Nutritional Profile of Four Shrub Species, Northeastern Mexico

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Abstract

The aim of this study was to assess the monthly variation in the chemical composition of four native shrubs in northeastern Mexico. Organic matter (OM), acid detergent fiber (ADF) and nitrogen were determined and digestible energy (DE) and insoluble neutral detergent fiber (INDF) were also estimated. Leaves from *Acacia amentacea*, *Parkinsonia texana*, *Forestiera angustifolia* and *Celtis pallida* were collected during twelve consecutive months (2009) in three county sites (China, Linares and Los Ramones Counties) of the state of Nuevo Leon, Mexico. The OM (total mean= 81%), ADF (22%), N (2.7%), DE (3.0 kcal kg^{-1} DM) and INDF (30 g kg^{-1} DM) were significantly different among sites, species and months and the double (month*site, month*species, species*site) and triple interactions (month*site*species) were also significant (p<0.001). In general, Linares site had higher OM, ADF and INDF than the other sites. The China site had the higher N and the DE content was similar among sites. Low content of INDF and FDA and high DE value in *C. pallida* and *P. texana* may indicate that these plants are a good food for range ruminants. Conversely, *A. amentacea* and *F. angustifolia* had low nutritional value because their high content of ADF, INDF and low DE value.

1. Introduction

Historically, those plants species distributed in arid and semiarid lands have been used as forage sources to wild and domestic ruminants around Tamaulipan thornscrub the world (Squella et al., 1985). The basis of ruminants feed are the grasses despite their high fiber content (more than 60%), low crude protein content (less than 10%) even though they are not available during the drought season (Bernal, 2007). Nunez et al. (2010) argue about the association between the nutritive value in forages with their chemical composition and their digestibility, being these attributes widely variable due to species, fertilization conditions and maturity stage. Regarding to digestibility, Jancik et al. (2008) indicated that it is limited by the extent of digestion of the cell wall because an important part of it is not available to microbial digestion into the rumen even if it is maintained by an infinite period of time.

The Tamaulipan thornscrub is a common vegetal community from the Northern Mexican Golf Coast Plateau. It has an extension of 200,000 km^2 throughout Nuevo Leon, Tamaulipas and Coahuila states in Mexico and Texas, in the United States of America (Gonzalez 1972; Diamond et al., 1987; Jurado and Reid 1989; WWF, 2001).

Woody species (trees and shrubs) play important roles and functions in the habitat. The native shrubs are characteristic of xerophytic scrublands (Villarreal 1999; Gonzalez and Cantu, 2001) according to past experiences and observations. Native species of the Tamaulipan thornscrub like *Acacia amentacea*Benth. (Leguminosae), *Celtispallida* Torr. (Ulmaceae), *Forestiera angustifolia* Torr.(Oleaceae) and *Parkinsonia texana* I. M. Johnst. (Leguminosae) are an important source of food to small ruminants in rangelands (Ramirez, 2004). Small ruminants have developed the ability of using plant material through microorganisms inhabiting the rumen. Approximately from 35 to 80% of the organic matter (OM) is allocated in the cell wall of plant tissues, mainly to provide structure and rigidity (Moya,

2002). Guerrero (2008) studied native forages from north of Mexico and found high values of organic matter content in trees (93 to 95%), shrubs (80 to 94%), forbs (86 to 93%), cacti (68 to 71%) and reproductive structures (flowers, fruits and pods in the order of 79 to 94%). Ramirez and Gonzalez (2010) assessed the organic matter digestibility in 32 forage species and observed digestibility figures of 53% in shrubs, 70% in forbs and 44% in grasses. The authors concluded that some of these shrubs belong to the Fabaceae family and because of their high digestibility, they should be incorporated into feed systems in the production of small ruminant. Besides, these plants also contribute to the environment providing nitrogen to soil. Furthermore, these species have the advantage as food sources because they show green foliage through most part of the year and also they provide high values of crude protein while forbs and grasses are available only during the rainfall season (Moya, 2002). The region of Tamaulipan thornscrub offers an opportunity to investigate the nutritive value of native plant species and is an important tool to manage natural resources. The aim of this study was to assess the monthly variation in the chemical composition of four native shrubs species in northeastern Mexico.

