Journal of Animal and Veterinary Advances 11 (22): 4279-4282, 2012
ISSN: 1680-5593

Seasonal Changes in Alimentary Value and Digestibility of *Gleditsia triacanthos* L.

[1]R. Foroughbakhch, [2]A. Carrillo-Parra, [1]M.L. Cardenas-Avila and [1]S. Moreno-Limon
[1]Biological Sciences Faculty, Universidad Autonoma de Nuevo Leon,
AP F-2 San Nicolas de los Garza, N.L. 66450, Mexico
[2]Universidad Autonoma de Nuevo Leon, Facultad de Ciencias Forestales,
A.P. 41, 67700, Linares, N.L., Mexic

Abstract: Pods and leaves as an energy supplement is a basic forage, rich in protein and highly digestible. The nutritional values of pods and leaves differ among trees due to highly specific proteins of different digestibility. To estimate and compare seasonally, the chemical composition and *in vitro* digestibility of nutrients in leaves and entire pods of *Gleditsia triacanthos* L. plants were harvested from a native shrubs and trees during Fall 2004, Winter, Spring and Summer 2005. The *in vitro* technique was used to measure the digestibility of Dry Matter (DM) and Crude Protein (CP). The crude protein content varied within range of 7.8% (Winter) to 9.4% (Summer) for leaves and from 12% (Spring) to 15% (Fall) for entire pods. The annual means of acid detergent fiber (19.5%) and neutral detergent fiber (35.8%) content in leaves was lower than the alfalfa (26%) as feed reference. However, the annual means of ADF for pods (30.6%) was higher than the (*Medicago sativa*). The lignin content was high both in leaves (10.4%) as well as in pods (12.1%) in comparison to the alfalfa (9%). In general, during the Spring (71.4%) and Summer (73.4%) the entire pods were higher in CP and DM digestibility and during Winter (56.3-64.2%) were low.

Key words: *Gleditisia triacanthos*, chemical composition, *in vitro* digestibility, dry matter, crude protein

INTRODUCTION

The genus *Gleditsia* contains a dozen species in the tropics. Trees of *Gleditsia* species growth under adverse climatic conditions, adapting well to drought and low temperatures due to their flexible radical system (Funk, 1965). *Gleditsia triacanthos* can produce fodder in addition to firewood and thus contribute to animal nutrition. At present, few firewood-producing shrub and tree species have been studied from agronomic and nutritional points of view hence, knowledge of the nutritional and forage aspects of this tree is limited.

The great majority of studies of animal feeding in rural areas during drought deal with chemical composition of feed consumed by ruminants and have been mainly focused on the relationship between feed composition and digestive tract decomposition (Pinos-Rodriguez *et al*., 2006; Lema *et al*., 2006). The difference between animal nutrition under pasture and caged conditions has been studied. These researchers emphasize the need to determine the quality of cattle diet under the prevailing conditions of each region and the availability of plant species, particularly leguminoseae shrubs and nitrogen fixing trees. A complete ration based only on leaves is deficient in nitrogen. However, this type of deficiency has not been found the seeds and pods of Gleditsia (Rodrigueza *et al*., 2003). The pods of Gleditsia are palatable and are not toxic (Duke, 1981).

According to Gold (1984) and Baertsche *et al*. (1986), the protein content of the seeds varies between 16.6 and 27.8% while the sugar content varies between 13.6 and 30.9%. Browsing by animals poses no danger to these trees as their mature pods fall on the ground and are thus easily available to the cattle. The production potential is left, therefore intact. The whole pods and leaves of *Gleditsia triacanthos* are palatable toxin free but nonetheless, deficient in nitrogen. Their nutritional value is quite similar to that of barley but low if compared with concentrated diets.

Digestibility of ground pods and leaves protein is low when compared with that of legumes for example *Medicago sativa* L. (Mostert and Donaldson, 1960). Dry pods and leaves added to concentrated feed increase considerably the quality and quantity of rations. Due to nutritional importance of some *Gleditsia triacanthos*, researchers have studied their foraging value by

Corresponding Author: R. Foroughbakhch, Faculty of Biological Sciences, University of Autonoma de Nuevo Leon, AP F-2 San Nicolas de Los Garza, N.L. 66450, Mexico

determining the degradability and digestibility *in vitro* of the pods. This research allowed more efficient rationing and the integration of Gleditsia into animal feeding.

MATERIALS AND METHODS

The experimental area is located on a plain region at 430-450 m altitude in the Piedmont of the Sierra Madre Oriental in Mexico 24°47" North latitude and 99°32" West longitude). The regional climate in the scheme of Koppen modified by Garcia is defined As semiarid and subhumid [(A)C(Wo)] with two rainy seasons (Summer and Autumn) and a dry spell between November and April. Mean annual precipitation is 780 mm. Potential evapotranspiration is 1150 mm (Navar and Bryan, 1994). The mean annual temperature is 22.3°C with a large difference between Winter and Summer and even within the same month.

