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Nutritional Characteristics of *Brachiaria brizantha* Cultivars Subjected to Different Intensities Cutting

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Abstract

This study evaluated the nutritional characteristics of *Brachiaria brizantha* cultivars subjected to three cutting intensities in the course of one year. The experiment was conducted at the University of Rio Verde. The experiment was performed as a randomized 3 × 3 factorial in complete block design with three replications and repeated measures in the time. Three *Brachiaria brizantha* cultivars (Marandu palisadegrass, Xaraes palisadegrass, and Piata palisadegrass), were tested at three cutting intensities (10, 20, and 30 cm sward height). The evaluations were conducted on the same plots throughout one year and during all four seasons (autumn, winter, spring, and summer). The results showed that the Piata palisadegrass had the best chemical composition compared to the Marandu palisadegrass and Xaraes palisadegrass. The management of *Brachiaria brizantha* cultivars at the lowest residual height (10 cm) affected the nutritional value of these feed grasses. Seasonality also influenced the nutritional value of these forages.

Keywords

Marandu Palisadegrass, Piata Palisadegrass, Sward Height, Xaraes Palisadegrass

1. Introduction

Pasture production capacity is intrinsically related to prevailing environmental conditions and management practices. Factors, such as temperature, light, water, and nutrients determine the photosynthetic potential of a

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plant, and management methods can influence these variables via defoliation of photosynthetic tissues in pastures [1]. Thus, pasture management in tropical grasses should aim to control flowering, reduce stem elongation, and, consequently, increase the nutritional value of the forage available to animals [2]. New cultivars are appearing every day, which are aimed towards sustainable production systems with high productivity to plant and animal given the morphological and structural limits of pastures. These cultivars are developed to meet the requirements of different production systems and promote greater forage grass diversification to meet livestock's grazing demands [3]. Thus, Xaraes palisadegrass and Piata palisadegrass have become popular forage options to meet the needs of cattle production and pasture diversification. Embrapa researchers have concluded that these grasses perform excellently in field soils of average fertility, have high re-growth rates, and stand out for their high forage production and nutritive value [4]. However, little information is available regarding their nutritional characteristics, which is common when dealing with any new cultivars. Thus, it is crucial to study the chemical composition and other aspects related to forage quality that may be affected by management, environmental conditions, and the seasons. Therefore, the objective of this study was to evaluate the nutritional characteristics of *Brachiaria brizantha* cultivars subjected to three cutting intensities throughout one year.

2. Material and Methods

The experiment was conducted on the Agronomy Campus of the University of Rio Verde (748 m altitude, 17˚48'S latitude, and 50˚55'W longitude). The total experimental area was approximately 500 m^2 with 16 m^2 for each plot. The soil was classified as Oxisol, which consisted of 600 $g \cdot kg^{-1}$ clay, 350 $g \cdot kg^{-1}$ silt, and 50 $g \cdot kg^{-1}$ sand. The chemical soil characteristics at 0 - 20 cm before planting were as follows: water pH: 4.8; Ca: 1.11 $cmol_c \cdot dm^{-3}$; Mg: 0.39 $cmol_c \cdot dm^{-3}$; Al: 0.10 $cmol_c \cdot dm^{-3}$; Al+H: 5.0 $cmol_c \cdot dm^{-3}$; K: 0.18 $cmol_c \cdot dm^{-3}$; CTC: 6.64 $cmol_c \cdot dm^{-3}$; P: 8.17 $mg \cdot dm^{-3}$; Cu: 3.7 $mg \cdot dm^{-3}$; Zn: 1.8 $mg \cdot dm^{-3}$; Fe: 83.2 mg^{-3}; and OM: 31.26 $g \cdot dm^{-3}$. The experimental area was prepared by eliminating invasive plants and applying glyphosate at a dosage of 1458 $g \cdot ha^{-1}$. Fifteen days after desiccation, 1.0 ton of lime with 95% RPTN was applied and then subsequently harrowed and leveled. At the time of sowing, 80 $kg \cdot ha^{-1}$ P_2O_5 and 20 $kg \cdot ha^{-1}$ FTE BR-12 were applied using simple superphosphate and fritted trace elements. Nine kilograms of pure viable seed per hectare of *Brachiaria brizantha* was applied during planting. The experiment was performed as a randomized 3 × 3 factorial in complete block design with three replications and repeated measures in the time. Three *Brachiaria brizantha* cultivars (Marandu palisadegrass, Xaraes palisadegrass, and Piata palisadegrass), were tested at three cutting intensities (10, 20, and 30 cm sward height). The evaluations were conducted on the same plots throughout one year and during all four seasons (autumn, winter, spring, and summer). The fertilization with nitrogen (200 kg N-ammonium sulfate) and potassium (100 kg K_2O-potassium chloride) was performed 45 days after planting, and one uniformed cutting was performed on all plots at each intensity (treatment). The application of nitrogen and potassium was divided across the four seasons and occurred after evaluating the cuttings; the first application was performed in March 2010, the second in October 2010, the third in December 2010, and the fourth in February 2011. The produced dry matter and nutritive value were evaluated during the dry and rainy seasons. We collected one 1 m^2 sample per plot from randomly placed sampling squares within each plot. The cutting process occurred at the following periods: autumn (04/2010 and 05/2010); winter (07/2010 and 09/2010); spring (10/2010, 12/2010); and summer (01/2011, 02/2011, and 03/2011). After each evaluation, the entire experimental area was uniformly cut according to the prescribed treatment height, and residues were removed of the area. The material collected in the field was packed in plastic bags and sent to the laboratory for weighing. A representative sample of approximately 500 g was then taken from each plot and placed in a forced circulation oven at 65˚**C** until a constant weight was reached for the dry weight determination. Subsequently, the samples were ground in a Willey ball mill with 1-mm sieves and stored in plastic bags to be analyzed. Chemical analyses were performed to determine dry matter (DM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), lignin, cellulose, and hemicellulose contents according to the method described by [5]. The total digestible nutrient (TDN) was obtained using the following formula, as proposed by [6]: TDN = 105.2 - 0.68 (NDF). The climatic data referring to the experimental period were obtained from the meteorological station at the University of Rio Verde. The monthly average temperature and rainfall data were monitored daily, and the results are shown in **Figure 1**.

