A comparison of *Leucaena leucocephala* and *Leucaena pulverulenta* leaf and stem age classes for nutritional value

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Abstract

After 3 months regrowth, *Leucaena leucocephala* and *L. pulverulenta* were cut 50 cm above the ground and divided into new leaves, old leaves, 3 branches fractions and 2 stem fractions. *L. leucocephala* had higher protein concentration, dry matter and organic matter digestibility than *L. pulverulenta*. *L. leucocephala* new leaves, old leaves and green stem portions ranged from 14 to 29% crude protein, and from 40 to 61% digestible organic matter. Similar fractions of *L. pulverulenta* ranged from 12 to 25% crude protein and from 26% to 36% digestible organic matter. That is, though the protein concentration of *L. pulverulenta* was only 14% less than that of *L. leucocephala*, the digestibility was nearly 50% less.

Resumen

Leucaena leucocephala *y* L. pulverulenta *fueron cortadas, despuès de tres meses de rebrote, a una altura de 50 cm sobre el nivel del suelo y el material colectado fue dividido en hojas nuevas y viejas, en 3 fracciones de ramas y en 2 fracciones de tallos. La concentración de proteína y la digestibilidad de la materia seca y de la materia orgánica fueron mayores en* L. leucocephala *que en* L. pulverulenta. *Las hojas nuevas y las viejas así como las fracciones de tallos verdes de* L. leucocephala *tuvieron un rango de 14 a 29% de proteína cruda y de 40 a 61% de digestibilidad de la materia orgánica. Las fracciones similares de* L.pulverulenta *tuvieron un rango de 12 a 25% de proteína cruda y de 26 a 36% de digestibilidad de la materia orgánica. A pesar que la concentración de proteína de* L. pulverulenta *fue únicamente 14% menor que en* L. leucocephala, *la digestibilidad fue casi 50% menor.*

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Introduction

Leucaena has a high protein content with leaf meal, green stems and the coarse stems reported to average 28, 15 and 7% protein, respectively (National Academy of Science 1977). Recent advances in rumen inoculation (Jones and Megarrity, 1986) have overcome the anti-metabolite effects of mimosine and its degradation products in ruminants. However, mimosine still limits the utility of leucaena in non-ruminants such as pigs and chickens. For these reasons there has been considerable research devoted to development of low mimosine hybrids, using *L. pulverulenta* as the genetic source of low mimosine (Bray *et al.* 1988). We examined *L. pulverulenta* since it has the lowest mimosine content of all *Leucaena* species (Brewbaker and Hylin 1965) and since it is more cold hardy than *L. leucocephala* (Glumac *et al.* 1987).

Brewbaker and Hutton (1979) have shown that the protein content of leucaena changes appreciably as a function of leaf and stem age class. To obtain an optimum combination of yield, protein, and digestibility it is important to know what size classes should be harvested. This is important whether leucaena is browsed directly by animals or whether it is harvested by mechanized farm equipment. We have observed cattle and deer to consume branches up to 6 mm in diameter and forage harvesters to sever and chop stems up to 20 mm in diameter. Thus it was considered necessary to examine stem size classes up to 20 mm in diameter.

This study investigated the N concentration and *in vitro* digestibility of *L. leucocephala* and *L. pulverulenta* after separation of the plant material into various fractions.

Materials and methods

Samples, resulting from 3 months regrowth, were collected in November 1985 from research plots of the Texas A&I University in Kingsville, Texas. Four replicates of each species were collected. Each stem was cut at 50 cm above ground and divided into leaves, branches and stems.

The leaves, including petioles, were separated into young leaves and old leaves. The young leaves were up to two months of age and were located in the top 20 to 30 cm of the branches. The remaining leaves were more than two months of age and were located on the lower portions of the branches and main stem.

