



## Bromatologic composition of the herbaceous species of the Northeastern Brazil Caatinga<sup>1</sup>

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**ABSTRACT** - The objective of this work was to evaluate the chemical composition of the pool and of four species of caatinga herbaceous vegetation in the rainy and dry seasons. The experiment was conducted in three selected shrub areas at different levels of conservation. Four samples of each species (*Arachis pintoii*, *Boerhavia diffusa*, *Heliotropium ternatum*, *Aristida adscensionis*) were collected in each area and from a pool of species for determination of bromatologic composition. In the dry season, only the pool of species and the grass *Aristida adscensionis* were evaluated. There was a significant effect of the studied area on the chemical composition of all analyzed species. The nutrient content found in the dry matter (DM) and the digestibility of the pool of species indicate that caatinga herbs presented improved quality in the rainy season. The qualitative variables of the studied species were most heterogeneous due to the variability found in caatinga. Conservation conditions in caatinga and season of the year influence bromatologic composition of the species *Arachis pintoii*, *Boerhavia diffusa* L., *Heliotropium ternatum* Vahl. *Aristida adscensionis* L. and of a pool of typical species found in Caatinga.

Key Words: herbs, native species, quality, semiarid

## Composição bromatológica de espécies herbáceas da caatinga

**RESUMO** - Com o objetivo de avaliar a composição bromatológica do pool e de quatro espécies da vegetação herbácea da caatinga nos períodos chuvoso e seco foi conduzido um experimento em três áreas selecionadas de caatinga, com níveis diferenciados de conservação. Em cada área, foram colhidas quatro amostras de cada espécie (*Arachis pintoii*, *Boerhavia diffusa*, *Heliotropium ternatum*, *Aristida adscensionis*) e de um pool de espécies, para determinação da composição bromatológica. Na época seca foram avaliados somente o pool de espécies e a gramínea *Aristida adscensionis*. Houve efeito significativo da área amostrada na composição bromatológica de todas as espécies analisadas. Os teores de nutrientes na matéria seca (MS) e a digestibilidade do pool das espécies indicam que as ervas da caatinga apresentaram melhor qualidade na época chuvosa. As variáveis qualitativas das espécies analisadas mostraram-se heterogêneas, devido à variabilidade encontrada na caatinga. As condições de conservação da caatinga e o período do ano influenciam a composição bromatológica das espécies *Arachis pintoii*, *Boerhavia diffusa* L., *Heliotropium ternatum* Vahl. e *Aristida adscensionis* L. e de um pool de espécies típicas da caatinga.

Palavras-chave: ervas, espécies nativas, qualidade, semiárido

### Introduction

The Northeastern region in Brazil is characterized by having two well-defined climatic periods along the year: a wet and a dry season. During the rainy period, the caatinga vegetation re-grows, giving rise to an herbaceous layer, which possesses a large variety of plants, most of them with enormous forage potential. Over 80% of all herbaceous and woody species in the caatinga are used to feed all domestic ruminants (Lee et al., 1996) and they are very important for

soil conservation, water retention in the ecosystem and for the supply of forest products, such as stakes and firewood (Araújo & Ferraz, 2003).

One striking feature of the semi-arid regions is their high temperatures, which can directly affect the quality of the available forage. High temperatures promote rapid cell wall lignifications, accelerating the cellular metabolic activity, and resulting in decreased pool of metabolites in cellular content. They also promote the rapid conversion of photosynthetic products in the cell wall components (Van Soest, 1965).

Soil moisture affects forage plants directly. Severe water stress, as it often occurs in the semiarid, promotes growth paralysis and death of aboveground plant. This limits livestock production, both because of low quality and low availability of the forage shortage.

Despite its rich variety of plant species on the herbaceous layer and their important role in the diet of goats and sheep – mainly during the rainy season – little is known about *caatinga*, where the bromatologic composition of these species is concerned. So, a detailed study of the *caatinga* may provide some useful information as to what forms of management can be used to improve the use of its varied species.

Santos et al. (2009) evaluated the chemical composition of the diet of sheep grazing on the shrubs during the rainy season (March 2005). They observed that the sheep diet presented the following values: CP= 14.43%; NDF= 54.83%; ADF= 39.98%; CT= 67.69% and CNF= 12.86%. Rapini et al. (2006) stated that, knowing the semiarid biodiversity and its physical-chemical and biological processes which affect its biota constitutes is the first step towards an efficacious use of its resources with sustainability, reducing, therefore, environmental degradation.

