8%) concentration of the legume supplemented diets. Diets were fed to six lambs per treatment for two, consecutive 21-d periods. Annual and perennial peanut, cowpea, and soybean hays increased DM intake, but DM digestibility was only increased by supplementation with annual or perennial peanut hays. Nitrogen intake, digestibility, and retention were increased by all supplements and these responses were greatest when perennial peanut hay was supplemented followed by annual peanut hay. Warm-season legumes are promising supplements for growing ruminants. Perennial and annual peanut hays were the best supplements for the lambs.

Introduction

The quantity of bahiagrass and bermudagrass [*Cynodon dactylon* (L.) Pers.] that is available for winter grazing is limited because these grasses become dormant in the winter and do not provide sufficient nutrients to optimize the growth of beef cattle through the grazing season. Supplementing poor quality basal grass diets with legumes increases total feed intake and sometimes improves digestibility. In the United States, alfalfa (*Medicago sativa* L.) is the legume most commonly fed to livestock, but it does not persist in the Gulf Coast region. Perennial peanut is a warm-season legume adapted to this region and it is the main forage legume in Florida. However, because it is sprig-planted, it is more difficult and expensive to establish than tropically adapted, seeded warm-season legumes such as cowpea, soybean, pigeonpea, or annual peanut. Little is known about how performance of ruminant livestock is affected by supplementing bahiagrass hay with seeded warm-season legume hays. This study aimed to determine feed intake, digestibility, and nitrogen (N) balance of lambs fed bahiagrass hay supplemented with soybean meal, or hays of perennial peanut, annual peanut, soybean, cowpea, or pigeonpea. Lambs are excellent models for examining supplementation effects

on nutrient utilization in growing cattle.

Materials and Methods

Forage Production

Legume hays were produced at the North Florida Research and Education Center in Marianna, FL, (31° N) and fed at the Department of Animal Sciences, University of Florida, Gainesville, Florida. To prepare the field for planting seeded legumes, it was limed, fertilized, and plowed. In May of 2005, seeds were inoculated with the appropriate rhizobia drilled at 50 lb/ac and 6-in row spacings. Legumes were harvested at the following maturity stages: pod yellowing for cowpea (Twidwell et al., 2002), pod setting for pigeonpea (Le Houérou, 2006), and stage R6 (pod with full size seed at one of the four uppermost nodes and completely unrolled leaves) for soybean (Sheaffer et al., 2001). Established stands of perennial and annual peanut (self reseeding) were harvested as first cuttings in June and September of 2005, respectively. A mower-conditioner was used to harvest the legumes; windrows were turned with an inverter after 24 h, and then rolled into round bales. An established stand of bahiagrass was harvested as a six-wk regrowth and rolled into round bales.

Animals, Feeding, and Housing

Forty-two Dorper × Katadhin cross ram lambs weighing 67 ± 12 lb were used for the experiment. Lambs were stratified by weight and randomly assigned to seven treatments (six lambs per treatment per period). The experiment had 2 periods each containing 14 d of adaptation to diets and 7 d of measurement, and each lamb received a different diet in each period. Lambs were fitted with canvas feces collection bags and housed in individual metabolism crates adapted for collection of urine. Lambs were fed *ad libitum* (110% of previous days' intake) diets consisting of bahiagrass hay alone or bahiagrass hay supplemented (50% of diet DM) with perennial peanut hay, annual peanut hay, cowpea hay, pigeonpea hay, soybean hay, or soybean meal (4.25% of diet DM). The soybean meal inclusion level was aimed at matching the average CP concentration (10.8% DM basis) of the legume diets.

Sample Collection and Analyses

Samples of each feed were taken daily during the 7-d collection period and daily refusals were weighed and stored. Total fecal and urine output were collected daily from each lamb, weighed, and a subsample used for analysis. Samples of feed were dried, ground, and analyzed for DM, organic matter (OM), CP, neutral detergent fiber (NDF), acid detergent fiber (ADF), lignin, and in vitro true digestibility (IVTD). Feces was analyzed for DM after drying and grinding, and urine was analyzed for N.

Statistical Analyses

The experimental design was completely randomized. Data were analyzed with PROC MIXED (SAS Inst. Inc., Cary, NC). The model for analyzing chemical composition of forage included forage species and period (random variable). The model for analyzing intake, digestibility, and N retention included dietary treatment, period, dietary treatment × period, and lamb (random variable). Significance was declared at $P<0.05$.

Results and Discussion

Forage Chemical Composition

Dry matter concentrations were not different among forages, but OM concentration was greater in all other hays than in perennial peanut hay (Table 1). As expected, CP concentration was least ($P<0.01$) in bahiagrass hay. Among legumes, CP concentrations were greater in annual and perennial peanut hays than in cowpea and pigeonpea hays. Neutral detergent fiber concentration was greatest ($P<0.01$) in pigeonpea hay followed by bahiagrass hay, and least in annual and perennial peanut hays. The greatest ($P < 0.01$) ADF concentration was in pigeonpea hay and the least ($P<0.01$) concentration was in perennial peanut hay. Lignin ($P<0.10$) concentration was greater in pigeonpea hay than the other hays. In vitro true DM digestibility was greatest ($P<0.01$) in perennial peanut hay followed by annual peanut hay. Bahiagrass hay contained lower ($P<0.01$) IVTD than all legumes except pigeonpea hay

which contained the least ($P<0.01$) IVTD. Perennial and annual peanuts had greater IVTD than other legumes due to their lower NDF and ADF concentrations.