The branches were divided <4 mm in diameter, 4–6 mm in diameter, and >6 mm in diameter. The stems were cut into two 50-cm long sections: cut 1 (1.5 to 1.8 cm in diameter) was the first 50 cm from the bottom, and cut 2 (1.1 to 1.5 cm in diameter) was closer to the terminal.

The samples were air dried in a walk-in oven at 45 °C until constant weight was attained, then ground through a 1 mm screen (Wiley mill). The ground samples were analyzed for dry matter % (DM%), ash %, organic matter % (OM%) (AOAC 1984), protein concentration (%) (Felker 1977) and *in vitro* organic matter digestibility (%) (Moore and Mott 1976). The rumen inoculum for the organic matter digestibility determination was obtained from a Jersey cow maintained on a bermuda grass diet.

Results

An analyses of variance revealed significant differences ($p < 0.01$) between the species for percent dry matter, ash, protein, dry matter digestibility, organic matter digestibility, and digestible organic matter. There were highly significant differences ($p < 0.001$) among the fractions for all variables except for % dry matter ($P = 0.13$).

The overall crude protein means of 14.1 and 12.1% for *L. leucocephala* and *L. pulverulenta*, respectively were significantly different ($p < 0.05$, Table 1). Highly significant differences among fractions occurred within a species.

L. leucocephala was substantially higher in digestibility of each fraction than *L. pulverulenta* (Table 1). The overall means of % organic matter digestibility were 42.7 and 28.9% for *L. leucocephala* and *L. pulverulenta*, respectively. Significant differences among fractions occurred within a species ($p < 0.001$).

The mean digestible organic matter (DOM) content of *L. leucocephala* (39.4%) was significantly greater ($p < 0.001$) than *L. pulverulenta* (27.3%) (Table 1). Again, significant differences among fractions occurred within a species ($p < 0.001$). *L. leucocephala* edible fractions (leaves and branches less than 4 mm) compare favorably with published TDN values for alfalfa (whole plant) (NRC 1984) using % DOM for leucaena as an estimate of TDN.

It is useful to compare the percentage of leaves per stem and the % DOM between species (Table 1). In *L. leucocephala* about 58% of the stem weight consisted of leaves while only 46% of the stem weight of *L. pulverulenta* consisted of leaves. Further, in *L. leucocephala* the woody parts of the plant over 6 mm diameter constituted only 27% of the stem weight, while in *L. pulverulenta*, this fraction had 41% of the stem weight. When both the lower percentage of leaves as dry matter, and the lower % DOM OF *L. pulverulenta* leaves are taken into account, the overall % DOM per stem in *L. leucocephala* was considerably greater than *L. pulverulenta* (47% compared to 26%). The DOM of the new and old leaves in *L. leucocephala* constituted 73% of the total DOM in the stem. In contrast, DOM of the *L. pulverulenta* leaves represent 47% of the total DOM in the harvested material. The *in vitro* dry matter digestibilities of the readily edible fractions (less than 6 mm branches and leaves) of *L. leucocephala* in this investigation are in close agreement with the data of Arora *et al.* (1986).

Discussion

In this study *L. leucocephala* had a higher protein content and higher digestibility than *L. pulverulenta* (Table 1). In a four year Texas field trial, *L. leucocephala* had slightly higher forage yield than *L. pulverulenta* (P. Felker, unpublished data). On the other hand, *L. pulverulenta* has a lower mimosine content (Gonzalez *et al.* 1967, Brewbaker and Hylin 1965), and more cold tolerance (Glumac *et al.* 1987). Also during the transplanting of 4 month old seedlings of *L. pulverulenta* and *L. leucocephala* to the field, it was observed that *L. pulverulenta* has a substantially larger root system than *L. leucocephala*.

