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INTAKE AND DIGESTIBILITY OF BLACK LOCUST FOLIAGE FED TO GROWING GOAT WETHERS

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Abstract

Leaves of Black locust (BL, *Robinia pseudoacacia*), a native southeastern United States tree species known to contain substantial levels of condensed tannins, were fed to 16, four month old (20.4 kg body weight [BW]) Boer wether goats (*Capra hircus hircus*) to determine their effects on intake and digestibility. Four diets were stall fed in a randomized complete block design (RCBD) with four replications. Diets included: (1) 100% eastern gamagrass (EGH; *Tripsacum dactyloides*) hay; (2) 70% EGH and 30% mixture of ground corn (GC; *Zea mays*) and soybean (*Glycine max*) meal (SBM); (3) 75% EGH and 25% fresh BL leaves; (4) 50% EGH and 50% fresh BL leaves. Diet apparent digestibilities of dry matter (DM) [62.4, 68.2, 57.6 and 60.6%] and crude protein (CP) [62.8, 72.7, 55.5, 60.6%] were respectively different (P<.03). Goats that consumed diet 1 and diet 2 had higher digestibilities (P<.01) of neutral detergent fiber (NDF) and acid detergent fiber (ADF) than goats consuming diet 3 and 4. Lignin digestibilities for diet 3 (-56.7%) and diet 4 (-49.3%) were negative due to the probable complexing of tannins with the CP fraction. Intake of DM was similar across diets. The

overall differences in the diets may be related to the chemical nature of tannins present in BL leaves.

Keywords: *Robinia pseudoacacia*, Boer goats, intake, digestibility

Introduction

In southeastern United States, goats (*Capra hircus hircus*) are becoming an important livestock species due to increased demand for goat meat by various ethnic groups. Goat meat also fills a gap in a high-value niche market for people who prefer low levels of total and saturated fat (Pinkerton et al., 1994). For the past decade, the domestic market has not been able to supply these increasing demands.

An important consideration in developing a plan to increase meat goat production is the development of environmentally-sustainable production systems. Black locust (BL, *Robinia pseudoacacia*) is indigenous to Southern Appalachian deciduous forests. As a component of the regional forestry industry, BL is used as a source of timber for fenceposts, yet in some situations it is considered to be an aggressive invading species. However, BL is an appropriate source of biological nitrogen (N), which is used to enhance nitrogen-poor ecosystems, control erosion, and provide potential browse for livestock (Keresztesi, 1980). Black locust is known to contain condensed tannins (Horigome et al., 1988) that may negatively affect intake and digestibility of the foliage (Robbins et al., 1987). The objective of this research was to evaluate the potential of BL foliage as a source of forage for growing goats.

Material and Methods

A stall feeding trial was conducted at North Carolina State University in Raleigh NC (35 52 N 78 47 W) in a RCBD with four replications. Data were collected to measure effects of a BL diet on dry matter (DM) and crude protein (CP) intake, and diet digestibility. Black locust leaves were collected from trees planted four years earlier. The foliage was stripped from stems, and fed as fresh green matter. Sixteen, four month old (20.4 kg body weight) Boer goat wethers, were individually housed in metabolism crates and fed four different diets (% DM basis): (1) 100% Eastern gamagrass hay (EGH; *Tripsacum dactyloides*); (2) 70% EGH and 30% mixture of ground corn (GC; *Zea mays*) and soybean meal (SBM; *Glycine max*); (3) 25% BL leaves and 75% EGH; (4) 50% BL leaves and 50% EGH. Animals were fed hay in the morning and BL leaves in the afternoon feeding. Feed intake was monitored for 24 days, after which animals were fitted with fecal bags for a 5-day total excreta collection. All animals received free access to water and minerals. Feed refusals were removed and weighed before each feeding. Urine and fecal samples were taken daily throughout the experiment to monitor N excretion. Blood samples were withdrawn by jugular venipuncture at the start of the experiment, weekly during the trial, and at the end of the experiment to determine plasma urea-N. At the completion of the experiment, ruminal fluid samples were collected by stomach tube. Feed offered, feed refused, fecal and urine samples were analyzed for DM, N, neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose, and lignin concentrations. Detergent fiber analysis was done according to Van Soest et al. (1991) as modified by Komarek et al. (1994). Kjeldahl N was analyzed according to AOAC (1999). Statistical analysis of data was conducted using SAS (1998). Means were separated by orthogonal contrasts ($P<0.05$; Steel and Torrie, 1980).

