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Evaluation of Fodder Trees for Goats

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Summary

White mulberry (*Morus alba*) and three leguminous tree species, Black locust (*Robinia pseudoacacia* L.), Mimosa (*Albizia julibrissin* Durazz) and Honey locust (*Gleditsia triacanthos*), were evaluated for growth, leaf biomass, nutritive value and browsing preference by yearling crossbred Boer goats (*Capra hircus hircus*). One-year-old seedlings were planted in March 1995. Based on leaf production data taken in September 1997 and May 1998, *Robinia pseudoacacia* (560 and 1,493 kg dry matter [DM]/ha) and *Albizia julibrissin* (773 and 608 kg DM/ha) have high potential as silvopastoral species for meat goats. *Morus alba* did not produce as much herbage (243 and 258 kg DM/ha) as the other two species, but was highly preferred by goats. Goats exhibited an initial low preference for *Albizia julibrissin* but readily consumed that species following defoliation of the other three tree species. Crude protein and neutral detergent fiber concentrations and *in vitro* true DM disappearance of leaf samples averaged, respectively: 23, 31 and 96% for *Morus alba*; 23, 44 and 60% for *Robinia pseudoacacia*; 24, 33 and 84% for *Albizia julibrissin*; and 18, 43 and 71% for *Gleditsia triacanthos*. Although of good quality and readily consumed by goats, *Gleditsia triacanthos* was judged to be a low value browse species due to its low biomass production (98 and 172 kg DM/ha). These results also indicate that *Robinia pseudoacacia*, *Morus alba*, and *Albizia julibrissin* have the potential to play an important role in meat goat production systems. The importance of anti-quality factors such as tannins, that decreased *in vitro* DM disappearance of *Robinia pseudoacacia* will have to be evaluated in *in vivo* experiments. Conversely, tannins present in *Robinia pseudoacacia* may represent a useful alternative to traditional anthelmintics to control gastrointestinal worm loads in goats.

Introduction

Goats (*Capra hircus hircus*) are becoming increasingly important contributors to the income of many producers in Southeastern United States (Pinkerton et al., 1994). Concomitantly, the demand for goat meat in the Eastern United States is growing as a result of preference from expanding ethnic communities. Furthermore, goat meat has the potential to fill a presently untapped, high value niche market because it contains low levels of total and saturated fat (Pinkerton et al., 1994).

Goats choose the most nutritious parts and portions of plants and given a choice among grasses, forbs and shrubs, they usually prefer shrub diets (Wilson et al., 1975; Bryant et al., 1979). Selective feeding and a strong preference for browse (Norton, 1984) allows goats to reduce variations in dietary energy and protein caused by environmental conditions or management (Fedele et al., 1991). Because of their versatile grazing/browsing behavior, goats are able to successfully control encroaching vegetation while at the same time selecting a diet that meets their nutritional requirements (Child et al., 1985). This opportunistic behavior has served goats well in situations where other domestic ruminant species would be at a clear disadvantage or even nutrient deficient (Coblentz, 1977; Mackenzie, 1993). Therefore, efficient meat goat production systems in the Southeastern United States must take advantage of regional pasture ecologies and the natural preference of goats for browse. The inclusion of native or naturalized fodder tree species could contribute to system productivity and efficiency by supplying required nutrients during the seasonal production cycle (mid-late summer) when demand by growing or lactating animals is critical and availability of high quality forage is scarce.

Goats may also be viewed as an alternative or supplement to beef cattle (*Bos Taurus*) production due to potential increased efficiencies when grazing both species together (Terril, 1993). Integrating goats into grazing systems enables them to utilize the palatable brush as a feedstuff to produce a saleable commodity while suppressing the brush, resulting in greater grass production for cattle (Harrington et al., 1982; Mackenzie 1993).

The objectives of this study were to evaluate the growth characteristics, leaf biomass, nutritive value and goat browse preference of White mulberry (*Morus alba*) and the three leguminous tree species Black locust (*Robinia pseudoacacia* L.), Mimosa (*Albizia julibrissin* Durazz) and Honey locust (*Gleditsia triacanthos* var. *inermis* Schneid.) for their potential as protein and/or energy banks for meat goats during the summer.

Materials and Methods

A field study was initiated at the Center for Environmental Farming Systems located near Goldsboro, North Carolina at approximately 35.4° N latitude and 78.0° W longitude. The experimental site was first mowed and each row was sub-soiled to a 30-cm depth. *Morus alba*, *Robinia pseudoacacia*, *Albizia julibrissin* and *Gleditsia triacanthos* were then planted in double rows (12 trees per row, planted 1 m apart within row and 3 m apart between rows) in plots measuring 11 m by 3 m and spaced 6 m apart. One year old bare-root seedlings were planted in March 1995 in an endophyte-infested tall fescue (*Festuca arundinacea* L. Schreb.), bermudagrass (*Cynodon dactylon* [L.] Pers.), bahiagrass (*Paspalum notatum* Fluegge), crabgrass (*Digitaria sanguinalis* L. Scop.) and white clover (*Trifolium repens* L.) pasture on a Typic Hapludult (Wickham loamy sand) soil. Trees were cut back to a 50-cm height in February 1996 to 2002. After planting, a 5-strand high-tensile electrified fence was erected at the perimeter of the experimental site.

