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Perennial peanut hay nutritive value

Abstract

The aim of this work was to determine the contents of dry matter (DM), neutral detergent fiber (NDF), acid detergent fiber (ADF), crude protein (CP), mineral matter (MM), and lignin and to evaluate the in vitro dry matter degradability (IVDMD) of *Arachis pintoi hay*. Five beds with 3.99m² each were used and nine cuts were made after 40days intervals during a year. Mean NDF, ADF, MM, lignin and IVDDM were submitted to the Scott-Knott test ($p \leq 0.05$). DM and lignin did not vary statistically, the values of NDF, ADF, MM and IVDDM differed ($p \leq 0.05$) ranging respectively from 36.72 to 42.71%, 16.21 to 19.45%, 14.68 to 20.69%, 1.22 to 2.00% and 75.18 to 84.13%. The perennial peanut cut every 40days under the conditions of Montes Claros, Minas Gerais, Brazil showed good nutritional characteristics, and high IVDMD, suggesting its use for feeding cattle, especially in periods of scarcity of forage, because hay can be stored for long periods.

Keywords: nutritional composition, legume, forage, digestibility

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Thiago Meireles Félix,[1] Neide Judith Faria de Oliveira,[2] Luciana Castro Geraseev,[2] Norberto Mario Rodriguez[3]

[1]Agrarian Sciences Institute, Federal University of Minas Gerais (UFMG), Brazil
[2]Associated Professor, Agrarian Sciences Institute, Federal University of Minas Gerais (UFMG), Brazil
[3]Department, Federal University of Minas Gerais (UFMG), Brazil

Correspondence: Neide Judith Faria de Oliveira, Agrarian Sciences Institute, Federal University of Minas Gerais (UFMG), Av. Universitária n°1000, Bairro Universitário. Postal Box-135, ZIP CODE-39404547, Montes Claros, MG, Brazil, Tel +55 38 21017743,
Email neidewfmg@gmail.com, neidejwdith@hotmail.com

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Introduction

A. pintoi (Fabaceae and Papilionoideae subfamily) or perennial peanut is a tropical legume forage native of Brazil, tolerant of low fertility soils. Used as pasture, ground cover and as an ornament were found from North to South of the country, besides Argentina, Uruguai, Colombia, Australia and United States.[1–3]

Legumes have a typical foliar anatomy of the three-carbon metabolic pathway (C3) species, present higher protein content and digestibility and are recommended to increase crude protein availability to grazing animals. When compared with tropical grasses, C4 plants, possesses high protein and digestibility levels.[2,4]

Considering the costs of feeding in animal husbandry, to offer appropriate nutritional formulas with diversification of ingredients is essential for the animal production.[5] However, only to evaluate the amount of nutrients supplied to the ruminant by the nutritional composition can be insufficient. The in vitro anaerobic incubation of the food with ruminal fluid is a valuable tool to estimate the degradability with high precision and using small amount of sample.[6]

To mimetize the ruminal digestion in 48h, the food is placed under anaerobic conditions, in contact with the ruminal liquid containing viable microorganisms, with constant temperature of 39°C and buffered pH. Subsequently the digestion is done with pepsin and weak acid, for 24hours.[6] This procedure allows simulating the natural conditions of the digestion and obtaining representative and reliable results. In addition, it is possible to estimate the degradability of several samples at the same time.[6–8]

Despite several studies made with tropical grasses, few researches are conducted with this forage, especially in the North of Minas Gerais, Brazil. The objective of this work was to determine the nutritional composition and *in vitro* dry matter degradability of *A. pintoi* hay.

Material and methods

The experiment was conducted in the Institute of Agrarian Sciences, in Montes Claros, Minas Gerais State, Brazil. The weather of the region is tropical wet with dry summer (As) according to the Köppen classification.[9] Were utilized five flowerbeds, with 3.99m² each, of *A. pintoi* cv. Belmonte previously established as a study field five years ago. The soil presented medium fertility in the laboratory analysis, with low exchangeable aluminum, high levels of potassium, phosphorus and magnesium, and a good ratio of alkaline content. The fertilizing utilized was bovine tanned manure (40Kg/m²) in a unique use 40days before the first cut and watered daily as a field capacity.