Considering the fact that the *caatinga* vegetation presents a diversity of flora, consisting of herbaceous species, shrubs and trees of several families – mainly formed with plants used as animal food – there comes the need for additional studies to work out a better quality evaluation of these plants in connection with their nutritional value.

Consequently, the objective of this work is to evaluate the chemical composition of the *caatinga* herbaceous species on three areas at different degrees of conservation, namely the *Cariri* of Paraíba in rainy and dry years.

## Material and Methods

The present study was conducted at the Estação Experimental at the Universidade Federal da Paraíba, located in the municipality of São João do Cariri on a 320-ha area of gentle, undulating topography whose dominant vegetation consists of the *caatinga* shrub-trees.

The climate in the region, according to Köppen, is Bsh-hot semi-arid with summer-autumn rains. According to bioclimatic classification of Gaussen, the climate is hot Sub-desert tending towards tropical with a climate characterized by poor and irregular rainfalls (annual and inter-annual). In 2007, the rainfall recorded at the Estação Experimental was 362.6 mm (Figure 1).

The average annual temperature is 26°C with a minimal temperature of 18°C and a maximal temperature of about 34°C. The hottest time of the year is from November to January whereas the coldest period is in July. The average air relative humidity is 70%. Data on rainfall, humidity and temperature used in this study were obtained in the year 2007, from the database of a conventional weather station located at the Estação Experimental of São João do Cariri (Figure 2).

Three *Caatinga* areas were selected in different stages of secondary succession. Area 1 was the least preserved area; Area 2 was of intermediate preservation, and Area 3 was the most preserved, exhibiting the densest vegetation. In these areas, a floristic survey was conducted to identify botanical species. For this purpose it was collected and prepared voucher specimen of plant material, which was taken to the Laboratório de Botânica Jayme Coelho de Moraes CCA/UFPB for identification. In all three areas, the *caatinga* presented sized scrub-trees, with higher proportion of shrubs and higher incidence of *Aristida adscensionis* L., far more noticeable in areas 1 and 2.

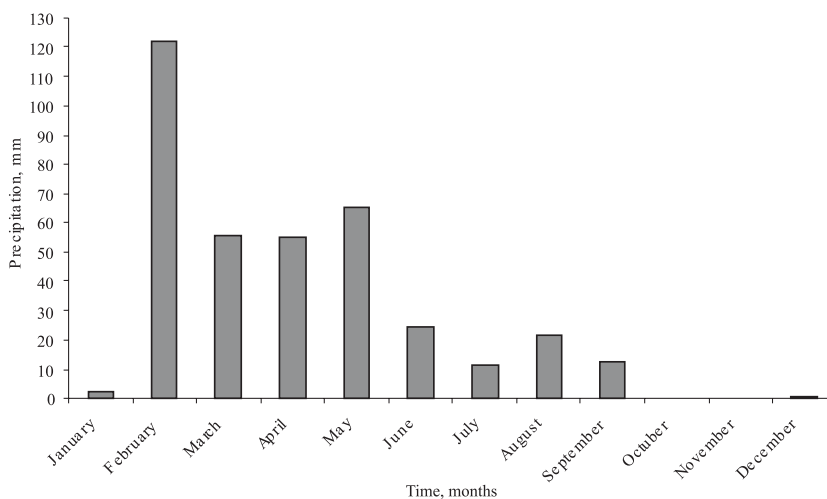


Figure 1 - Monthly rainfall recorded at the Experimental Station in 2007 (annual precipitation = 362.6 mm).

The selected areas were characterized by presenting the species *Sida* sp., *Lippia gracillis* Schauer, *Croton sonderianus* Müll. Arg., *Caesalpinia pyramidalis* Tul., *Jatropha mollissima* (Pohl) Baill., *Aspidosperma pyrifolium* Mart., and some cacti, such as *Cereus jamacaru* DS., *Pilocereus gounellei* F. Ritter, besides the herbaceous layer from where the species selected for this study were originated.

For the physicochemical characterization of the three experimental sites, soil samples were collected from an approximately depth of 20 cm. The samples were taken to the Laboratório de Análise de Solos e Água do CCA/UFPB of the CCA/UFPB. Measurements consisted of particle size analysis, clay dispersion and flocculation, soil bulk density and particle, total porosity and water available in soil at 0.01 and 1.5 MPa, according to the methodology proposed by Forsythe (1975). The chemical analysis consisted of water pH, phosphorus, potassium, calcium, magnesium, aluminum,

sodium and organic matter as ruled by methodologies recommended by EMBRAPA (1997) (Table 1).

