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# BIOMASS PRODUCTION AND NUTRITIVE VALUE OF LEUCAENA EDIBLE FORAGE OF DIFFERENT STEM DIAMETERS

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## ABSTRACT

Dry matter (DM) production, crude protein (CP) content, *in vitro* digestibility (IVOMD), and an intake of DM, CP and metabolizable energy (ME) of leucaena forage with stem diameters up to 8, 12, 15 and >15 mm were evaluated to determine maximum twig size for inclusion in chopped leucaena for feeding goats. CP and IVOMD for 8 mm (177 and 490 g/kg DM, respectively) were about 15 per cent higher but forage DM yields (13.5 t/ha/yr) were 36 per cent lower than for the other stem sizes. Intake (per kg body weight) of DM, was similar across all stem diameters, but that of CP and ME for >15 mm (1.79 g and 70.8 kJ) was lower ($P < 0.05$) than for 8 mm (2.40 g and 102.1 kJ). However, nutrient concentration and intake remained high up to 15 mm. It was concluded that chopping leucaena forage prior to feeding will permit the inclusion of twigs 15 mm in diameter (about twice the size of an ordinary pencil) without detracting from the nutrient intake of goats, while allowing for 20-40 per cent higher stocking rates.

## INTRODUCTION

Leucaena is one of the multipurpose trees now used extensively in the humid and subhumid tropics and subtropics as a source of roughage and protein supplement for ruminant livestock (Pound and Martinez Cairo 1983; Proverbs 1985). It is used principally in grazing and cut and carry production systems, but in either case the edible portion is limited to the leaves and the green soft stems up to 5-6 mm in diameter (Guevarra 1978; Hulman *et al.* 1978; Ferraris 1979; Kitamura 1985; Cooksley *et al.* 1991).

There is very little information on the feeding and utilization by small ruminants of leucaena forage with stems bigger than 5-6 mm. Quintyne *et al.* (1987) fed Barbados Blackbelly sheep leucaena silage (plus cassava silage) made from whole leucaena about 1 m high and with about 42% stem in the dry matter, and recorded live weight gain of 115.7 g/day. Sheep and goats, however, differ in their ability to consume and use leucaena forage. Goats tend to have higher dry matter intake, are better able to digest and retain more nitrogen from leucaena forage than sheep (Devendra 1982; Yates 1982). Thus it appears goats can probably derive more benefit from a greater portion of leucaena forage than what has previously been classified as edible forage.

This study was therefore undertaken to determine the dry matter production and nutritive value for goats of leucaena edible forage including stems of different diameters.

## MATERIALS AND METHODS

### Site

The study was conducted at the Hounslow Sheep and Goat Center in the parish of St. Elizabeth, Jamaica (18°2'N, 77°37'W, 1205 mm annual rainfall, bimodal distribution in May/June and September/November, and 28.9°C daily temperature). The soil at the site is St. Ann Clay Loam (Stark 1963) with pH 6.4.

**Treatments and forage sampling**

In November 1990 seeds of leucaena (var Cunningham) were sown, after hot water scarification, on a 2 x 1 m grid on a 0.5 ha land. The seeds were not inoculated and no fertilizer or lime was applied at establishment. A clearing cut was made 9 months after establishment. Subsequently the field was divided into 6 sections of about 800 $m^2$ and allotted randomly to 6 treatments.

The 6 treatments called categories of edible forage and defined by the maximum stem diameter were: 6, 8, 10, 12, 15 and >15 mm. Three random samples each 9 $m^2$ were taken from each treatment section after 12 weeks regrowth during the first cutting year. After weighing the total harvested forage three sub-samples of about 1 kg each was taken for each treatment. One sub-sample was weighed and dried in a forced draft oven for the determination of total biomass dry matter yields. The other two sub-samples were separated into edible and non-edible parts. One of the two edible parts sub-samples were weighed and dried for the determination of total edible forage yields, while the other was separated into leaf and stem fractions.