Soils of the region mostly derive from rocks of the Upper Cretaceous rich in calcite and dolomite. The dominant soils are deep, dark grey, lime-clay vertisols which are the result of alluvial and colluvial processes (FAO-UNESCO, 1974) characterized by high clay and calcium carbonate content (pH 7.0-8.0) and low organic matter content.

Leaves and pods were collected in Summer (August 2004) in Fall (December) in Winter (January) and in Spring (May 2005). Branches and pods from at least ten different plants of *Gleditsia triacanthos* were allowed to dry under a shed. Leaves were removed manually and partial Dry Matter (DM) was determined at 60°C in an oven for 72 h. After drying, samples of leaves and pods were ground in a Wiley mill (2 mm screen) and stored in plastic containers.

To estimate chemical composition and *in vitro* digestibility of leaves and pods a composite and homogeneous sample was prepared by mixing those samples that conformed diverse plants. Season samples of pods and leaves were subjected to the following assays after drying and grinding them: determination of Organic Matter (OM), ash and Crude Protein (CP) according to the AOAC (1997) methods; determination of Acid Fiber Detergent (AFD), Neutral Fiber Detergent (NFD), Cell-Wall (CW) and lignin based on Goering and van Soest (1970).

Digestibility *in vitro* of CP and dry matter was determined by the Tilley and Terry (1963) technique. Data were analyzed using a completely randomized factorial design with three replications where factor A was defined by plant's component and factor B by seasons. The Tukey test at 95% probability level was computed (Zar, 2010).

RESULTS AND DISCUSSION

The mean of DM (93%) and OM (76.8%) was high for pods in comparison to the leaves (83.8 and 71%, respectively). The lowest value corresponded to the Spring and Summer with 79 and 80% of leaves DM, respectively (Table 1). Organic Matter (OM) content was low also in Spring (67%). High ranges of ash (15-18%) in entire pods were observed however, low ranges of ash (12-14%) were determined in leaves in the Spring and Summer. It seems that during the Fall and the Winter, pods of honey locust had high CP values (14-15%) in comparison to leaves (7.8-8.3%). In this study, alfalfa hay (Medicago sativa) was included as a reference plant with high CP content (21%).

The mean of CP content of honey-locust pods (15%) is comparable to the *M. sativa*. The pods of *G. triacanthos* have high CP content compared to grasses (Buffel grass, 8-10%) during drought and therefore browse from trees and shrubs often is a protein source for both livestock and wildlife. However, there is a wide range in CP content among the leaves and pods (7-15%).

Table 1: Seasonal variations of the chemical composition and nutritive values of leaves and pods of *Gleditsia triacanthos*

	Leaves							Entire pods							
Season	Sp	Su	F	W	Mean	SE	Sig.	Sp	Su	F	W	Mean	SE	Sig.	Alfalfa
OM	67.0	69.0	72.0	76.0	71.0	0.2	NS	74.0	76.0	77.0	80.0	76.8	0.2	**	72
DM	79.0	80.0	86.0	90.0	83.8	1.1	*	89.0	93.0	93.0	97.0	93.0	0.9	***	85
Ash	12.0	11.0	14.0	14.0	13.0	0.5	*	15.0	17.0	16.0	18.0	16.5	0.5	**	14
CP	9.0	9.4	8.3	7.8	8.6	0.4	**	12.0	14.0	15.0	14.0	13.8	0.1	*	21
CW	19.0	21.0	20.0	22.0	20.5	0.8	*	18.0	21.3	20.9	19.2	19.9	0.5	*	32
ADF	19.0	19.0	19.0	21.0	19.5	0.4	**	28.0	30.6	29.9	33.7	30.6	0.7	*	26
NDF	32.0	36.0	37.0	38.0	35.8	0.5	*	41.0	43.2	45.3	51.2	45.2	1.2	***	30
CEL	14.0	12.0	12.0	14.0	13.0	0.3	NS	17.7	18.9	17.3	22.9	19.2	0.6	**	19
H.CEL	13.0	16.0	18.0	17.0	16.0	0.3	*	13.0	12.6	15.4	17.6	14.6	0.4	**	4
LIG	8.5	9.8	11.1	12.1	10.4	0.7	***	11.3	13.7	12.6	10.8	12.1	0.2	**	9
TAN	2.1	2.6	1.8	1.3	2.0	0.2	***	2.8	3.1	3.3	4.1	3.4	0.7	***	0

OM = Organic Matter; DM = Dry Matter; CP = Crud Protein; CW = Cell Wall; ADF = Acid Detergent Fiber; NDF = Neutral Detergent Fiber; CEL = Cellulose; H.CEL = Hemi-Cellulose; LIG = Lignin; TAN = Tannins; SE = Standard Error; Sig. = Significance; Su = Summer; F = Fall; W = Winter; Sp = Spring; *($p<0.05$); **($p<0.01$); ***($p<0.001$); NS = Not Significant

The leaves and pods evaluated had low CW content from 19-22% for the leaves and pods in all seasons compared to the *Medicago sativa* (32%). Low CW and consequent high cell content of *G. triacanthos* give this plant high nutritional value compared to grasses (Lowry *et al*., 1992). In this study, during the Spring (18%) and Fall (20%) seasons *G. triacanthos* showed low CW content but during Summer it was relatively high (Table 1).

