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# Nutrient Content and *in vitro* Dry Matter Digestibility of *Gliricidia sepium* (Jacq.) Walp. and *Leucaena leucocephala* (Lam. De Wit.)

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**Abstract:** The quality of cattle feed supplements may be enhanced by the addition of certain vegetable components which improve its nutritional value. However, these structural components may vary according to the climate conditions prevalent during the seasonal changes in temperate or subtropical areas. Leaves and pods of *Gliricidia sepium* and *Leucaenas leucocephala* are integrated with food and pasture crops and considered important forage complements into ruminant feeding. In order to determine the effectiveness of the use of *G. sepium* and *L. Leucocephala* as fodder, samples of leaves were collected for estimation of some of their chemical characteristics, cell wall components and mineral composition. The highest value of crude protein (24.6%) and lowest gross energy (4.095 Mcal $kg^{-1}$) were exhibited by *L. leucocephala* while the highest NDF (45.8%), ADF (24.5%), cellulose (14.6%) and cellular content were observed in *G. sepium*. Results from the proximate analysis revealed significant ($p<0.05$) differences in Crude Protein (CP), P, Mg, Fe, Na, Gross Energy (GE), ash, Neutral Detergent Fiber (NDF), Acid-Detergent Lignin (ADL), cellulose, hemicellulose contents and IVDMD among the species.

**Key words:** Gliricidia, feed supplementation, cattle, forage, Leucaena, Mexico

## INTRODUCTION

Because of its draught tolerance and high forage potential (Cheeke and Raharjo, 1987), leaves and pods of *Glirocidia sepium* and *Leucaena leucocephala* play an important role as source of feed for ruminants and can be an important protein supplement when used in conjunction with roughages which are generally protein deficient. Many fodder trees contain tannins which have long been associated with negative effects on nutritive value (Kumar and Singh, 1984; Mangan, 1988; Leiner, 1990).

The nutritive value of the different components of tree and shrubs has been studied with ovine livestock and goat cattle (Chadhokar, 1982; Cooper and Owen-Smith, 1985; Cooper *et al*., 1988). Thick grounding of dry leaves and their incorporation to feed concentrates enhances the quantity and quality of the animal diet. However, this practice may be combined with others to preserve the resources and increase the economical output (Hentgen, 1985; Webb, 1988). Most of the researches about the chemical composition of forage consumed by ruminants are essentially based on the relationship between the nature of the vegetal components and their degradation in the digestive apparatus (Jarrige, 1988; Genin, 1990; Martin *et al*., 1995; Ramirez *et al*., 2001). However, the available information about this kind of relationship is still insufficient for the case of forage from trees and shrubs.

Many shrubs and trees in Northeastern Mexico can provide feed material but only a few of them have been actually incorporated into ruminant feeding systems. The scattered information on the nutritive value of forages from shrubs and trees suggests that in general, leaves from shrub and trees contains higher levels of crude protein the many common forages despite some browse forages are high in deleterious components (Devendra, 1990).

Legume forages are advantageous for their high quality protein and energy content. Among them *L. leucocephala* and *G. sepium* have become popular for incorporation into ruminant feeding systems (Blair, 1990; Amata and Bratte, 2008). These species have shown good potential in Northeastern Mexico as a high-protein fodder that could substitute conventional concentrated feeds for cattle under special circumstances.

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## MATERIALS AND METHODS

The choice of species was made only after careful consideration of their nutritive importance value for ruminant feed supplementation, uses and preference by grazing animals and their use by the rural population.

Leaves from legume species were collected in summer from the Tamaulipan scrubland that occurs in Northeastern Mexico (24°27'N, 99°32'W; elevation 400 m). The selection of the vegetal material was carried out under a simple random sampling considering at least 5 shrub trees per species.

Leaves were taken from these trees at 1.6 m height from the ground for their corresponding analysis. The climate of the sampling area is semiarid and the mean annual precipitation is about 750 mm. Mean annual temperature is 22.3°C. Most soils of the region are a rocky type of Upper Cretaceous calcite and dolomite. The dominant soils are deep, dark grey and lime-clay vertisols (Foroughbakhch *et al*., 2006).

About 350 g of leaves were removed from branches by hand and dried in a forced air drier at 60°C during 48 h and grounded to pass a 2 mm screen. Dry matter (105°C), ash (550°C), crude protein (N-6.25 by Kjeldahl digestion using sulfuric acid and a selenium catalyst), Ehter Extract (EE) and crude fiber (AOAC, 1999) were determined.

*In vitro* dry matter digestibility determination was carried out on duplicate 0.5 g (0.001 lb) leaves samples of each plant according to the Moore (1970) modified two-stage digestion technique. The procedure of Goering and Van Soest (1970) was used in to the partitioning of cell-wall components into Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and cellulose as the difference between ADF and Acid Detergent Lignin (ADL) to which ash was added. Gross energy was determined using an adiabatic bomb calorimeter.