Three species of herbaceous dicots (*Arachis pintoi*, *Boerhavia diffusa* L. *Heliotropium ternatum* Vahl.) were identified, and a monocot (*Aristida adscensionis* L.) and a pool of species were identified for bromatologic analyzes (Table 2). The criterion for the choice of species was based on the natural preference of goats and sheep, according to field observations, coupled with greater amount of biomass presented in these species.

Samples of these plants were collected to determine their bromatologic values in two seasons: rainy season (April) and dry season (August). In the rainy season, four species of herbs and pool were collected, and in dry season, it was only possible to collect the *Aristida adscensionis* L. and the pool because the other species only come up in these areas in the rainy season.

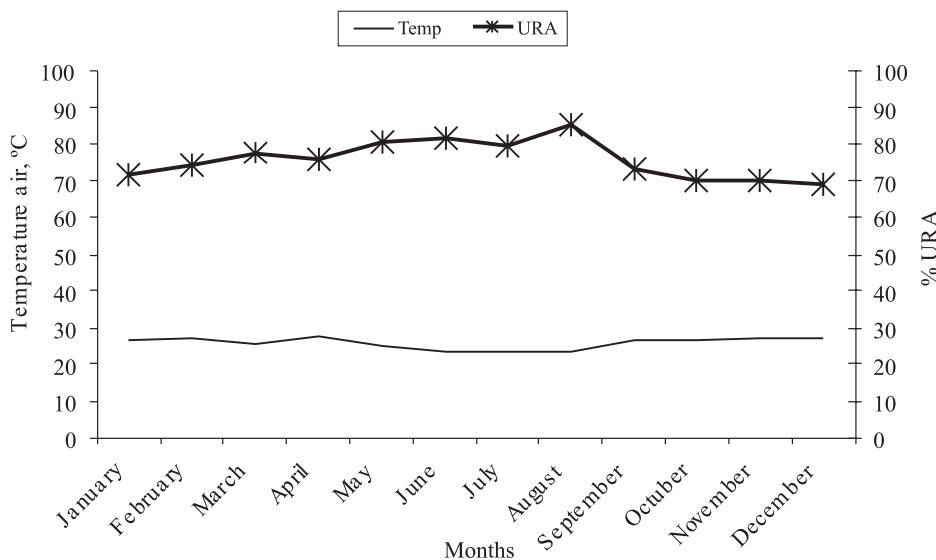


Figure 2 - Average temperature and relative humidity in 2007 at the Experimental Station of São João do Cariri, Paraíba.

Table 1 - Chemical and physical analysis of soil samples from areas located at the experimental station

Area	Particle size			Dispersed clay	Flocculation	Density			Humidity			*Texture class
	Sand (g kg <sup>-1</sup> )	Silte (g kg <sup>-1</sup> )	Clay (g kg <sup>-1</sup> )			Soil (g cm <sup>-3</sup> )	Particle (g cm <sup>-3</sup> )	0.033MPa (g/100 g)	1.5 MPa (g/100 g)	H <sub>2</sub> O (%)		
1	602	293	105	64	390	1.75	2.92	15.42	8.10	7.32	Sand	
2	637	264	99	76	232	1.63	2.74	12.98	5.39	7.59	Sand	
3	676	208	116	51	560	1.60	2.60	11.62	4.47	7.15	Sand	
Chemical characterization												
	pH H <sub>2</sub> O (mg dm <sup>-3</sup> )	P (mg dm <sup>-3</sup> )	K <sup>+</sup> (mg dm <sup>-3</sup> )	Ca <sup>2+</sup> (mg dm <sup>-3</sup> )	Mg <sup>2+</sup> (mg dm <sup>-3</sup> )	Al <sup>3+</sup> (cmol <sub>c</sub> dm <sup>-3</sup> )	Na <sup>+</sup> (cmol <sub>c</sub> dm <sup>-3</sup> )	SB (g/kg)	CTC (g/kg)	Organic Matter (g/kg)	V (g/kg)	
1	7.10	1.73	55.0	10.80	5.45	0	0.08	16.87	16.97	6.18	97.05	
2	6.67	1.84	164.0	4.85	3.35	0	0.05	8.67	9.66	9.85	89.75	
3	6.51	2.85	200.0	4.45	1.85	0	0.06	6.87	8.52	11.84	80.63	

Table 2 - Species identified and analyzed for their chemical compositions

Species and <i>Pool</i>	Family	Scientific name	Popular name
1	Fabaceae	<i>Arachis pintoi</i> Benth.*	Amendoim-forrageiro
2	Nyctaginaceae	<i>Boerhavia diffusa</i> L.**	Pega-pinto
3	Boraginaceae	<i>Heliotropium ternatum</i> Vahl.**	Flor-branca
4	Poaceae	<i>Aristida adscensionis</i> L.**	Capim-panasco
5	—	—	<i>Pool</i>

\* Higher expression in areas 2 and 3. \*\* Higher expression in areas 1 and 2.