The experimental design was a randomized complete block with four replications (Steel et al., 1997), analyzed with the GLM procedure of SAS (1998). Variables measured included total tree height (**TH**), herbage mass (**HM**), defined as leaves and leaf petioles, herbage nutritive value and goat preference. Total tree height was measured in April

1996, February 1997 before coppicing trees, May 1998, and June 1997 and 1998 before trees were browsed. In September 1997 and May 1998, HM was estimated by cutting branches from two randomly selected trees per plot at the coppice height, and hand-stripping all leaves. In June and August 2001 and June and September 2002, *Robinia pseudoacacia* HM was estimated by hand-stripping leaves from two randomly selected trees per plot without cutting the branches. The second HM estimation within the same year represented leaf and petiole regrowth. The browsing preference of the tree species was determined by sequentially defoliating each experimental replication with 30 yearling crossbred Boer goats using electrified netting as temporary fences. Each tree was given a defoliation score based on the proportion of foliage consumed by the animals at 6 and 24 h after the start of browsing. Trees were scored using a 10-point system where 0 was no defoliation and 10 complete defoliation.

Results and Discussion

Robinia pseudoacacia grew more rapidly than *Morus alba*, *Albizia julibrissin* or *Gleditsia triacanthos* (Table 1). *Robinia pseudoacacia* TH increased 484% between the first (1996) and second coppice (1997), followed by *Albizia julibrissin* (228%), *Morus alba* (140%) and *Gleditsia triacanthos* (86%). In September 1997, 2.5 months after defoliation by goats, regrowth HM was greatest in *Albizia julibrissin* and *Robinia pseudoacacia* (Table 1). However, no difference in HM was observed between *Robinia pseudoacacia* and *Morus alba*. In comparison, *Gleditsia triacanthos* regrowth HM was very poor. In May 1998, 3 months after coppicing trees to a 50-cm height, a large difference in HM was observed between *Robinia pseudoacacia* and the other three tree species. During that period, *Robinia pseudoacacia* grew very aggressively, produced a large number of branches and yielded more than twice HM as *Albizia julibrissin*. The HM produced by *Morus alba* and *Gleditsia triacanthos* was low, but similar to *Albizia julibrissin*. The low HM produced by *Gleditsia triacanthos* is consistent with its slow growth pattern and small leaves and leaflets. According to Le Houérou (1978), *Gleditsia triacanthos* is most useful as an overstory tree for the production of pods and seeds. Similar patterns of growth and HM production were reported recently by Addlestone et al. (1998) for *Robinia pseudoacacia*, *Albizia julibrissin* and *Gleditsia triacanthos*. The potentially high rate of photosynthesis of *Robinia pseudoacacia* (Mebrahtu, 1992) most likely accounted for its rapid growth and high HM. Similar results were reported by Papachristou and Papanastasis (1994). *Robinia pseudoacacia* produced even much larger amount of HM on August 10, 2001 and June 11, 2002. The reduction in *Robinia pseudoacacia* HM regrowth on September 4, 2002 was due to a two-month long drought.

Goats exhibited an initial high preference for *Morus alba* and *Gleditsia triacanthos* and a low preference for *Robinia pseudoacacia* and *Albizia julibrissin* (Table 1). The much higher HM produced by *Robinia pseudoacacia*, compared to *Morus alba* or *Gleditsia triacanthos*, accounted for the low defoliation score of the former species 6 hours after the start of browsing and the high defoliation scores of the latter two species. After one day, *Morus alba* and *Gleditsia triacanthos* were completely defoliated and almost 75% of *Robinia pseudoacacia* had been browsed. Goats were observed to relish browsing *Robinia pseudoacacia*, even using bipedal stance to reach higher in the canopy. Conversely, goats would taste the leaves of *Albizia julibrissin* only sporadically and then

move on to one of the other species. However, when kept on the same block for an additional 24 hours with *Albizia julibrissin* the only remaining option for browsing, goats defoliated that species satisfactorily. Addlestone et al. (1998) observed similar behavior with goats browsing the leguminous trees studied herein.