Leaves were also analyzed for condensed tannins using the method of Wood and Plumb (1995) although, modifications were made to achieve a higher solvent/solid ratio. Atomic absorption spectrophotometer was used to measure the mineral contents (Ca, P, Mg, Na, K, Mn, Fe, Zn and Co).

In this study, alfalfa hay (*Medicago sativa*) was included as a reference feed. The data generated from study were analyzed via ANOVA for completely randomized design using the GLM procedure (SAS, 1990). Differences between species were measured using the student test. Differences between proximate compositions (mean) were measured (Zar, 2010) using the Least Significant (LSD) Method (Steel and Torrie, 1980).

## RESULTS AND DISCUSSION

The results in Table 1 shows that Organic Matter (OM), Dry Matter (DM), Crude Protein (CP), Ether Extract (EE), Nitrogen Free Extract (NFE) and Gross Energy (GE) contents were significantly different ($p<0.05$) among two species.

Dry Matter content was low *in L. leucocephala* (43.3%) and *G. sepium* (35.9%) in comparison to the *M. sativa* (516%).

During the Summer, leaves of *L. leucocephala* had high CP (24.6%) values in comparison to the *M. sativa* (22.0%). Tree and shrub species as *L. leucocephala* and *G. sepium* have high CP content compared to the grasses during drought periods (Neira *et al*., 1994) and therefore, browsing from trees and shrubs is often a protein source for both livestock and wildlife. However, there is a wide range in CP content among tree and shrub species. The mean value of 277 species reviewed from 22 literature reports was 17% within a range of 11.1-41.7%.

It has been reported that the CP content is reduced as the plant goes throughout maturation. In this respect, the results are in good concordance with those obtained by Devasena *et al*. (1994) who found that the CP content was higher in Summer for most of the plants since samples were collected at the end of this station.

Gross energy (4.095 and 4.110 Mcal $kg^{-1}$) and crude fiber contents (11.1 and 10.8%) were found to be statistically similar ($p>0.05$) for both species.

**Cell-wall and mineral composition:** Cell-wall components were significant ($p<0.05$) between species (Table 2). Natural-detergent fiber content ranged from a low of 33.6% for *L. leucocephala* to a high of 45.8% for *G. sepium*. Acid-detergent fiber content ranged from 20.5% for *L. leucocephala* to 24.5% for *G. sepium*. In general, ADF, ADL and cellulose contents followed the same trend as NDF. The highest acid-detergent lignin content (8.1%) was recorded for *G. sepium* and *L. leucocephala* (6.4%) in comparison to the *M. sativa*

Table 1: Proximate composition (DM %) of leaves of *L. leucocephala* and *G. sepium*

| Analysis | *L. leucocephala* | *G. sepium* | SE | *M. sativa* |
|---|---|---|---|---|
| Organic matter (%) | 80.550 | 90.100 | 0.98* | 84.000 |
| Dry matter (%) | 43.300 | 35.900 | 1.33* | 65.200 |
| Crude protein (%) | 24.600 | 20.400 | 1.05** | 22.000 |
| Gross energy (Mcal $kg^{-1}$) | 4.095 | 4.110 | $0.35^{NP}$ | 7.350 |
| Total ash (%) | 16.450 | 14.100 | 0.72** | 13.000 |
| Ether extract (%) | 3.550 | 1.890 | 0.13*** | 2.140 |
| Crude fiber (%) | 11.120 | 10.800 | $0.65^{NS}$ | 8.600 |
| Nitrogen-free extract (%) | 49.300 | 43.200 | 2.12** | 50.500 |

*Within a column, values followed by different superscripts are statistically different at: *$p<0.05$; **$p\leq0.01$; ***$p\leq0.001$; NS = Not Significant differences ($p>0.05$)

Table 2: Cells wall components (NDF, ADF, ADL) and condensed tannins (DM %) of *L. leucocephala* and *G. sepium*

| Analysis (%) | *L. leucocephala* | *G. sepium* | SE | *M sativa* |
|---|---|---|---|---|
| Neutral Detergent Fiber (NDF) | 33.6 | 45.8 | 1.82** | - |
| Acid Detergent Fiber (ADF) | 20.5 | 24.5 | 1.24** | 26.0 |
| Cellular content | 68.6 | 75.5 | 2.04** | 53.7 |
| Cellulose | 9.8 | 14.6 | 0.81* | 18.0 |
| Hemicellulose | 15.5 | 12.9 | 0.77** | 14.0 |
| Lignin | 6.4 | 8.1 | 0.81*** | 0.1 |
| Tannins | 8.9 | 8.3 | $0.89^{NS}$ | 0.2 |
| *In Vitro* DM Digestibility (IVDMD) | 56.2 | 68.5 | 2.32* | 79.6 |

*Means within rows followed by different letters differ significantly at the 5% level, **$p\leq 0.01$; ***$p\leq 0.001$; NS = Not Significant differences ($p>0.05$)

(0.1%). Both species differed significantly in ADL while for tannins content we were not detected the statistically differences (p>0.05) among the species. Cellulose content ranged from 9.8-14.6% the lowest being that of *L. leucocephala* and the highest that of *G. sepium*. The range for hemicellulose content was from 12.9% (*G. sepiums*) to 15.5% (*L. leucocephala*).