2. Materials and Methods

2.1. Sites of study

This study was carried out at three sampling sites situated in the state of Nuevo Leon, northeastern Mexico. The first site was located at *El Abuelo* Ranch in Los Ramones County (25º40' N; 99º27' W) with an elevation of 200 m and a surface of 100 ha. The climate is semiarid with warm summer. The annual mean temperature is 22 ºC and an annual mean precipitation of 700 mm. The second site was located at "Zaragoza" Ranch in China County (25º31'N; 99º16'W). It has an elevation of 200 m and a surface 300 ha. The weather is dry and warm through the year. The annual temperature and precipitation is 22 ºC and 500 mm, respectively. The third site was located in the Campus of the School of Forest Sciences, Universidad Autonoma de Nuevo Leon (24º47'N; 99º32' W) located at Linares County with 500 ha and an elevation of 370 m. The annual precipitation of the region is 800 mm with an annual mean temperature of 22.3 ºC (Reid et al., 1990), temperatures of 45 ºC are common during summer (Gonzalez et al., 2004). In general, the three sampling sites are under a similar climatic pattern where similar peaks of maximum rainfall are shown during May, June and September. The main type of vegetation of the area is known as the Tamaulipan thornscrub or Subtropical Thornscrub Woodlands (SPP-INEGI, 1986). The most abundant species are *Helietta parvifolia, Diospyros palmeri, Prosopis laevigata, Acacia amentacea, A. farnesiana, A. greggii, A. berlandieri, Cordia boissieri, Fraxinus greggii, Forestiera angustifolia, Havardia pallens, Ebenopsis ebano, Leucophyllum texanum* and *Guaiacum angustifolium,* among others (Alanis et al., 1996). Dominant soils are deep, dark-gray, lime-gray, lime-clay Vertisols, with montmorillonite, which shrink and swell noticeably in response to changes in soil moisture content (INEGI, 2002). During this study, annual precipitation and mean temperature were: 205 mm and 23.7 °C; 249 mm and 24.1 °C and 570 mm, 22.8 °C in sites 1, 2 and 3, respectively.

The shrub species such as *Acacia amentacea* D.C. (Leguminosae), *Celtispallida* Torr. (Ulmaceae) *Forestiera angustifolia* Torr. (Oleaceae) and *Parkinsonia texana* I.M. Johnst. *Varmacra*(Leguminosae) are part of the native vegetation of the northeastern Mexico and the subtropical savanna ecosystems of southern Texas, USA (Everittet al., 2002) and are consumed by grazing ruminants (Ramirez, 2009).

2.2. Sampling

Representative and undisturbed experimental plots (50 m x 50 m) were established in each site. Collection of mature leaves were undertaken (800 g) at browsing height (1.0 to 1.5 m) from five of the most representative individual plants, randomly selected (Montgomery, 2004) of *A. amentacea, P. texana*, *F. angustifolia* and *C. pallida*. Monthly samples were collected from January to December 2009.

2.3. Chemical analyses

Partial dry matter (DM) was established by drying samples in an oven at 55 °C during 72 h, then grounded in a Thomas Willey mill (Thomas Scientific Apparatus, Model 3383) using a Nº 60 (1 mm x 1 mm) mesh. The milled material was stocked in labeled plastic recipients for further analyses. By triplicate, samples were analyzed for Organic Matter (OM) according AOAC (1995); percentage of nitrogen were calculated by micro Kjeldahl (AOAC, 1997) and finally the ADF content was determined through a fiber analyzer ANKOM^{200} according to the procedures described by Van Soest et al. (1991).

Although the value of accurate digestibility data is unbiased, obtaining actual data is time consuming, expensive, and requires large amounts of the forage samples that was not feasible in this study then dry matter digestibility (DMD,%) was estimated using the formula developed by Oddy et al. (1983): DMD=83.58-0.824 ADF%+2.626 N%. Dry matter digestibility values were used to estimate digestible energy (DE, kcal kg^{-1} DM) using the regression equation reported by Fonnesbeck et al. (1984): DE = 0.27+0.0428 (DMD, %). The insoluble neutral detergent fiber (INDF, g kg^{-1} DM) was calculated from the equation developed by Jancik et al. (2008): INDF = -86.98+1.542 (NDF)+31.63 (ADL). Values of the variables DMD, NDF and ADL were taken from Dominguez et al. (2011). The results obtained in the chemical composition of the plant species were corrected on dry basis and expressed in (%).