Chemical analysis of foliar samples indicated that leaflets of all species were of high quality (Table 2). With the exception of *Gleditsia triacanthos* in September 1997, CP values were above the nutritional requirements for actively growing or lactating goats (NRC, 1981). In June 1998, CP values were surprisingly high. Leaflet NDF values were low, being lowest for *Morus alba* and *Albizia julibrissin*. Highest IVTDMD were observed for *Morus alba*, followed by *Albizia julibrissin* and *Gleditsia triacanthos*. Recently, Bransby et al. (1992) reported DM digestibility values of 66% by sheep (*Ovis aries*) fed *Albizia julibrissin*, with no apparent signs of toxicity. *Robinia pseudoacacia* IVTDMD values were low, substantiating the findings of Cheeke and Schull (1985) who reported *Robinia pseudoacacia* to contain high levels of anti-quality factors such as tannins, phenolics, and robin, a toxic lectin. However, goats are known to have a high tolerance to secondary compounds, including tannins, due to unique tannin-binding proteins secreted by their salivary glands (Cheeke, 1992). Therefore, the IVTDMD values reported here for *Robinia pseudoacacia* may not be reflected in *in vivo* DM digestibility values. In the present study, *Robinia pseudoacacia* leaves contained 100 mg/g DM condensed tannins and 310 mg/g DM hydrolyzable tannins (Luginbuhl et al., 2001). Tannins have been reported to reduce fecal parasite egg counts in lambs (Barry et al., 2001). Therefore, *Robinia pseudoacacia* could also be browsed to reduce gastrointestinal worm loads.

Conclusions

These results indicated that *Morus alba*, *Robinia pseudoacacia* and *Albizia julibrissin* have the potential to play an important role in meat goat production systems. Although of excellent quality and readily consumed by goats, *Gleditsia triacanthos* was judged to be a low value browse species due to its slow growth and low HM production. *Morus alba* did not produce as much HM, but was of excellent quality and highly preferred by goats. Goats exhibited a low initial preference for *Albizia julibrissin* but readily consumed that species following complete defoliation of the other three tree species. *Robinia pseudoacacia* produced the most HM and as such had a much higher potential as a silvopastoral species for goats due to its rapid growth, survivability, high herbage production and goat preference. In addition, *Robinia pseudoacacia* has a high concentration of hydrolysable tannins (Luginbuhl et al., 2001) that should be investigated for their potential to reduce gastrointestinal parasite loads. Nevertheless, the presence of anti-quality factors in that species may reduce animal performance. Further research will need to be undertaken to assess the frequency of browsing of these fodder tree species, the evolution of forage quality throughout the growing season, stocking rate, animal performance and how to best integrate these fodder tree species in mixed silvopastoral systems.

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Table 1. *Tree height, leaf biomass, and browsing preference by goats of four fodder tree species.*

Item	<i>Morus alba</i>	<i>Albizia julibrissin</i>	<i>Robinia pseudoacacia</i>	<i>Gleditsia triacanthos</i>
<i>Tree Height, cm¹</i>				
April 4, 1996	67 ^b	53 ^b	129 ^a	52 ^b
February 26, 1997	120 ^{b, c}	164 ^b	292 ^a	93 ^c
June 16, 1997 ²	75 ^b	94 ^b	169 ^a	81 ^b
May 26, 1998	98 ^b	106 ^b	175 ^a	99 ^b
June 5, 1998 ²	111 ^b	125 ^b	223 ^a	101 ^b
<i>Leaf Biomass, kg/ha¹</i>				
September 29, 1997	243 ^{b, c}	773 ^a	560 ^{a, b}	98 ^c
May 26, 1998	258 ^b	608 ^b	1,493 ^a	172 ^b
June 5, 2001	- ⁴	-	1,682	-
August 10, 2001 ³	-	-	4,060	-
June 11, 2002	-	-	5,580	-
September 4, 2002 ³	-	-	2,043	-

^{a, b, c}Means with different superscripts in the same row differ ($P < .05$).

¹Trees were cut back to a 50-cm height in February 1996 to 2002.

²Measurements taken immediately before browsing by goats.

³Regrowth.

⁴Data not taken.

⁵0 = no defoliation; 10 = complete defoliation.

Table 2. *Crude protein and neutral detergent fiber concentrations, and in vitro dry matter (DM) disappearance of four fodder tree species.*

Item	Morus alba	<i>Albizia julibrissin</i>	<i>Robinia pseudoacacia</i>	<i>Gleditsia triacanthos</i>
<i>Crude protein, %</i>				
September 29, 1997	18.1	18.7	17.3	15.7
June 5, 1998 ¹	28.6 ^a	29.5 ^a	28.0 ^a	20.1 ^b
<i>Neutral detergent fiber, %</i>				
September 29, 1997	31.0 ^c	38.0 ^b	46.7 ^a	42.5 ^{a, b}
June 5, 1998 ¹	31.5 ^b	28.3 ^b	42.2 ^a	43.2 ^a
<i>In vitro true DM disappearance, %</i>				
September 29, 1997	96.1 ^a	78.7 ^b	58.8 ^d	73.8 ^c
June 5, 1998 ¹	96.1 ^a	88.8 ^b	61.9 ^d	69.1 ^c

^{a, b, c, d} Means with different superscripts in the same row differ ($P < 0.05$).

¹ Samples taken immediately before browsing by goats.

Black locust Leaf Tannin (mg/g DM)