In *L. leucocephala* was well as in *L. pulverulenta*, the edible leaves and the green stem por-

Table 1. Mean protein concentration and *in vitro* digestibility for *L. leucocephala* (leu) and *L. pulverulenta* (pul)

Fractions	Protein		Organic matter digestibility		Digestible organic matter		Fraction total weight		Digestible organic matter/stem	
	leu	pul	leu	pul	leu	pul	leu	pul	leu	pul
					(%)					
New leaves	29.4	24.8	66.8	28.7	61.4	27.1	33.5	28.2	20.6	7.6
Old leaves	23.9	22.5	60.9	27.7	55.1	25.8	25.3	18.4	13.9	4.8
Branches < 4 mm	13.8	11.5	43.5	38.9	39.8	36.3	7.6	7.2	3.0	2.6
Branches 4–6 mm	10.2	7.7	35.6	30.6	32.8	28.7	6.7	5.0	2.2	1.4
Branches > 6 mm	6.9	6.6	33.0	26.9	30.7	25.5	5.2	6.7	1.6	1.7
Stem cut 1 (50 cm long)	6.9	5.5	29.9	24.0	28.1	23.0	6.5	21.5	1.8	5.0
Stem cut 2 (50 cm long)	7.3	6.0	29.5	25.8	27.6	24.6	15.3	13.0	4.2	3.2
Mean	14.1	12.1	42.7	28.9	39.4	27.3				
LSD ($P < 0.05$)										
between species	1.3		2.5		2.3					
between fractions	3.8		7.1		6.6					

The mean total dry stem weight for *L. leucocephala* and *L. pulverulenta* was 125 g and 170 g, respectively. The total percent digestible organic matter per stem was 47.4% for *L. leucocephala* and 26.3% for *L. pulverulenta*.

tions less than 6 mm, had an adequate protein content (over 7%, Table 1) for feeding mature domesticated ruminants at maintenance. Leaves and branches less than 4 mm of both species contained more than 11% protein which is sufficient for growth of most young domestic ruminants (NRC 1984).

In vitro digestion values in this study may have been influenced by inoculum source. Rumen microorganisms are differentially adapted for digesting forage species (Van Soest 1982). Blankenship *et al.* (1982) and Priebe *et al.* (1987) studied *in vitro* digestibility of a variety of range plants using inoculum from white-tailed deer, nilgai antelope, sheep, goats and steers. Depending upon substrate, different animal species demonstrated superiority in digestive activity *in vitro*. Similar studies indicated the significance of source of rumen inoculum and diet of donor animal for *in vitro* digestion comparisons (Robbins *et al.* 1975; Palmer *et al.* 1976). The *in vitro* digestion data of *L. pulverulenta* in particular, may have been higher if adapted ruminants, domestic or wild, were used as inoculum donors. Selection of ruminant microorganisms with the capability of high digestibility of woody browse is an intriguing possibility.

The very low *in vitro* digestibility, in comparison with only a slightly lower protein concentration, suggests an interference in the digestion of *L. pulverulenta* leaves. These could be due to tannins and related polyphenols which are capable of interfering with rumen microbial activity (Van Soest 1982; Cheeke and Shull 1985; Zucker 1983).

Levels of tannin in *L. leucocephala* have been reported to range from 1.9 to 2.5% (DM basis) and total phenols from 10.3 to 11.7% (DM basis) (Tangenjaja *et al.* 1986). Leaves are generally higher in tannin than stems or woody plant parts (Zucker 1983; Robbins *et al.* 1987) thereby potentially depressing leaf digestibility. In *L. pulverulenta* young stems had higher *in vitro* digestibility than the leaves. Evaluation of the effect on rumen digestion of tannin/phenol extracts from the two species might explain the differences in *in vitro* digestion between species and plant fractions.

The successful introduction of rumen microorganisms that can degrade mimosine and its metabolites should eliminate the problem of mimosine toxicity in ruminants (Jones and Megarrity, 1986; Allison *et al.* 1983; Quirk *et al.* 1988). Nevertheless there is still a problem with mimosine toxicity in non-ruminants and *L. pulverulenta* offers potential for use in hybridization to create low mimosine hybrids.

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