2.4. Statistical analyses

Statistical analyses (analyses of variance and mean comparison of foliar chemical composition) corresponding to each sampling date and site of study were carried out by using the SPSS software for Windows version 13 (SPSS, 2004). Data of each variable were analyzed according to one way analysis of variance with three repetitions using a tri-factorial arrangement experiment, considering the factors as follows: sites (3), months (12) and shrub species (4). The *w* Tukey procedure test was employed for multiple mean comparison with a probability level of p=0.05. These procedures were carried out according to Steel and Torrie (1980).

3. Results and Discussion

The OM, ADF, N, DE and INDF were significantly different among sites, species and months and also the double and triple interactions (p=0.001) were also significant (Tables 1 to 5).

3.1. Organic matter content

The species at Linares site acquired the highest content of organic matter, followed by China and Los Ramones. Maximum (94%) and minimum (60%) values in OM content were observed *Forestiera angustifolia* in China and Los Ramones, respectively, during November and December (Table 1). The results of this study are similar to those found by Moya (2002) and Foroughbakhch et al. (2007) in native shrubs from northeast Mexico. In addition, the results of this research are similar to those reported by Kazemi et al. (2012) in six forage species from northeast Iran, but different to those results observed in ten shrubs from northeast Mexico (Ramirez, 2003).

3.2. ADF content

The species from Linares site showed the highest content of ADF followed by China and Los Ramones. *A. amentacea* had the highest contents of ADF during April in the three study sites, with an average of 47% (Table 2). The lowest content was observed in *C. pallida* (10%) in China and Linares during February, but in Los Ramones was *P. texana* with the lowest content of ADF (13%) during July. The present results are similar to those reported by Moya (2002), Foroughbakhch et al. (2007) and Alvarado et al. (2012). In contrast, the values observed in this research are higher than those reported by Sultan et al. (2008, 2009, 2010) when they studied shrubs and forbs in northeast Pakistan. The high ADF content in *A. amentacea* in this study could be associated to higher temperatures registered in the three sites since it has been documented that high temperatures increase the syntheses of ADF (Nelson and Moser, 1994). The maturity of plants have been positively correlated with ADF content (Minson, 1990) and negatively correlated with protein content (Parissi et al., 2005; Gonzalez et al., 2011). Lopez et al. (2008) indicated that those species with high content of ADF exhibited low ruminal degradation and high concentration of

Table 1: Monthly content of organic matter (%) in four shrub species growing in northeastern Mexico

Month	Counties												Mean	SEM
	China				Linares				Los Ramones					
	a.a.	c.p.	f.a.	p.t.	a.a.	c.p.	f.a.	p.t.	a.a.	c.p.	f.a.	p.t.		
January	89	75	76	87	87	72	89	89	91	72	73	89	83	1.4
February	81	69	74	78	77	65	92	83	91	72	70	77	77	1.6
March	84	83	74	83	87	79	93	81	87	76	75	86	82	1.3
April	84	78	91	82	92	81	89	88	78	81	73	84	83	1.1
May	85	81	91	84	89	81	87	85	89	77	85	86	85	1.9
June	72	65	91	76	87	73	90	85	68	79	71	72	77	1.8
July	76	83	79	80	86	69	89	85	89	76	82	82	81	1.3
August	81	86	91	85	86	78	84	80	77	81	72	81	82	1.3
September	80	76	76	80	81	71	84	76	73	77	76	84	78	1.2
October	92	77	89	84	80	71	90	88	89	71	91	78	83	1.4
November	71	75	94	83	85	63	76	82	75	78	87	82	79	1.6
December	67	76	75	86	83	69	84	85	68	73	60	83	76	1.4
Mean	80	77	83	82	85	73	87	84	81	76	76	82	81	1.2
SEm±	1.7	1.1	1.4	1.0	1.6	1.1	1.0	1.1	1.7	0.8	1.5	1.1		
Effects	Sites (A)		Months (B)		Species (C)		A*B		A*C	B*C	A*B*C			
Probability	<0.001		<0.001		<0.001		<0.001		<0.001	<0.001	<0.001			

a.a.= *Acacia amentacea*; c.p.= *Celtis pallida*; f.a.= *Forestiera angustifolia*; p.t.= *Parkinsonia texana*

NDF is associated with a lower feed intake (Fahey and Berger, 1988).