Intake, Digestibility, and Nitrogen Retention

With the exception of pigeonpea hay, legume hay supplementation increased intake of DM (Table 2). Intake of DM was greatest ($P<0.01$) in lambs supplemented with perennial peanut hay, followed by annual peanut hay, and they were lower in lambs consuming bahiagrass hay alone or pigeonpea hay than those consuming other legume hays. Intake of DM was not improved by addition of soybean meal. Digestibility of DM was only increased by perennial or annual peanut hay supplementation, and the values were greater when perennial peanut was supplemented. Unlike the other legumes, annual and perennial peanut are prostrate, spreading plants with relatively high leaf-to-stem ratios, therefore they have low concentrations of NDF and ADF, and consequently, they are more digestible than the other legumes. Pigeonpea had higher NDF and ADF concentrations because of its thick, woody stems, which probably increased gut fill, thereby decreasing intake.

Nitrogen intake was increased ($P<0.01$) by supplementation regardless of supplement type and it was greatest ($P<0.01$) in lambs fed perennial peanut hay, followed by ($P<0.01$) annual peanut hay. Nitrogen retention and digestibility were increased by all supplements and the greatest ($P<0.01$) values occurred in lambs fed perennial peanut, followed by annual peanut. Legume hay supplementation increased N intake because of the greater CP concentrations of the legumes versus bahiagrass, as well as the greater DM intake of most of the legume-supplemented diets. Nitrogen retention increased accordingly because all supplements increased N digestibility and most supplements decreased the proportion of intake N lost as urine (data not shown).

The fact that supplementation with N from legume hays or soybean meal increased N intake, digestion, and retention indicates that supplementation is necessary for optimizing the utilization of bahiagrass in lambs. At the moderate dietary CP concentration evaluated, supplementation with annual and perennial peanut hays was more effective than soybean meal supplementation at improving N intake, digestion, and retention. Perennial peanut and annual peanut were the most promising legume supplements because they resulted in the greatest DM intakes and digestibility and the greatest N retention. Pigeonpea hay supplementation increased N retention, but did not improve DM intake and it reduced DM digestibility; therefore, it was the least desirable supplement. This study suggests that supplementing bahiagrass with warm-season legumes can improve the performance of growing sheep and cattle.

Literature Cited

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Table 1. Chemical composition and in vitro true DM digestibility (IVTD) of hays.

Item[2]	Bahiagrass	Annual peanut	Perennial peanut	Cowpea	Pigeonpea	Soybean	SEM[1]
DM, %	91.1	91.0	90.8	91.5	91.8	91.6	1.8
OM, % DM	94.5[a]	92.4[b]	90.8[c]	92.6[b]	94.7[a]	93.8[ab]	0.5
CP, % DM	8.1[d]	14.7[ab]	15.2[a]	11.7[c]	12.2[c]	13.5[b]	0.4
NDF, % DM	73.8[b]	46.2[e]	43.3[f]	62.2[c]	78.6[a]	59.0[d]	1.0
ADF, % DM	39.8[cd]	37.8[d]	32.1[e]	48.7[b]	60.2[a]	42.8[c]	1.3
Lignin, % DM	6.2[b]	7.9[b]	6.7[b]	9.5[b]	17.1[a]	9.6[b]	1.1
IVTD, %	50.7[d]	71.4[b]	77.2[a]	57.9[c]	35.1[e]	57.4[c]	1.1

[1]Standard error of the mean values reflect the variation of samples collected daily and composited within each of 2 Periods (n=2).
Abbreviations: Dry matter (DM); organic matter (OM); crude protein (CP); neutral detergent fiber (NDF);
acid detergent fiber (ADF).
Within a row means without a common superscript letter differ ($P < 0.05$).

Table 2. Intake and apparent digestibility of dry matter (DM), nitrogen (N), and N retention of lambs fed bahiagrass hay supplemented with warm-season legume hays or soybean meal (SBM)

Item	Bahia-grass	SBM	Annual peanut	Perennial peanut	Cowpea	Pigeonpea	Soybean	SEM[1]
DM Intake, lb/d	1.5[ef]	1.6[de]	2.1[b]	2.4[a]	1.8[cd]	1.3[f]	1.9[c]	0.06
DM Digestibility, %	58.5[cd]	60.3[c]	64.3[b]	67.8[a]	58.8[cd]	56.3[d]	60.7[c]	0.9
N intake, lb/d	0.019[e]	0.034[c]	0.039[b]	0.047[a]	0.028[d]	0.026[d]	0.034[c]	0.0011
N digestibility, %	46.5[e]	56.8[cd]	62.4[b]	66.8[a]	54.0[d]	55.6[cd]	58.1[c]	1.1
Retained N, lb/d	0.0044[d]	0.0092[c]	0.015[b]	0.023[a]	0.010[c]	0.0090[c]	0.011[c]	0.0012

[1]Standard error of the mean values reflect the variation of measurements taken from each of the lambs on a treatment in each of 2 periods (n = 12 for intake and digestibility; n = 10 for retained N).
Within a row means without a common
superscript letter differ ($P < 0.05$).