

Warm-Season Legume Haylage or Soybean Meal Supplementation Effects on the Performance of Lambs

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This study showed that perennial and annual peanut and cowpea haylages are quality forages that improve intake, digestibility and nitrogen retention when supplemented to bahiagrass hay basal diets.

Summary

*This study determined how supplementing bahiagrass haylage (*Paspalum notatum* Flügge cv. 'Tifton 9') with soybean (*Glycine max* (L.) Merr.) meal or warm-season legume haylages affected the performance of lambs. Forty-two Dorper x Katadhin lambs (60 ± 11 lb) were fed ad libitum bahiagrass haylage alone, or supplemented with soybean meal or haylages of annual peanut (*Arachis hypogea* (L.) cv. 'Florida MDR98'), cowpea (*Vigna unguiculata* (L.) Walp. cv. 'Iron clay'), perennial peanut (*Arachis glabrata* Benth. cv. 'Florigraze'), or pigeonpea (*Cajanus cajan* (L.) Millsp. cv. 'GA-2'). Legumes were supplemented at 50% of the diet and soybean meal fed to match the average crude protein (CP) concentration (12.8%) of legume diets. Haylages were harvested, wilted to 45% dry matter (DM), baled, wrapped in polyethylene, and ensiled for 180 d. Each diet was fed to seven lambs for 21 d, and then to four lambs for 21 d. Supplementation with pigeonpea decreased DM intake but other supplements increased DM intake by approximately the same amount. Soybean meal supplementation increased DM digestibility but pigeonpea supplementation decreased DM digestibility. Nitrogen (N) intake, digestibility, and retention were increased by all supplements except pigeonpea haylage and these responses were greatest when soybean meal was supplemented. In conclusion, perennial peanut, annual peanut, and cowpea haylages are*

promising protein supplements for growing lambs.

Introduction

Protein supplementation is often necessary to meet nutrient requirements of ruminant livestock. Legumes are commonly utilized as protein supplements because their symbiotic relationship with microbes that fix atmospheric N increases their CP concentrations. Legumes also increase soil N status, and this may be a more economical method of improving N in soils than inorganic fertilizer application, especially with increasing fuel, and thus fertilizer costs. Alfalfa (*Medicago sativa* L.) is the most commonly used legume supplement in ruminant rations in the United States. However, alfalfa does not persist in southern states due to diseases, insects, and nematodes; therefore, research on tropically-adapted warm-season seeded legumes that can be used as protein supplements in the Southeast is needed. Due to inclement weather during harvest in some subtropical and tropical locations there is considerable interest in conserving such legumes as haylage rather than hay, but only a few studies on the feeding value of ensiled warm-season legumes exist. This study aimed to determine the feed intake, digestibility, and N balance of lambs fed bahiagrass haylage supplemented with soybean meal or haylages made from either perennial peanut, annual peanut, cowpea, or pigeonpea.

Materials and Methods

Forage Production and Ensiling

Legume haylages were produced at the North Florida Research and Education Center in Marianna, FL (31° N). To prepare the field for planting annual legumes the field was limed, fertilized, and plowed. Cowpea and pigeonpea seeds were inoculated with the appropriate rhizobia, drilled at 50 lb/ac in May of 2006, and harvested at the recommended maturity stages which are pod yellowing for cowpea (Twidwell et al., 2002) and pod setting for pigeonpea (Le Houérou, 2006). Established stands of perennial and annual peanut (self reseeding) were harvested as first cuttings in August 2006. An established bahiagrass stand was fertilized and harvested as the third cutting after five-wk of regrowth. Forages were cut with a mower conditioner, windrows were wilted to 45% DM, rolled into small round bales, and wrapped with a single roll wrapper.

Animals, Feeding, and Housing

Forty-two Dorper × Katadhin cross ram lambs weighing 60 ± 11 lb were used for the experiment. Lambs were stratified by weight and randomly assigned to six treatments (seven lambs per treatment during Period 1, and four lambs per treatment during Period 2) in a completely randomized design with two periods. Each period consisted of 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 haylage alone or bahiagrass haylage supplemented (50% of diet DM) with one of the legume haylages or with soybean meal at 8% of diet DM. The soybean meal inclusion level was aimed at matching the average CP concentration (12.8% 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 was collected daily from each lamb, weighed, and a subsample analyzed. Samples of feed

were dried, ground, and analyzed for DM, organic matter (OM), CP, neutral detergent fiber (NDF), acid detergent fiber (ADF), lignin, water-soluble carbohydrates (WSC), 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

The DM and OM concentrations of all haylages were similar ($P > 0.10$) (Table 1). Among the legumes, the CP concentration of annual peanut haylage was greater than that of pigeonpea haylage. Concentration of NDF was greatest ($P < 0.10$) in pigeonpea and bahiagrass haylages, but pigeonpea had greater ($P < 0.10$) ADF concentration than the other haylages. The lignin concentrations of cowpea and pigeonpea haylages tended ($P \leq 0.08$) to be greater than that of bahiagrass, but WSC concentration was not different ($P > 0.10$) among haylages. The IVTD was greater in annual and perennial peanut haylages than bahiagrass and pigeonpea haylages, and pigeonpea had the least ($P < 0.01$) IVTD. Differences in IVTD for these haylages can be partly explained by differences in their NDF, ADF, and lignin concentrations. Apart from pigeonpea, legume haylages had greater IVTD than bahiagrass haylage because they contained less NDF. Although the NDF concentration of pigeonpea was similar to that of bahiagrass, pigeonpea had a lower IVTD because it contained more ADF.