After a cut for homogenization nine successive cuts (C) were made to each 40days, being in 2008 June, 17th; July, 27th; September, 09th; October 16th and November, 26th and in 2009 January, 08th ; February, 16th ; April 06th and May, 16th, denominated C1 to C9, respectively. The hay was obtained by drying in the sun on canvases, with the mixture to each hour, up to reaching the hay point less than 15% of humidity and stored in plastic woven bags. Homogeneous samples of each flowerbed and cut were collected and ground Willey mill, using mesh of 1mm. The samples were conditioned in plastic opaque bottles.

In the laboratory of Animal Nutrition of the department of Zootechny Veterinary School of the UFMG, in Belo Horizonte, Minas Gerais, Brazil were determined dry matter (DM), Crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), mineral matter (MM) and lignin of the samples. The sequential method 18 was utilized. For the in vitro dry matter degradability (IVDMD) was utilized an Holstein bovine, with 450Kg of body weight maintained in the Veterinary School of the UFMG, fed with 9Kg of Coast cross hay, 4Kg of commercial concentrate and Brachiaria (Urochloa) brizantha pasture, water, and mineral commercial supplement ad libitum. Through ruminal fistula were collected the ruminal liquid and maintained in thermos container. The protocol was approved by ethics in the use of animals committee with n°42/2008.

According to IVDMD modified methodology,[10] samples 1,0g of the cuts were weighed in duplicate, bagged in wrappings with 25µm mesh (F57 - ANKOM®) and deposited in individual jars of the equipment ANKOM® (Daisy II Incubator) with the ruminal liquid. At the same time, were prepared buffer solution A and complementary solution named B. For the first solution were used 32.64g of monobasic potassium phosphate (KH_2PO_4) and 69.76g of dibasic sodium phosphate (Na2HPO4); 12g of magnesium sulfate ($MgSO_4 .7H_2$) and 4g of potassium chloride (KCl). For the complementary solution B were used 160ml of anhydrous sodium carbonate solution 15.73% (w/v) (15.73g Na_2CO_3/100mL), 80mL of the 8% (w/v) urea solution were used; 0.80g of calcium chloride ($CaCl_2$) and 0.2 g of sodium sulfate monohydrate ($Na_2S_9H_2O$). Were added to each jar 1332ml of buffer A and 268ml of solution B, resulting in 6.8 final pH. After reaching 39°C, carbon dioxide was purged to obtain anaerobiosis and after 30minutes 400ml of the filtered rumen liquid was added. The jar remained in the incubator at 39.0°C for 48h under constant stirring. After that time 8g of pepsin and 40ml of HCl were added and the same incubation was carried out for another 24h. After this interval the jars were drained and the F57 wrappings were washed in distilled water at room temperature to remove residues and gas contained in that. Subsequently, they were dry at 105ºC for 24h, cooled in desiccators and weighed, according to the methodology adapted.[10]

The data of nine cuts (treatments) and five flowerbeds (repetitions) were subjected to the variance analysis with the Statistical Analyses System.[11] The averages of the cuts were compared with the Scott-Knott test ($p \leq 0.05$).

Results

Table 1 describes climate variables during the experiment, obtained in a climatic station located in the Agrarian Sciences Institute in Montes Claros. The North of Minas Gerais, as can be verified in Table 1, has two marked seasons in the year, one dry and another wet, but with few rainy months. In three months of a year were accumulated 1023.9mm of precipitation, corresponding to 95.04% of the total.

Table 1 Average meteorological data from 2008, May to 2009, May in Montes Claros, Minas Gerais, Brazil

Period	Temperature (⁰C)			Relative humidity (%)	Precipitation (mm)	Solar radiation (W/m²)
	Minimum	Medium	Maximum			
05/07/2008 to 06/17/2008	20.1	20.5	20.9	70.5	0.2	208.8
06/18/2008 to 07/27/2008	18.2	18.6	19.1	65.7	0	199
07/28/2008 to 09/06/2008	20.6	21.1	21.6	55.2	0	230.8
09/07/2008 to 10/16/2008	24.6	25	25.4	52.8	11.2	243
10/17/2008 to 11/26/2008	25.4	25.7	26	61.8	196.5	218.7
11/27/2008 to 01/08/2009	23.3	23.6	23.8	81.3	607.4	244.5
01/09/2009 to 02/16/2009	25	25.3	25.7	69.7	92.8	322.5
02/17/2009 to 04/06/2009	24.4	24.7	25	74.5	127.2	284
04/07/2009 to 05/16/2009	22.1	22.4	22.6	77.5	42	268.3