Chemical analyses

The dried total edible forage, and the leaf and stem fractions were ground through a 1 mm screen and analyzed for crude protein concentration (Nitrogen x 6.25) and *in vitro* organic matter digestibility. Metabolizable energies were calculated from equations relating crude protein and gross energy, and gross energy and digestible /metabolizable energy (Xandé *et al.* 1989).

**Intake**

In a 23-day feeding trial edible forage from the 6 treatments was chopped using a motorized forage chopper and fed to three classes of three goats each in two replicates. The classes of goats were adult Anglo-Nubian x Native (AN x N)(body weight 41.8±1.21 kg), young AN x N (24.2±3.68 kg) and young Anglo-Nubian (24.1±2.45 kg). The goats were offered the leucaena at the rate of 15 g/kg body weight dry matter and king grass *(Pennisetum typhoides* x *P. purpureum) ad libitum.* The leucaena was fed continuously for 21 days and intake was measured on the next two consecutive days.

**Statistical analyses**

The data were first analyzed using GENSTAT 5 statistical packages (Lawes Agricultural Trust 1990) and the means tested by pair wise multiple comparisons. These initial analyses showed no significant differences ($P>0.05$) between the 6 and 8 mm, and between the 10 and 12 mm treatments. The data for each of the two pairs of treatments were therefore pooled, and the mean for up to 8 mm compared with those for 12, 15 and >15 mm using Bonferroni t-test for post data contrasts (Gill 1978).

RESULTS AND DISCUSSION

The yield of edible forage with stems 12 mm and above was on average 36% higher ($P<0.01$) than that for 8 mm stems (Table 1). Associated with this increased yield was a corresponding significant increase ($P<0.01$) in the percentage edible forage in the total biomass, and of the stem fraction. The leaf fraction of the edible forage was, however, inversely related ($P<0.01$) with the increased stem diameter.

The crude protein (CP) concentration and organic matter digestibility (IVOMD) of the edible forage with stem diameter >15 mm declined by 18% and 22% ($P<0.01$) respectively compared with the values for the 8 mm edible forage (Table 2). The levels of decline for the 15 mm stems (10% for

CP and 11% for IVOMD) were just about one-half those for >15 mm stems. The decline of nutrient concentration in the stem fraction followed similar trends as for the total edible forage, but there were no apparent changes in the leaf fraction nutrient concentration (Table 2).

The yield of leucaena edible forage with stems up to 8 mm in diameter was consistent with that of Cunningham and other Peru type leucaena in the Caribbean (Pound and Martinez Cairo 1983; Proverbs 1985) and in Australia (Hutton and Beattie 1976; Ferraris 1979). Likewise the CP concentration and the IVOMD were comparable with those obtained elsewhere (Hulman *et al.* 1978; Brewbaker and Hutton 1979).

The decline in CP concentration and IVOMD in the total edible forage was attributed primarily to the decline of the concentration of these nutrients in the stem since there were no significant changes in the nutrient concentration of the leaf fraction (Table 2).

Forage intake was on average 13.1 g/kg body weight (86.1% of forage dry matter offered) and there was no significant difference (P>0.05) between 8 mm stem and the bigger stems (Table 3). This high percentage voluntary consumption even with chopped bigger stems in the forage corroborates the knowledge (Pound and Martinez Cairo 1983) on leucaena palatability. On the other hand the intake of CP and metabolizable energy (ME) declined by 25% and 31% respectively for >15 mm stems, and by 13% and 15% respectively for 15 mm stems.

There were no effects of breed or age of goats on the intake of forage or intake of nutrients. The range of intake values across the three classes of goats was: dry matter (g/kg body weight), 12.4-13.5, dry matter (% dry matter offered), 82.0-88.8, CP (g/kg body weight), 2.01-2.16 and ME (kJ/kg body weight), 83.6-92.8.

The literature on leucaena edible forage with stems >5-6 mm in diameter is scanty, but there are indications that the forage yield, stem fraction and CP concentrations recorded for stem diameters 12 mm and above in this study agree with the findings for Cunningham variety in the literature. Ferraris (1979) reported that the yield of total leucaena cut to 5-15 cm above ground level and at 2-4 months interval was 21.8 t/ha/yr, with 53% stem in the dry matter. The corresponding CP values were 15.6% and 6.3% respectively. Quintyne *et al.* (1987) also recorded 42% stem fraction in the forage of whole leucaena.