3.3. N content

The plant species at the China site showed the highest nitrogen content, followed by Los Ramones and Linares (Table 3). *Parkinsonia texana* showed the highest N content (5%) in China and Los Ramones during October and January, respectively, while *F. angustifolia* displayed the lowest value (1%) in Los Ramones. The nitrogen is the most critical element in plant growth. Ramirez (2007) mentioned that N is the most important element of aminoacids and proteins in animals and plants. In this study, *P. texana* had the highest values of N because it belongs to the Leguminosae family, which are characterized to possess a deep root and nitrifying nodules, which through *Rhizobium* genera, are capable to fix nitrogen from atmosphere. Previous research has demonstrated that a high proportion of fixed nitrogen can be transferred to the no leguminous plants associated in the ecosystem. Crews and Peoples (2005) mentioned that association with nitrogen fixing species causes a spatial heterogeneity and local acceleration of the nitrogen cycle in the ecosystems. Similar nitrogen contents were reported by Alvarado et al. (2007) and Petit et al. (2010) when they analyzed the chemical composition and nitrogen fixing in forage species in Costa Rica and south of Mexico, respectively. Ruiz and Febles (1987) indicated that most nitrogen content is found in leaves, followed by tender stems, flowers and a minor proportion in thick stems. Van Soest (1994) and Ramirez (2007) found that climatic variables (high temperatures, radiation and moisture) increased the metabolic activity and consequently the syntheses of structural compounds and conduced to diminish the content of nitrate, nitrogen, protein and water-soluble carbohydrates in forages.

3.4. Digestible energy content

The values of digestible energy (DE) are shown in Table 4. The plant species at the three sites showed an average of 3.4 kcal kg^{-1} DM. The highest content (3.8) of DE was observed in *C. pallida* and *P. texana* in China and Los Ramones, respectively, while the lowest value was registered in *A. amentacea* and *F. angustifolia* (2.4) at the same sampling sites. The highest values apparently occurred during February and March. The values of the digestibility of dry matter (DMD) observed by Dominguez et al. (2011) were used to correlate with the digestible energy (DE) data of the present study. Based on this, it was found a positive relationship between DMD and DE ($r = 0.98$; $P=0.001$). Similar results were reported by Ramirez (2004), Guerrero et al. (2009) and Alvarado et al. (2012) in studies of native plants from north of Mexico. The last two authors mentioned that those equations based on ADF and N measurements reduce relative costs and frequently forage quality assessment. Alvarado et al. (2012) studied native shrubs of northeastern

Table 2: Monthly content of acid detergent fiber (%)in four shrub species growing in northeastern Mexico

Month	Counties												Mean	SEM
	China				Linares				Los Ramones					
	a.a.	c.p.	f.a.	p.t.	a.a.	c.p.	f.a.	p.t.	a.a.	c.p.	f.a.	p.t.		
January	38	17	21	21	40	17	27	22	38	18	23	23	25	1.4
February	29	10	13	17	25	10	23	14	29	15	16	19	18	1.1
March	31	18	12	15	36	19	25	16	28	20	17	14	21	1.2
April	47	27	29	22	48	19	33	33	46	30	19	23	31	1.7
May	30	18	18	15	34	14	18	21	34	15	19	18	21	1.2
June	28	19	18	15	33	17	20	18	31	17	16	14	21	1.0
July	29	21	18	13	29	15	15	14	29	16	15	13	19	1.0
August	31	21	16	15	28	16	16	17	30	18	15	15	20	1.0
September	34	18	18	21	30	15	19	21	27	20	15	13	21	1.0
October	45	18	27	23	44	22	24	26	31	16	17	17	26	1.6
November	32	15	15	16	33	14	20	18	30	15	21	14	20	1.2
December	33	18	19	15	34	15	24	21	35	15	16	15	22	1.3
Mean	34	18	19	17	35	16	22	20	32	18	17	16	22	1.0
SEm±	1.0	0.7	0.8	0.6	1.1	0.5	0.8	0.9	0.9	0.7	0.4	0.6		
Effects	Sites (A)		Months (B)		Species (C)		A*B		A*C	B*C	A*B*C			
Probability	<0.001		<0.001		<0.001		<0.001		<0.001	<0.001	<0.001			

a.a.= *Acacia amentacea*; c.p.= *Celtis pallida*; f.a.= *Forestiera angustifolia*; p.t.= *Parkinsonia texana*

Table 3: Monthly content of N (%) in four shrub species growing in northeastern Mexico