Intake, Digestibility, and Nitrogen Retention

All supplements except pigeonpea, increased DM intake (Table 2) and perennial peanut supplementation gave greater values than

cowpea supplementation. Apparent digestibility of DM was greater ($P<0.01$) in sheep fed soybean meal than in sheep fed bahiagrass haylage alone or pigeonpea haylage. Digestibility of DM was similar in lambs fed bahiagrass haylage alone and those fed legume supplements, except pigeonpea which had lower values. Nitrogen intake was greatest ($P<0.01$) in lambs fed soybean meal, followed by annual peanut haylage, and least ($P>0.10$) in lambs fed bahiagrass haylage alone or pigeonpea haylage. Digestibility of N was greatest ($P<0.01$) in lambs supplemented with soybean meal, followed by annual and perennial peanut and cowpea haylages, and least ($P<0.01$) in lambs fed bahiagrass haylage alone or pigeonpea haylage. Retained N was greatest in lambs fed soybean meal, followed by annual or perennial peanut and cowpea haylages, and least ($P<0.01$) in lambs fed bahiagrass haylage alone or pigeonpea haylage.

When basal grass diets of sheep are supplemented with legumes, DM intake increases because legumes have a faster rate of passage through the rumen. Supplementation with pigeonpea haylage decreased DM intake because its thick, woody stems would have caused greater gut fill than stems of bahiagrass. In contrast, addition of soybean meal increased DM intakes because the increased protein supply to ruminal microbes increased DM digestibility.

The N status of supplemented lambs was better than that of lambs fed only bahiagrass haylage. Perennial peanut and annual peanut haylage were the best legume supplements because they increased DM intake, N digestibility, and N retention relative to feeding bahiagrass haylage alone. Soybean meal supplementation resulted in the greatest N intake, digestibility, and retention and the greatest DM digestibility, indicating that it was the best supplement. Nevertheless, perennial peanut and annual peanut and cowpea haylages are promising supplements for sheep and cattle fed bahiagrass diets.

Literature Cited

Le Houérou, 2006. <http://www.fao.org/ag/agP/AGPC/doc/gbase/data/Pf000150.HTM>
Twidwell et al. 2002. S. Dakota State Univ. Circular 8070.

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Table 1. Chemical composition and in vitro true DM digestibility (IVTD) of haylages ensiled for at least 180 d

Item ²	Bahiagrass	Annual peanut	Perennial peanut	Cowpea	Pigeonpea	SEM ¹
DM, %	52.1	54.3	49.2	53.0	47.6	1.32
OM, % DM	96.9	95.7	95.9	93.9	95.8	0.79
CP, % DM	9.6 ^c	18.7 ^a	15.8 ^{ab}	16.0 ^{ab}	13.7 ^{bc}	1.23
NDF, % DM	67.8 ^a	39.6 ^b	40.0 ^b	44.1 ^b	65.0 ^a	2.40
ADF, % DM	32.2 ^b	25.3 ^{bc}	24.1 ^c	29.8 ^{bc}	48.6 ^a	1.99
Lignin, % DM	6.2	11.7	7.1	14.4	14.0	2.54
WSC, % DM	5.1	7.2	4.4	4.4	2.6	1.32
IVTD, %	60.4 ^b	73.8 ^a	76.9 ^a	68.6 ^{ab}	38.3 ^c	3.11

¹Standard error of the mean values reflect the variation of samples collected daily and composited within period (n=2).

²Abbreviations: Dry matter (DM); organic matter (OM); crude protein (CP); neutral detergent fiber (NDF); acid detergent fiber (ADF); water soluble carbohydrates (WSC).

^{abc}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 in lambs fed bahiagrass hay supplemented with warm-season legume haylages or soybean meal (SBM).

Item	Bahiagrass	SBM	Annual peanut	Perennial peanut	Cowpea	Pigeonpea	SEM ¹
DM intake, lb/d	1.4 ^c	1.7 ^{ab}	1.7 ^{ab}	1.8 ^a	1.6 ^b	1.1 ^d	0.05
DM digestibility, %	65.2 ^b	68.0 ^a	65.5 ^{ab}	66.7 ^{ab}	67.0 ^{ab}	58.7 ^c	0.9
N intake, lb/d	0.02 ^d	0.05 ^a	0.04 ^b	0.048 ^c	0.04 ^c	0.02 ^d	0.001
N digestibility, %	58.5 ^c	73.9 ^a	68.0 ^b	67.6 ^b	67.6 ^b	61.1 ^c	1.24
Retained N, lb/d	0.005 ^c	0.020 ^a	0.015 ^b	0.013 ^b	0.013 ^b	0.006 ^c	0.002

¹Standard error of the mean values reflect the variation of measurements taken on each lamb in each of 2 periods (n = 11 for intake and digestibility; n = 10 for retained N).

^{abc}Within a row means without a common superscript letter differ ($P < 0.05$).