The general trends demonstrated in the present work were that with the inclusion of stems >8 mm in leucaena edible forage yields was maximized and there were increased fractions of leucaena forage offered, of which more than 80% was consumed by both young and adult goats.

Notwithstanding the consumption of a high proportion of the forage, the intake of CP and ME was compromised with the inclusion of stem >15 mm. On the contrary the dilution of nutrient concentration with the inclusion of stems up to 15 mm in diameter was not dramatic; the CP concentration was even well maintained (160 g/kg dry matter) up to this point (Table 2). Also it can be determined from the data on forage yield and forage offered that by including stems 12-15 mm in diameter as part of the edible forage 20-40% more adult goats (45 kg body weight)per annum can be accommodated on a unit leucaena pasture compared with edible forage with stems only up to 8 mm (calculated stocking rate = 54 goats/ha/yr).

The conclusion from the study is that where a forage chopper is available the edible forage of leucaena fed to goats may include stems up to 15 mm in diameter (about twice the size of an ordinary pencil) without detracting from the nutrient intake and at the same time increasing the stocking rate.

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Table 1. Effect of stem diameter on dry matter (DM) yield, and proportion of leaves and stem in leucaena edible forage.

| Parameter | Stem diameter (mm) | | | | SE[1] |
|---|---|---|---|---|---|
| | 8 | 12 | 15 | >15 | |
| Edible forage DM yield (t/ha/yr) | 13.5 | 16.2 | 18.5 | 20.4 | 2.40 |
| Edible forage in total biomass DM (%) | 71.8 | 84.2 | 89.9 | 100.0 | 5.53 |
| Leaves in edible forage DM (%) | 67.0 | 59.3 | 55.6 | 44.8 | 3.00 |
| Stem in edible forage DM (%) | 33.0 | 40.7 | 44.4 | 55.2 | 2.96 |

[1] SE = Standard error for comparing 8 mm vs 12, 15, >15 mm (error degrees of freedom = 30; number of contrasts = 4).

Table 2. Effect of stem diameter on crude protein concentration and *in vitro* digestibility (IVOMD) of total forage and of leaf and stem fractions of leucaena edible forage.

| Parameter | Stem diameter (mm) | | | | SE[1] |
|---|---|---|---|---|---|
| | 8 | 12 | 15 | >15 | |
| Crude protein (g/kg DM[2]) | | | | | |
| Total forage | 177 | 162 | 160 | 145 | 5.7 |
| Leaves | 224 | 238 | 241 | 241 | 17.2 |
| Stem | 86 | 64 | 62 | 60 | 8.6 |
| IVOMD (g/kg DM) | | | | | |
| Total forage | 490 | 453 | 435 | 381 | 20.9 |
| Leaves | 607 | 615 | 609 | 630 | 27.7 |
| Stem | 256 | 216 | 206 | 184 | 13.2 |

[1] SE = Standard error for comparing 8 mm vs 12, 15, >15 mm (error degrees of freedom = 30; number of contrasts = 4).

[2] DM = Dry matter.

Table 3. Effect of stem diameter of leucaena edible forage on intake of dry matter (DM), crude protein (CP) and metabolizable energy (ME).

| Parameter | Stem diameter (mm) | | | | SE[1] |
|---|---|---|---|---|---|
| | 8 | 12 | 15 | >15 | |
| DM intake (g/kg body weight) | 13.3 | 13.0 | 12.9 | 12.6 | 2.99 |
| DM intake (% DM offered) | 90.0 | 87.0 | 84.1 | 83.4 | 10.47 |
| CP intake (g/kg body weight) | 2.40 | 2.12 | 2.08 | 1.79 | 0.205 |
| ME intake (kJ[2]/kg body weight) | 102.1 | 90.6 | 86.8 | 70.8 | 10.44 |

[1] SE = Standard error for comparing 8 mm vs 12, 15, >15 mm (error degrees of freedom = 14; number of contrasts = 4).
[2] kJ = kilo joule.