Month	Counties												Mean	SEM
	China				Linares				Los Ramones					
	a.a.	c.p.	f.a.	p.t.	a.a.	c.p.	f.a.	p.t.	a.a.	c.p.	f.a.	p.t.		
January	2.2	2.5	2.4	3.4	2.1	2.5	1.8	3.0	2.3	2.4	2.4	4.0	2.6	0.10
February	2.3	2.8	2.6	3.3	3.3	2.3	2.5	3.2	2.4	2.2	2.1	3.7	2.7	0.08
March	3.0	4.1	2.8	3.2	2.6	2.7	2.3	3.2	2.8	3.0	2.2	2.6	2.9	0.09
April	2.4	3.1	1.9	3.7	2.2	3.2	1.8	3.3	2.2	3.1	2.1	3.0	2.7	0.11
May	2.1	3.4	1.6	2.8	2.1	3.6	1.6	2.7	2.3	3.2	1.4	3.2	2.5	0.12
June	2.2	3.4	1.7	3.6	2.1	3.3	1.7	3.0	2.3	3.3	3.1	3.1	2.7	0.11
July	2.2	3.6	3.6	3.3	2.1	2.8	1.8	3.4	2.0	3.2	1.5	2.9	2.7	0.12
August	2.2	3.5	1.7	3.5	1.9	3.0	1.6	3.3	2.4	2.7	2.2	2.9	2.6	0.11
September	2.4	3.6	3.6	4.5	2.5	3.6	2.0	3.2	2.4	3.2	3.0	3.4	3.1	0.12
October	2.7	3.1	2.3	3.5	2.4	3.3	2.0	3.4	2.2	3.3	1.7	3.5	2.8	0.11
November	2.5	3.1	2.0	3.8	2.7	3.3	2.0	3.5	2.5	3.0	1.6	3.2	2.8	0.11
December	2.4	2.7	1.9	3.7	2.7	2.8	2.1	3.4	2.2	2.9	2.0	3.5	2.7	0.10
Mean	2.4	3.3	2.3	3.5	2.4	3.0	1.9	3.2	2.3	3.0	2.1	3.3	2.7	0.16
SEm±	0.04	0.08	0.11	0.07	0.07	0.07	0.04	0.04	0.04	0.06	0.09	0.07		
Effects	Sites (A)		Months (B)		Species (C)		A*B		A*C	B*C	A*B*C			
Probability	<0.001		<0.001		<0.001		<0.001		<0.001	<0.001	<0.001			

a.a.= *Acacia amentacea*; c.p.= *Celtis pallida*; f.a.= *Forestiera angustifolia*; p.t.= *Parkinsonia texana*

Table 4: Monthly content of digestible energy (kcal g^{-1} DM) in four shrub species growing in northeastern Mexico

Month	Counties												Mean	SEM
	China				Linares				Los Ramones					
	a.a.	c.p.	f.a.	p.t.	a.a.	c.p.	f.a.	p.t.	a.a.	c.p.	f.a.	p.t.		
January	2.8	3.5	3.4	3.5	3.5	3.1	3.4	2.8	3.3	3.5	2.8	3.5	3.2	0.05
February	3.1	3.8	3.7	3.6	3.8	3.3	3.7	3.1	3.5	3.6	3.1	3.8	3.5	0.04
March	3.1	3.7	3.7	3.7	3.5	3.2	3.7	3.2	3.5	3.6	3.1	3.7	3.4	0.05
April	2.4	3.2	3.0	3.5	3.5	2.9	3.1	2.5	3.4	3.4	2.4	3.2	3.0	0.07
May	3.0	3.6	3.4	3.6	3.7	3.4	3.4	2.9	3.3	3.6	3.0	3.6	3.4	0.05
June	3.1	3.6	3.4	3.7	3.6	3.3	3.6	3.0	3.6	3.7	3.1	3.6	3.4	0.04
July	3.1	3.5	3.6	3.8	3.6	3.5	3.7	3.1	3.5	3.7	3.1	3.5	3.5	0.04
August	3.0	3.5	3.5	3.7	3.6	3.5	3.6	3.1	3.6	3.7	3.0	3.5	3.4	0.04
September	2.9	3.6	3.6	3.6	3.7	3.4	3.5	3.2	3.7	3.8	2.9	3.6	3.5	0.04
October	2.6	3.6	3.2	3.4	3.5	3.2	3.3	3.0	3.5	3.7	2.6	3.6	3.3	0.06
November	3.0	3.7	3.5	3.7	3.7	3.4	3.6	3.1	3.3	3.7	3.0	3.7	3.4	0.05
December	3.0	3.5	3.4	3.7	3.6	3.3	3.5	2.9	3.5	3.7	3.0	3.5	3.4	0.05
Mean	2.9	3.6	3.5	3.6	3.6	3.3	3.5	3.0	3.5	3.6	2.9	3.6	3.0	0.05
SEm±	0.04	0.02	0.03	0.02	0.02	0.03	0.03	0.03	0.02	0.02	0.04	0.02		
Effects	Sites (A)		Months (B)		Species (C)		A*B		A*C	B*C	A*B*C			
Probability	<0.001		<0.001		<0.001		<0.001		<0.001	<0.001	<0.001			

a.a.= *Acacia amentacea*; c.p.= *Celtis pallida*; f.a.= *Forestiera angustifolia*; p.t.= *Parkinsonia texana*