From each area, four samples and the *pool* were collected from every species and from the pool. The sampling was chosen from each area and the cutting was done by means of a pair of pruning shears, at ground level, where all the aerial part of the plants shoots represented the sample of each area. In the rainy season, the crop was harvested when most species (more than 50%) were in the reproductive stage (flowering and/or fruiting), since in the *caatinga* vegetation, the phenological events do not happen at a particular time and there is no standardization even within the same species.

The plant material sampled, about 500 g, was taken to the Laboratório de Nutrição Animal of the CCA/UFPB, placed in an incubator at 65°C for 72 hours, prepared for dry matter determination (DM), organic matter (OM), mineral matter (MM), crude protein (CP), ether extract (EE), neutral detergent fiber (NDF) and acid detergent fiber (ADF), lignin, cellulose, hemicellulose and *in vitro* digestibility of DM according to the methodology described by Silva & Queiroz (2002). NDF was estimated according to recommendations by Mertens (2002). Total carbohydrates (TC) were also estimated according to methodology of Sniffen et al. (1992), and soluble carbohydrates (CHO), according to Mertens (1997). The equations to calculate the total and soluble carbohydrates were:  $TC = 100 - (\% CP + \% EE + \% \text{ash})$  and  $CHO = 100 - (\% NDF + \% CP + \% EE + \% \text{Ash})$ .

The design selected was completely randomized in  $5 \times 3$  factorial schemes, considering four species and the pool, and three areas, with four replications. The data were subjected to analyses of variance and the means were compared by using Tukey's test at 5% probability with the SAS (1997) program.

## Results and Discussion

According to data statistical analyses, there was an interaction ( $P < 0.05$ ) between plant species and the area sampled. Crude protein ranged from 7.85% to 19.23% in the species *Aristida adscensionis* and *Arachis pintoi*, respectively. The two species that presented lower crude

protein values were *Heliotropium ternatum* and *Aristida adscensionis* in areas 1 and 2, respectively.

The average protein content found in this study for the *caatinga* herbaceous species, except for the panasco grass (*Aristida adscensionis*), may be considered quantitatively satisfactory, being higher than the values recommended in the literature for ruminants. Another important feature is that these species received no fertilization, and even so, the percentage of CP was higher in some of them. In the species *Arachis pintoi*, there was no difference among the areas, and this result is probably linked to its ability to fix nitrogen which is very important from the standpoint of animal nutrition and the nitrogen incorporation via atmospheric fixation by the bacteria present in its roots.

Regardless of the studied area, the species with the highest percentage of NDF was *Aristida adscensionis*. However, the percentage of lignin was not very high whereas the hemicellulose was 26.60%. The grass hemicellulose content usually ranges from 14 to 25% in tropical species.

The ADF content of the species ranged from 39 to 48%, when it was analyzed separately area by area, being verified very similar values among species in these areas. The ADF contents showed little variation among species (39 to 48%) regardless of the areas analyzed. However, the contents of hemicellulose in the species had marked variation in the three areas: from 1.57% for the species *Heliotropium ternatum* to 29.60% for *Aristida adscensionis*, suggesting that the hemicellulose content tends to be higher in grasses than in dicots.

For lignin, the values found were very similar among species from the three areas, except for *Heliotropium ternatum*, which stood out with greater value in areas with an average of 10.18%. The lignin content in plants can vary in dry matter from 2 to 12%; however, from a nutritional standpoint, it is interesting that this value is kept low to avoid jeopardizing the digestibility of other nutrients.

The total carbohydrate of the species *Arachis pintoi*, *Boerhavia diffusa* and the pool in all three areas were around 64 and 68% DM. The *Heliotropium ternatum* species and the *Aristida adscensionis* species exhibited higher

percentages in the three scrub areas, at 75.15 and 82.80% respectively.