According to Lowry *et al.* (1992), low CW and consequent high cell content give these plants high nutritional value compared to the grasses. The higher content of ADF is likely owed to the accumulation of lignin-cellulose as a result of the higher temperatures (Nelson and Moser, 1994).

In general terms, shrub species reached cellulose levels inferior to the values shown by the reference forage feed. This fact could be a disadvantage for the rumen microorganisms since a lower energy amount is obtained through the degradation of these shrub components than that obtained with *M. sativa* as it was also reported by Moor and Hatfield (1994).

In this study, hemicellulose content (Table 2) was low compared to cellulose. This finding was also reported by Norton and Poppi (1995) who acknowledged that leaves from temperate legume species had lower hemicellulose content than cellulose while in tropical grasses the concentration of both plant constituents were comparable.

Lignin content was high in *G. sepium* (8.1%) and *L. leucocephala* (6.4%) in comparison to *M. sativa* (0.2%). It has been reported that lignin content is related to the low *in vitro* DM digestibility found in forage from trees and shrubs (Ramirez *et al*., 2001). It has been also demonstrated that the high lignin content exert a negative effect in the digestibility of the cell walls which in turn causes a reduction in forage consumption (Jung and Allen, 1995).

The condensed tannins contents were high in the plants of *L. leucocephala* (8.9%) and *G. sepim* (8.1%) which showed high values in the Summer. However, the variation of tannin content wasn't significant (p>0.05) between species. Condensed tannins are also related to low digestibility in trees and shrubs. Mangione *et al.* (2000) and Gonzalez (1989) reviewed the tannin content of 69 trees and shrubs reported from four literature reports and found that tannins negatively affected (r = -0.39) the *in vitro* DM digestibility of browse. These authors found that those shrub species are only consumed by grazing ruminants during drought and critical periods when there is no forage availability.

Table 3: Mineral composition of leaves of *L. leucocephala* and *G. sepium*

| Analysis | *L. leucocephala* | *G. sepium* | SE |
|---|---|---|---|
| Ca (DM basis %) | 1.46 | 1.28 | $0.29^{NS}$ |
| Mg (DM basis %) | 0.35 | 0.52 | 0.23** |
| P (DM basis %) | 0.26 | 0.28 | $0.05^{NS}$ |
| Cu (ppm) | 5.89 | 4.62 | 0.43** |
| Zn (ppm) | 13.38 | 15.37 | 0.88*** |
| Fe (ppm) | 110.02 | 75.62 | 3.61** |
| Co (ppm) | 0.05 | 0.04 | $0.03^{NS}$ |
| Mn (ppm) | 30.03 | 38.36 | 2.23* |
| Al (ppm) | 122.12 | 43.28 | 4.70** |
| Na (ppm) | 72.53 | 112.61 | 3.86** |
| Cr (ppm) | 1.97 | 1.89 | $0.17^{NS}$ |

*Within rows, means with different letters significantly ($p<0.05$), *$p\leq 0.05$, **$p\leq 0.01$; ***$p\leq 0.001$; NS = Not Significant differences ($p>0.05$)

Table 3 shows significant differences (p<0.05) in Mg, Cu, Zn, Fe, Mn, Al and Na content among species. Substantial variation but not significant differences (p>0.05) was observed in Ca, P, Co and Cr content with values ranging from 1.28-1.46% DM basis for Ca from 0.26-0.28% DM basis for P and from 1.89-1.97 ppm for Cr.

As with most of the other variables, the effect of species (*G. sepium* and *L. leucocephala*) on *in vitro* DM digestibility was significant (p<0.05) with 68.5% of digestibility for *G. sepium* and 56.2% for *L. leucocephala* having the lowest values in comparison to the *M. sativa* (79.6%).

## CONCLUSION

It was found that during the Summer season leaves of *L. leucocephala* and *G. sepium* showed high CP content whereas cell wall and its derivatives were low. Cellulose and hemicellulose mean values from these shrub species were lower than the values shown by *M. sativa* (the reference feed) while lignin average content was higher than lignin content for *M. sativa*. The high levels of cellulose and hemicellulose in summer is attributed to its availability and represent the most important energy source for ruminants although, this energy contribution depends on the degree of binding of nutriments to lignin.

Regarding the tannin content in the evaluated species it was found that this nutritional factor was higher in the period of study (Summer) for both species. The chemical composition suffers changes as the plan matures and may be further modified by the environmental conditions during growth (soil fertility, season, temperature, shade and water stress). These effects will vary in different plant species. Those introduced species like *L. leucocephala* and *G. sepium* that maintain a high nutritive during periods of adverse environmental conditions are those with good value for animal feeding and they should be incorporated into ruminant feeding systems under grazing conditions.

In conclusion, the study revealed the existence of significant varietal differences in nutrient content, cell-wall composition and digestibility of *L. leucocephala* and *G. sepium* species. The results of the study will provide useful guidelines to live stock producers for comparing woody plants for livestock feeding purpose.

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