Mexico and found a range between 2.9 and 3.7 kcal kg^{-1} DM in *C. pallida, F. angustifolia* and *A. amentacea* during eight seasons in two years of study (summer 2004 to spring 2006). These findings agree with the results observed for the same shrub species of this study. Benavides (1999) evaluated trees and shrubs used as forage in Costa Rica and reported values of 2.1 kcal kg^{-1} DM, while Hussain and Durrani (2009) studied 10 species of forage plants in Pakistan documenting an average of 2.9 Mcal kg^{-1} DM, and in the same latitude at the United Arab Emirates it was reported a range of 3.5 Mcal kg^{-1} DM in five range species by Shaltout et al. (2008).

3.5. Insoluble neutral detergent fiber content

The values of INDF are shown in Table 5. The species of Linares site presented the highest content of INDF, followed by China and Los Ramones. *A. amentacea* and *F. angustifolia* showed the highest content (80 g kg^{-1} DM) in China and Los Ramones, respectively, during October, while the lowest value was 12 g kg^{-1} DM (*C. pallida* in China and *P. texana* in Los Ramones) during February. The values of DMD were used to correlate with INDF of the present study and a negative relationship was found (r = -0.84; P=0.001). A similar response trend was reported by Ramirez et al. (2009) who found that INDF of native grasses growing in northeastern Mexico was negatively correlated with DMD. Besides, Jancik et al. (2008) argued that the INDF content of grasses increased during plant maturation. In another study, Alvarado et al. (2012) found a negative correlation between these two nutritive parameters.

Table 5: Monthly content of insoluble neutral detergent fiber (g kg^{-1} DM) in four shrub species growing in northeastern Mexico

Month	Counties												Mean	SEM
	China				Linares				Los Ramones					
	a.a.	c.p.	f.a.	p.t.	a.a.	c.p.	f.a.	p.t.	a.a.	c.p.	f.a.	p.t.		
January	55	11	17	26	14	32	24	54	21	29	55	11	29	2.7
February	44	1	9	22	1	37	20	45	10	29	44	1	22	2.6
March	49	11	7	20	18	41	23	45	18	19	49	11	26	2.4
April	76	36	50	27	18	55	51	68	16	29	76	36	45	3.6
May	48	20	24	21	15	29	40	57	27	25	48	20	31	2.6
June	45	26	26	22	19	33	30	51	18	22	45	26	31	2.2
July	41	26	23	17	12	19	19	45	18	16	41	26	25	1.9
August	49	25	21	23	15	20	26	49	16	21	49	25	27	2.0
September	56	19	24	34	13	30	37	44	16	17	56	19	30	2.3
October	81	14	45	41	19	40	49	48	25	26	81	14	40	3.6
November	48	10	18	21	8	29	27	47	35	19	48	10	28	2.7
December	53	16	27	21	12	40	35	54	19	20	53	16	30	2.8
Mean	54	18	24	25	14	34	32	51	20	23	54	18	30	2.2
SEM	2.1	1.5	2.1	1.1	0.9	1.6	1.8	1.2	1.1	0.8	2.1	1.5		
Effects	Sites (A)		Months (B)		Species (C)		A*B		A*C		B*C		A*B*C	
Probability	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	

a.a.= *Acacia amentacea*; c.p.= *Celtis pallida*; f.a.= *Forestiera angustifolia*; p.t.= *Parkinsonia texana*

The variables of chemical composition indicate better quality were OM, N, DE, while the worst were ADF, INDF during late year. The studied species could be considered as protein source because their nitrogen content, providing good conditions to microbial growing in the rumen.

4. Conclusions

Chemical composition suggests that *C. pallida* and *P. texana* have potential as forage for ruminants, contrary to *A. amentacea* and *F. angustifolia* because their high content of acid detergent fiber and insoluble neutral detergent fiber and low content of digestible energy. However, more research about selectivity, palatability and digestibility is required. During early year

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