The non-fibrous carbohydrates varied markedly among species in the areas. The species *Arachis pintoii* varied from 11.74 to 21.75% in areas 3 and 1. The species *Boerhavia diffusa* showed a non-fibrous carbohydrates variation from 5.23 to 17.87% in areas 2 and 1. The soluble carbohydrates of species *pool* showed values from 6.96% in area 1 and 21.25% in area 3. The non-fibrous carbohydrate contents vary, besides other factors because of the plant phenologic state. It can be seen in the course of the experiment, that the two species did not show uniformity in their phenology, which may be attributed to soluble carbohydrates variations.

*In vitro* digestibility of dry matter was above 50% for most species in the areas studied. The species *Boerhavia diffusa* in area 1 (66.8%) had the highest value, and the lowest value was found for the *Heliotropium ternatum* in area 2 (38.4%). Figure 3 shows that the highest percentages of lignin occurred in the species *Heliotropium ternatum*, suggesting reduction in digestibility. According to Euclid (1995), the DM accumulation during the growth and development of plants is primarily responsible for reduction in DM digestibility. This is probably due to the increased deposition of DM in the plant cell wall and the intensification of its lignification.

It is generally expected that plants of the same species have similar phenologic cycles, because they share the same environment. However, for *Caatinga* species, there was a disconnection between these cycles, probably associated with survival strategies, because if the plants showed uniform phenologic cycles, they might have

disappeared when environmental conditions were unfavorable (Andrade et al. 2006). The differences in chemical composition among species observed in this study can be attributed to the fact that these species were different, and even growing in similar environmental conditions, they may have different chemical composition – a result of the genetic diversity of species (Van Soest, 1965).

Besides the differences observed in species and among species, another important feature lies in the difference in the conservation levels and in the physical and chemical characteristics of the soil in the areas under study, which certainly influenced fertility, moisture, and floristic and chemical composition of the species that make up these environments. When the chemical characteristics of the three areas were investigated, it was observed that area 3, the most preserved area, did show higher concentrations of phosphorus, potassium and organic matter than the other areas.

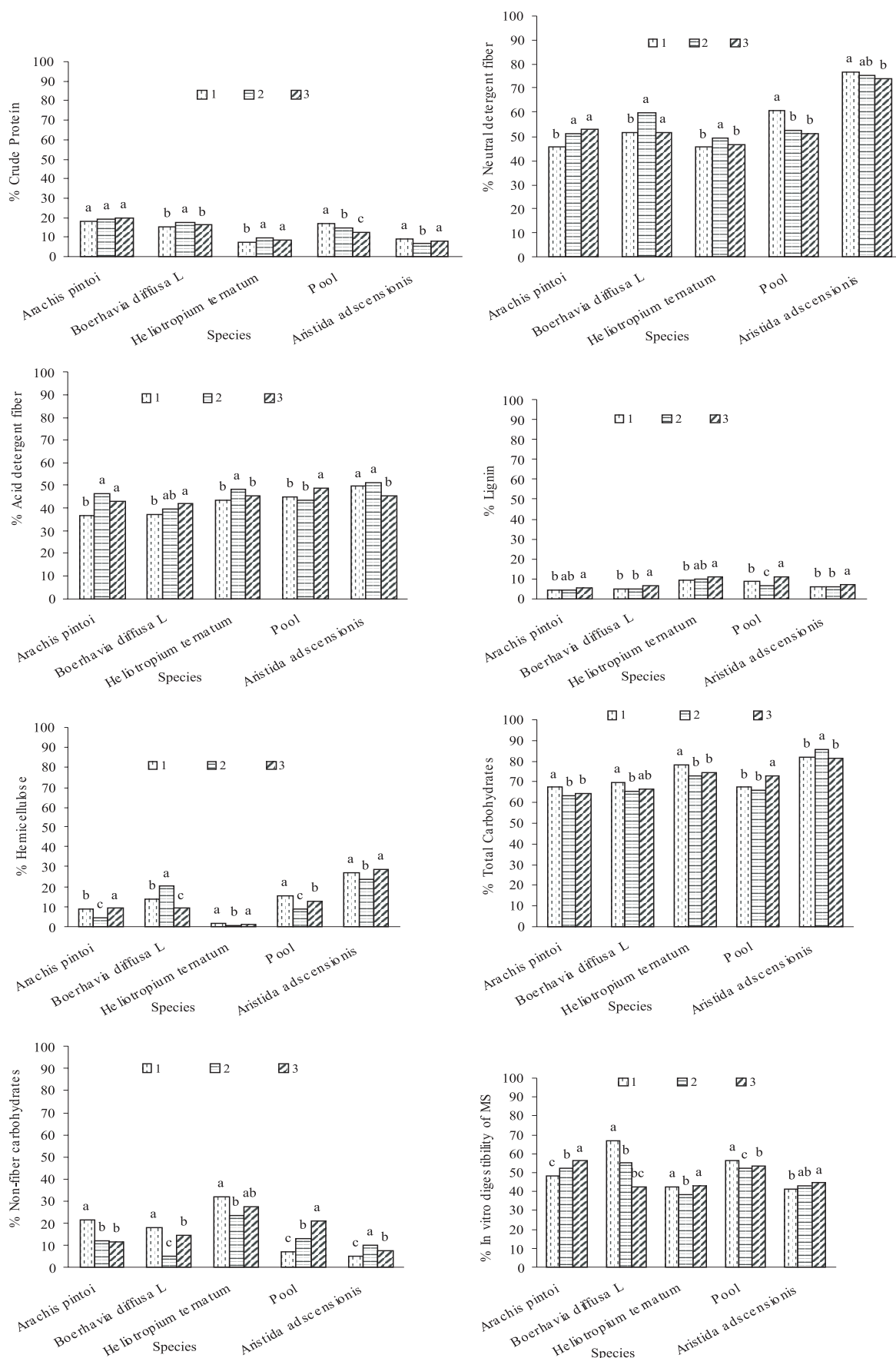
In this study, it was possible to observe that the herbs studied had relatively higher fractions of DM, NDF and ADF values consistent with tropical forages as mentioned before. Wilson et al. (1991) stated that high temperatures, a hallmark of the semi-arid conditions, promote rapid lignifications of the cell wall, accelerating their metabolic activities.