The same pattern as for CW was found for the ADF and NDF content of leaves and pods (Table 1). Low cellulose values were found in leaves of Gleditsia plant during the Summer and Fall (12%) whereas during Winter (22.9%) the pods were high in cellulose content. In all seasons, hemicellulose content was high such for the leaves as well as for pods (13-18%), compared to *Medicago sativa* (4%) as reference feed. This finding was also reported by Norton and Poppi (1995). They discussed that leaves from temperate legumes had lower hemicellulose content than cellulose however hemicellulose and cellulose had comparable content in tropical grasses.

In this study, lignin content was low in leaves (8.5-12.1%) compared to the entire pods (10.8-13.7%) during the Spring and Winter but it was relatively high in Summer. In general terms, the mean of Lignin content of honey-locust pods (12.1%) and leaves (10.4%) is superior to the *M. sativa* (9%). It has been reported (Ramirez *et al*., 2001a) that lignin content is related to low *in vitro* DM digestibility of forage from trees and shrubs.

The condensed tannins were high in entire pods during the Fall (3.0%) and the Winter (4.1%) when it is compared to the native shrubs and trees (0-2.1%) reported by Foroughbackch *et al*. (2001). Condensed tannins are also related to low digestibility in trees and shrubs. Ramirez *et al*. (2001a, b) 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.

Dry matter and CP digestibility is high for the pods (64.2-73.1%) in comparison to the leaves (56.3-65.5%).

Table 2: Digestibility *in vitro* (±standard deviation) of DM and CP of honeylocust leaves, pods and reference feed

	Digestibility				
	Pods diet		Leaves diet		Reference feed
Seasons	DM	CP	DM	CP	*Medicago sativa*
Spring	64.2±2.6[a]	71.4±3.7[b]	54.2±1.6[a]	58.3±3.0[a]	74.3±1.7
Summer	63.2±2.3[ab]	73.4±2.1[a]	45.8±0.9[b]	52.7±3.5[b]	72.6±4.6
Fall	65.5±1.3[a]	70.9±1.7[ab]	41.1±2.2[c]	48.4±1.4[c]	71.4±5.2
Winter	56.3±3.3[c]	64.2±2.2[c]	36.9±2.4[d]	41.6±2.8[d]	70.9±2.4
Mean	62.3	70.0	44.5	50.3	72.3

Means in a column with no common superscript differ ($p<0.05$)

Whole pods top alfalfa for digestibility (70% versus 72%). The differences between the seasons are significant suggesting that the seasons might have an important impact on the feeding value of pods (Table 2). The results obtained from the nutritional value are in accordance with the data obtained by other researchers (Cooper *et al*., 1988) who mentioned that the OM digestibility was the best criteria for estimation of the digestibility value. Besides the OMD value, the dry matter digestibility and Ash Brute (AB) can be calculated.

CONCLUSION

The pods showed a higher DM and CP digestibility compared to the leaves. The nitrogen digestibility values varied significantly between the plant components (p = 0.035). This value is remarkably inferior to the DM or CP digestibility of the reference feed (*M. sativa*). Higher CP, Acid Detergent Fiber (ADF) values were observed in pods and lower values in cellulose corresponded to the leaves of *G. triacanthos*.

Considering the results obtained on the digestibility values of the DM and protein, the honeylocust pods and leaves represent the following forage characteristics: a pods represented nearly 70% of the DM from which 10-13% was crude lignin, 12-17% hemicellulose, 12-14% cellulose and the rest was ADF, NDF and ash. The crude cellulose content in leaves (12-14%) is considerably lower to cellulose in alfalfa (19%).

It seems that during the Summer season leaves from evaluated plants had high CP content whereas during Fall and Winter seasons CP was low. Cell wall and its derivatives were low during the Winter season however they were high in the Summer. The chemical composition changes as the plant matures and may be further modified by the environmental conditions during growth (soil fertility, season, temperature, shade, water stress). These effects will vary in different plant species. Those native species that maintain a high nutritive value during periods of environmental challenge are those with good value for animal feeding and they should be incorporated into ruminant feeding systems under grazing conditions.

ACKNOWLEDGEMENT

Research was funded by PAICTY (Programa de Apoyo a la Investigacion Cientifica y Tecnologica) Project No. CN-631-11.

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