Temperature: in Celsius (⁰C); Solar Radiation, in watts per square meter (W/m²)
Source: Meteorological Station - available on: <http://www.ica.ufmg.br/gemisa/index.php?option=com _content&view=a rticle&id=22&Item id=57>. Access on: 24 set. 2010

Table 2 Dates of cuts (C) with average levels (%) of dry matter (DM), neutral detergent fiber (NDF), acid detergent fiber (ADF), crude protein (CP), mineral matter (MM), lignin (LIG), *in vitro* dry matter degradability (IVDMD) and coefficient of variation (CV) for the perennial peanut hays of nine successive cuts

Levels(%)	Years 2008					2009				CV(%)
	June 17th	July 27th	September 09th	October 16th	November 26th	January 8th	February 16th	April 6th	May 16th	
	C1	C2	C3	C4	C5	C6	C7	C8	C9	
DM	90.80a	90.60a	91.26a	90.67a	89.85a	89.10a	90.31a	91.49a	91.63a	1.24
NDF	38.12b	38.25b	36.95b	36.72b	39.51a	41.14a	39.98a	40.79a	42.71a	7.44
ADF	16.85c	17.11c	16.21c	16.70c	17.66b	19.45a	19.10a	17.91b	17.87b	4.88
CP	20.49a	20.03a	20.69a	20.49a	18.51b	15.60c	14.68c	17.73b	17.96b	5.57
MM	1.73a	2.00a	1.78a	1.76a	1.86a	1.75a	1.52b	1.22b	1.33b	17.35
LIG	3.10a	2.98a	3.17a	2.43a	3.87a	3.30a	3.32a	3.77a	3.87a	23.57
IVDMD	83.33a	81.81a	84.13a	80.94a	82.26a	76.92b	75.18b	76.29b	78.29b	3.35

[a] Averages followed by different lowercase letters in line differ by Scott-Knott test ($p \leq 0.05$). Results expressed in dry matter basis

Table 2 demonstrates the nutritional composition and degradability of *A. pintoi* hay, with DM similar in all cuts. The NDF ranged ($p \leq 0.05$) between 36.72 in 2008, October to 42.71% in 2009, May. From November to May NDF were statistically significant higher demonstrating the growing of this tropical plant in the wet months, favoring the stems elongation.

The mean values of ADF were different ($p \leq 0.05$) between the cuts, being 16.21 in 2008, September to 19.45% in 2009, January. The lower levels of ADF occurred from June to October (C1 to C4), considered dry months. In this research seems that precipitation was the limitation factor to *A. pintoi* growth.

The CP averages oscillated ($p \leq 0.05$) from 14.68 in 2008, September to 20.69 in February, 2009. As ADF, the lower levels of CP occurred in dry months (C1 to C4). Probably the lesser growth supports the leaves accumulation, and in this part of the plant were accumulated nitrogen compounds like amino acids.

For the MM, the averages were 1.22 to 2% (Table 2), and C1 to C6 showed higher means ($p \leq 0.05$), corresponding from 2008, June to 2009, January. Probably the successive cuts can reduce the plant mineral stores in C7, C8 and C9. The lignin averages were similar in all cuts, but have to be considered the elevated variation coefficient of the methodology.

IVDMD showed mean varying from 75.18 in February, 2009 to 84.13% in 2008, September and in C1 to C5 was higher ($p \leq 0.05$) than other cuts. These values were corroborated by lower NDF means from June to October making the perennial peanut hay more degradable by ruminal fluid in these cuts.

Discussion

The meteorological data confirms the historical values described in the North of Minas Gerais1, Brazil. And can influence the tropical plant growing physiology and consequently modify the nutritional components. The DM averages ranged from 89.1 to 91.6% (Table 2) and corroborate MS values 88.70; 88.10 and 92.80% reported for perennial peanut hays.[2,7,12] Normally to be considered a hay foodstuff, it DM can be below 15% in order to avoid damage microorganisms proliferation.[10,13] Considering only the DM (Table 2) the *A. pintoi* hay can be a forage source without contamination problems, if the storage conditions were adequate.