In the two evaluation periods, a decrease in the protein content of the species *pool* during the transition from the wet season to the dry season was observed (Table 3). This decline was most pronounced in area 1 from 17.21% to 4.69% between seasons, respectively. The samples of areas 2 and 3 were very similar in the dry season: 8.15 and 8.79% respectively. According to Pereira Filho et al. (1997) because of lack of rain, the CP content of dicotyledonous plants and grasses tended to fall.

Table 3 - Chemical composition of the species *pool* of in three areas over two assessment periods

Item, %	Area * Period					
	Area 1		Area 2		Area 3	
	Rainy	Dry	Rainy	Dry	Rainy	Dry
Dry matter	25.80Bb	73.19Aa	19.76Cb	63.25Ba	35.10Ab	55.93Ca
Organic matter	87.10Aa	85.77Ba	84.22Bb	88.73Aa	87.02Ab	91.26Aa
Mineral matter	14.22Aa	12.90Ab	15.75Aa	11.26Bb	12.97Ba	8.74Cb
Crude protein	17.21Aa	4.69Bb	14.70Ba	8.15Ab	12.11Ca	8.79Ab
Neutral detergent fiber	60.42Ab	65.53Aa	52.41Bb	65.28Aa	51.29Bb	59.89Ba
Acid detergent fiber	44.75Bb	64.12Aa	43.79Bb	63.98Aa	48.35Ab	57.63Ba
Ether extract	2.51Ba	0.98Cb	3.88Aa	2.38ABb	2.36Ba	3.24Aa
Lignin	8.58Bb	14.69Aa	6.13Cb	14.39Aa	11.00Ab	15.76Aa
Celulose	15.80Ab	23.58Aa	20.15Aa	21.34Aa	19.08Ab	26.07Aa
Hemicellulose	5.66Ba	1.40Ab	8.62Aa	1.30Ab	2.85Ca	2.25Aa
Total carbohydrates	67.37Bb	80.10Aa	65.66Bb	78.18Aa	72.54Ab	79.22Aa
Non-fiber carbohydrates	14.56Ba	6.95Cb	13.21Ba	12.90Ba	21.25Aa	19.33Aa
<i>In vitro</i> digestibility of DM	56.85Aa	26.20Bb	51.97Aa	30.98ABb	53.12Aa	32.35Ab

\* In the line for the same column area, the mean followed by the same lowercase letter, and in the line for columns of different area, the mean followed by the same capital letter do not differ statistically at 5% probability according to Tukey test.



The means followed by small letters on the bars of each area differ ( $P < 0.05$ ) from each other as determined by Tukey test.

Figure 3 - Chemical composition of four species of herbs and pool in the *Caatinga*.