Results and Discussion

For diet 1, the high NDF and low CP values represented the maturity of the experimental hay (Table 1). The CP concentrations of diet 2, 3, and 4 were higher than for diet 1 because of the addition of concentrate or BL foliage. The grain mix consisted of 59% GC (9.8% CP), 36% SBM (54.1% CP), and 5% of a mineral mix. Leaves of BL averaged 27.4% CP (data not shown). In diet 3 and 4, the hay was used to dilute the CP concentration of locust foliage. Concentrations of CP were similar in diet 2 and 3, but the latter was lower than in diet 4 due to the presence of 75% EGH. The nutritional requirement of a 20-kg growing meat goat is 14% CP (Luginbuhl et al., 1995). Therefore with the exception of diet 1, all diets contained sufficient amounts of CP.

Goats consumed similar amount of DM (g/d) during both intake and digestion phases (Table 2). However, during the digestion phase intake of diet 2 was greater than intakes of diet 3 and 4. Intakes of DM were low and only averaged 1.6% BW. Apparent digestibilities of DM and CP differed between diets, being greater for diet 2 than for diets 3 and 4. Apparent digestibilities of DM and CP were similar for diet 3 and 4. Goats consuming diet 1 and 2 had much higher NDF and ADF apparent digestibilities than animals consuming diets containing BL leaves. In addition, NDF and ADF digestibilities were higher for diet 3 than for diet 4. Lignin digestibility varied widely and was highly negative for the diets containing BL leaves. Closer examination of the data indicated that feeding BL foliage resulted in negative lignin digestibility in every animal. Fecal excretion of CP as a percent of CP intake differed among diets and was lower for diet 2 than for diet 3 and 4. In addition, a positive correlation was observed between CP and

lignin digestibilities for diet 3 and 4 ($r = .78$; $P < .01$). This relationship may indicate that lignin and tannins complexed with the CP fraction. Fahey et al. (1980) postulated that lignin and other phenolic complexes such as tannins are degraded as they pass through the gastrointestinal tract and that the resulting phenolic acids form undigestible complexes with N fragments that are excreted in the feces.

Results from this study seem to indicate that adding BL foliage to diets of growing goats had a relatively small effect on intake, whereas digestibility of DM, CP and fiber fractions were negatively affected. Additional research is warranted to examine meat goat performance under grazing situations where animals would have free access to a much greater variety of herbaceous plants to possibly counter-balance the negative effects of anti-quality compounds found in BL, while taking advantage of the high CP concentration found in that browse species.

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Table 1 - Chemical composition of diets (DM basis)*

	Diet			
	1	2	3	4
Component	100% Hay	70% Hay and 30% grain	75% Hay and 25% Black Locust	50% Hay and 50% Black Locust
	---------- % DM----------			
Crude protein	12.9	17.5	17.7	21.3
Neutral detergent fiber	75.2	54.6	61.3	50.4
Hemicellulose	38.6	28.7	30.0	22.9
Acid detergent fiber	36.6	25.9	31.3	27.5
Cellulose	33.1	23.3	25.4	20.2
Lignin	3.7	2.9	6.1	7.7

*Corrected for feed refusals

Table 2 - Intake and digestibility of goats fed diets containing black locust leaves

	Diet				Orthogonal Contrast		
Item	1[†]	2[‡]	3[§]	4[¶]	Treatment	Diet 2 vs Diet 3 & 4	Diet 3 vs Diet 4
					P-value		
Intake phase							
DM intake (g /d)	283.5	407.1	321.3	313.3	0.7	0.19	0.9
Digestion phase							
DM intake (g /d)	295.8	453.4	316.1	311.3	0.3	0.04	0.9
Digestibilities (%)							
DM	62.4	68.2	57.6	60.6	<0.01	<0.01	0.15
Crude Protein (CP)	62.8	72.7	55.5	59.1	<0.01	<0.01	0.13
NDF	70	66.4	51.8	47.5	<0.01	<0.01	0.07
ADF	69.6	65.8	39.1	30.7	<0.01	<0.01	0.02
Lignin	23.5	19.8	-56.7	-49.3	<0.01	<0.01	0.40
CP excreted as % CP intake	37.2	27.3	44.5	40.9	<0.01	<0.01	0.13

[†] 100% Eastern gamagrass hay

[‡] 70% Eastern gamagrass hay and 30 % ground corn and soybean meal

[§] 75% Eastern gamagrass hay and 25% black locust

[¶] 50% Eastern gamagrass hay and 50% black locust