The greatest averages of the NDF (Table 2) have been verified rainfall period with higher solar radiation incidence and elevated temperatures (Table 1), thereby contributing to greater growth of the legume and consequently favoring the stems elongation. So the stem: leaves relation increased and is reflected in fiber containing. Tropical forages develop more in rainy season; consequently can contain higher concentration of fiber in this period.[5] These results of NDF (Table 2) are close to or lower than those 43.4; 46.8; 51.60; 52.50 and 55.50% achieved in *A. pintoi* with 60, 70, 100, and 42days, respectively[1,2,7,14,15] and to the 44% obtained in *Arachis glabrata*.[16]

The mean values of ADF (Table 2) were lower than the 33.6, 28.1, 34.8, 35.8 and 30.7 described to forage legumes between 40 to 100days of age.[1,2,7,14,15] *A. pintoi* partially dehydrated and as silage presented ADF of 36.4 e 39%, respectively.[17] The ADF of 43.7, 32.9, 33.3 and 28.5% was described in forage legumes Medicago sativa, Desmodium ovalifolium, Stylosanthes guianensis and Cajanus cajan.[18] The fibers rising could be related to morphological chemical changes occurred with the growth of the plants and decrease the nutritional ideal compounds like protein and soluble carbohydrates. Increased deposition of cell wall also reduces the intake and digestibility of foodstuff, being undesirable.[15,18] So the lower content of ADF (Table 2) could indicate a good nutritive value, because when the plant accumulates cell wall the cytoplasmic area is reduced.[15]

The CP was higher ($p \leq 0.05$) in the C1 to C4 of *A. pintoi* hays (Table 2). In dry season the plants showed lower fiber content (Table 2). CP tends to elevate when the tropical plant legume grown less, because the leaves concentrate more amino acids with high biological value in consequence of the climate, as can be verified in Table 1. In same way the greater growth of the tropical forage in the summer favors the accumulation of the cell wall and CP tends to reduce.[8] So the relation stem: leaves increase in wet season and the levels of CP tend to reduce in flowering and mature plants. The CP averages (Table 2) are close to 20.80, 14.30 and 18% described to perennial peanut.[2,7,15] Several Arachis spp. genotypes show CP of 21.30 or 21.60%[3,14] and this legume silage, 21.62%.[17] When grown with different levels of fertilization and liming, CP up to 26.2% was described in *A. pintoi*[19] reinforcing that the successive cuts can decrease the protein content of the plant. Furthermore, these variations can be explained by the experimental conditions, because at the present work only one fertilization were made 40days before the first cut and it can be reflected in soil nitrogen and plant protein storages being consumed with the successive cuts.

For the MM, the averages were are lower than the 9.10; 10.90 and 10.20%.[7,14,17] The lignin average of *A. pintoi* ranged from 2.43 to 3,87% and the results are below of 7.60; 4.90 and 11.20%.[2,14,20] These variations can be explained by the different experimental methods of analyses adopted by authors, diverse cultivation practices, plant ages and other conditions as fertilization between experiments.

Even the less value of *A. pintoi* IVDMD in this experiment (Table 2) was superior to 71, 72.3 and 72.4 or 67.1, 67.7 and 67.3% in two successive cuts every 34days in the rainy season, with cutting heights of 1.0; 5.0 and 10cm, respectively.[19] Other experiment reported IVDMD between 61.2 the 67.8% obtained for the same forage.[4] *A. pintoi* and *Arachis repens* cultivated and cut at every 42days showed IVDMD of 69.30 and 70.60%.[14] The perennial peanut in situ digestibility of the DM was 83.70% in horses,[16] value that approaches to the maximum value of ruminal in vitro degradability obtained in this work (Table 2). These variations can be explained by the different methods and species used, plant ages and other experimental conditions as plant fertilization and cutting age or height.

Tropical forages have fibrous constituents negatively correlated with the digestibility,[6] in this way, the high IVDMD is related to the reduced levels NDF and ADF as exposed in Table 2. The lowest digestibility comes to thickening the cell and the thickness of the walls lignified, increasing the non digestible fiber.[8] Legumes are generally more digestible when compared to grasses, because they have less content of cell wall and a typical foliar anatomy of the three-carbon metabolic pathway (C3) species, present higher protein content and digestibility.[16] Thus, the lowest averages of the IVDMD between the C6 to C9 are justified by higher levels of the FDN (Table 2) associated to the favorable climate (Table 1) contributing to the increased growth of tropical plants, like the perennial peanut.[21]

Conclusion

The *A. pintoi* hay cultivated in a year in the North of Minas Gerais, Brazil has high content of CP, small NDF and ADF and elevated in vitro dry matter degradability. This legume can be used as an option to ruminants ensuring favorable nutritional composition and digestibility.

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Conflict of interest

Authors declare that there is no conflict of interest.

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