Area 1 soil showed a greater amount of calcium and this element is directly related to kinase, which is an enzyme that catalyzes protein activities (Raven & Evert, 2007). According to the authors, more than 30 protein kinase have been identified and ten of these are calcium dependent. Another important feature to consider is the amount of magnesium, which was much lower in areas 2 and 3. Magnesium is a nutrient required for the phosphorylation and protein synthesis (Malavolta et al., 1997) which may have induced a change in the protein content of the species studied.

The neutral detergent fiber of the *pool* did not differ in areas 3 and 2 in the rainy season, with values of 51.29 and 52.41% respectively. In contrast to the dry season, similarity was found between the NDF of the *pool* in areas 1 and 2. In area 3, it was found low contents of NDF in DM during the dry season in comparison to other areas.

The amount of ADF did not differ between areas 1 and 2; however, those of the *pool* were affected by the season in all areas, with an increase of this fraction in the transition from rainy to dry season. Probably, there were a leaf reduction and an increase in the stem length, increasing acid detergent fiber content, and reducing the dry matter digestibility. The lignin and cellulose of the *pool* increased in all areas in the dry season. As for the hemicellulose, differences in levels between areas did occur, but only in the rainy season, when the *pool* of area 3 showed a higher content of hemicellulose in comparison to other areas.

In the *pool*, the highest total carbohydrate was observed in three samples from area 3 in the rainy season, whereas during the dry season, there were no differences in the percentages of carbohydrates in the *pool* of the areas. The non-fiber carbohydrate of the *pool* did not differ between

areas, with higher percentage in the *pool* of area 3 along two seasons. Differences between seasons were observed for just one area where the collected material showed a lower percentage of non-fiber carbohydrate in the dry season (6.95% DM).

*In vitro* digestibility of the dry matter in the *pool* did not differ between the areas in the rainy season. However, from the rainy season to the dry season, there was a reduction of digestibility of the *pool*, which was lower in the *pool* of area 1 (26.20% in DM).

The data collected in the present study for the chemical composition of the *pool* of herbs showed significant changes in plant material available to the animals between the two seasons (rainy and dry). These are important informations for animal nutrition, because they provide subsidies for the evaluation of nutrient deficiencies based on the chemical composition of the plants that animals consume at different times.

There was no effect of studied areas on the dry matter of the panasco grass (*Aristida adscensionis* L.) (Table 4). However, there was a period effect in view of the increased dry matter found in the three areas assessed during the dry season. Ramirez et al. (1995), doing research on buffel-grass, a grass adapted to the semiarid conditions, stated that in Mexico, the buffel grass had its pasture composition and quality greatly altered during the year, a trend observed in this study for plants of the *caatinga*, and more specifically for *Aristida adscensionis* L. grass.

The DM content increased in dry season, probably due to its reduction in leaf percentage and an increase in stem growth and also due to the dehydration of plant material.

Crude protein exhibited a major reduction in between seasons, with a decrease of approximately 50% from the

Table 4 - Chemical composition of panasco grass (*Aristida adscensionis* L.) from three areas during two assessment periods

Item, %	Area * Period					
	Area 1		Area 2		Area 3	
	Rainy	Dry	Rainy	Dry	Rainy	Dry
Dry matter	48.77Ab	64.08Ba	49.87Ab	66.80Ba	46.98Ab	71.06Aa
Organic matter	91.85Aa	87.92Bb	93.15Aa	91.65Aa	91.81Aa	90.66Aa
Mineral matter	8.15Ab	12.07Aa	6.85Aa	8.35Ba	8.20Aa	9.34Ba
Crude protein	8.87Aa	4.23Ab	6.44Ba	4.26Ab	8.25Aa	4.11Ab
Neutral detergent fiber	76.64Aa	80.15Aa	75.30Ab	80.23Aa	74.03Aa	77.71Aa
Fiber in acid detergent	49.36Ab	58.67Aa	51.40Aa	55.53Aa	45.40Bb	54.44Aa
Ether extract	1.36Aa	1.34Aa	1.38Aa	1.41Aa	2.09Aa	1.58Aa
Lignin	5.60Ab	12.91Aa	5.54Aa	7.89Ba	6.80Aa	7.99Ba
Celulose	13.10Bb	21.75Aa	21.17Aa	21.19Aa	18.59Aa	21.05Aa
Hemicellulose	27.27Aa	21.47Ab	23.89Aa	24.69Aa	28.62Aa	23.25Ab
Total carbohydrates	81.61Ba	82.35Ba	85.32Aa	85.97Aa	81.47Bb	84.95ABa
Non-fiber carbohydrates	4.98Ca	2.20Cb	10.02Aa	5.74Bb	7.43Ba	7.25Aa
DM <i>in vitro</i> digestibility	41.08Aa	23.37Ab	42.80Aa	23.15Ab	44.40Aa	22.84Ab

\* In the line for the same column area, the mean followed by the same lower case letter, and in the line for columns of different area, the mean followed by the same capital letter do not differ statistically at 5% probability according to Tukey test.

rainy season to the dry season. This reduction was mainly associated to the senescence and abscission of leaves found most strongly in the dry season. With the maturing of tropical forage, crude protein levels tend to drop significantly. Dantas Neto et al. (2000) observed that the CP content of buffel grass decreased linearly as age of the plant increased from 12.4% to 6.0% from 35 days to 110 days.

NDF and the ADF showed values compatible with data from tropical grasses. The lignin and cellulose increased in the dry season and the hemicellulose decreased, a result which is probably associated to a reduced cellular content and increased lignifications of plant tissues.

The total carbohydrates content exceeded 80% of dry matter and there was no variation between seasons whereas the content of non-fibrous carbohydrates showed differences between both areas in different seasons. In the rainy season, in area 1, *Aristida adscensionis* L. showed the lowest non-fiber carbohydrate and in area 2 the highest. In the dry season, it was observed in area 3, the highest level of non-fiber carbohydrates, and in area 1 this remained at the lowest level. When comparing these periods, with the exception of area 3, there was a decrease in non-fibrous carbohydrate from the rainy season to the dry season.

Dry matter *in vitro* digestibility of *Aristida adscensionis* L. did not differ between areas, but between periods there was a reduction of approximately 50% from the rainy season to dry season. In the dry period, the process of cell wall lignifications is stronger, which causes a reduction in the dry matter digestibility.

Panasco grass (*Aristida adscensionis* L.) is an important contribution to forage in the diet of goats and sheep in the semi-arid, and therefore its chemical composition is the most important to be known. This participation of panasco grass in the diet of goats was studied by Araujo Filho et al. (1996) who noticed a participation of 61.2% of it, confirming, therefore, the importance of this grass.

The studied plants showed in their chemical composition crude protein values close to 15%; while those values of NDF and ADF remained within the range found for tropical grasses (Tables 3 and 4). It was also noticed that the mineral content of these plants is very high. In most studies on the *caatinga* species high values of mineral content have been reported in these plants. Works by made Lima Junior (2006) and Pinto (unpublished data) indicate this trend. Lima Junior (2006) found 10.25% of the minerals in the dry matter of these species whereas Pinto found percentages ranging from 8.21 to 15.03%.

Digestibility of dry matter of the *caatinga* species studied in the rainy season was all above 50%. Digestibility

of dry matter above 50% did not show the dry matter intake as being restricted to the filling effect (Van Soest, 1965). However, in the dry season, the digestibility of the plants decreased significantly, falling to about 30%, which can lead to lower dry matter intake by ruminants, reducing animal production, besides its lower nutritional value.

In a study on the *caatinga* species, Araujo Filho et al. (2002) stated that the nutritional value of the woody *caatinga* changes throughout the year. In this study, it was also observed variations in the values of bromatologic indicators, in the same way i.e., in the same area, the values vary with the conditions of rainfall distribution along the year.

According to Pereira Filho et al. (1997), the herb layer, chemical composition, palatability, digestibility and intake are influenced by the time of the year, since crude protein and non-fibrous carbohydrates contents decrease the levels of neutral fiber detergent, and lignin increases as the rainy season approaches to its end. According to Van Soest (1965), increasing levels of structural carbohydrates and lignin and reduction in cellular content invariably cause reduction in digestibility.

Consequently, during the dry season, with the absence of rains, which makes it possible the renewal of plant re-growth, the remaining vegetation loses its nutritional value progressively and rapidly. Finally, because of the high variability of the rainfall, it is suggested that more studies should be done based on parameters of performance indicators about animals fed on grass species found in the *caatinga*.

## Conclusions

The bromatologic composition of the *caatinga* herbaceous species varies depending on the area conservation state and the season of the year (dry or rainy season). The *pool* of herbaceous species in the rainy season presents qualitative indicators that allow to classify these plants as suitable for consumption by ruminant animals already adapted to the semiarid conditions.

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