The data were subjected to variance analyses, and the averages were compared using a Tukey's test with 5% significance. Analyses were performed by modeling the subdivided plot across time and fit to a Gauss-Markov linear model using SISVAR software [7].

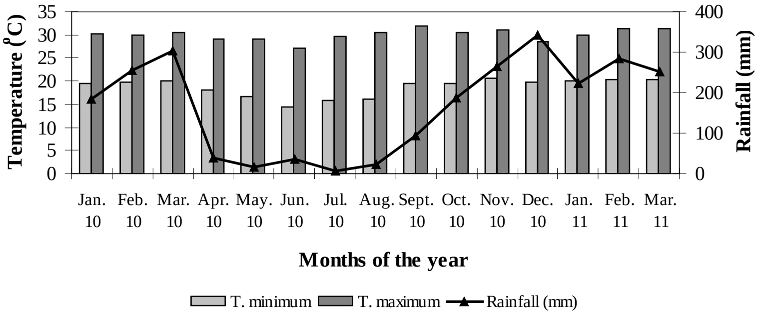

Figure 1. Maximum and minimum temperatures (˚C) and rainfall (mm) observed from January 2010 to March 2011 in Rio Verde-GO, Brasil.

3. Results and Discussion

The contents of CP, TDN NDF, ADF, lignin, cellulose and hemicellulose of the *Brachiaria brizantha* were influenced by the cutting intensity, season, and by the interaction of these factors. When the cultivars managed at different cutting intensities were analyzed, the Piata palisadegrass showed to have the highest CP content in all cutting intensities (**Table 1**). The Marandu palisadegrass and the Xaraes palisadegrass had similar contents (**Table 1**). This result was due to the greater leaf: stem ratio in the Piata palisadegrass [8] had evaluated three *Brachiaria brizantha* cultivars for a three-year period with animal production and found similar CP contents (8.8%, 8.3%, and 9.1%) for the three cultivars (Marandu palisadegrass, Piata palisadegrass, and Xaraes palisadegrass, respectively). These values were lower than those obtained in the present study. Comparing the cutting intensities within each cultivar revealed that the CP contents at cutting intensities of 20 and 30 cm sward height were similar for the Marandu palisadegrass and Piata palisadegrass; these two cultivars only differed by 10 cm in the cut height. Significant differences were found in the Xaraes palisadegrass between intensities of 10 and 30 cm; when managed at the 10 cm sward height, there was an 11% decrease in crude protein content due to the higher stem proportion, which resulted in higher tiller mortality rates.

The assessment of CP content at various cutting intensities during the different seasons (**Table 2**) revealed that the CP content was similar in summer and spring for all cutting heights but differed between the fall and winter seasons. [8] has conducted comparative studies that assessed the nutritional values of the Marandu palisadegrass, Xaraes palisadegrass, and Piata palisadegrass and found that regardless of the experimental years, the CP content was higher during the rainy season compared to the dry season. Considering both the season and cutting intensity, the summer and fall seasons had the highest CP content at 20 and 30 cm sward heights. This may be linked to the higher tiller turnover rate when the pasture was managed at those heights. In the winter, the 10 cm sward height differed from the 30 cm sward height with a 17.3% increase in CP content when the crop was managed at 30 cm. During periods of low rainfall (winter) and decreased grass growth, a different management strategy was needed to increase the proportion of green leaves in the pasture, thereby improving the nutritional value in the forage plants during this time. The reducing the deferred pasture period and nitrogen fertilization application, can contribute to increased green leaf content and a decreased stem mass (and dead material) in plants, thereby improving the nutritive value of deferred forage in some regions [9].

During the evaluated periods, the CP content of cultivars varied with the seasons (**Table 3**). For the Marandu palisadegrass, only the winter season differed from the other seasons. For the Xaraes palisadegrass and Piata palisadegrass, the CP contents were similar in the summer and spring and showed significant differences in the fall and winter seasons. The highest average CP content was obtained in the summer (13.26%) and spring (13.40%) seasons. This result was probably due to favorable climatic conditions (**Figure 1**) for herbage growth and development during these periods. However, the temperature and precipitation were limiting factors for development in the winter, which undermined the growth and new tiller formation as well as promoted pasture maturation. This result was due to the cutting that occurred at 56 days in the growth cycle and not at 28 days as in other seasons, which was in response to the seasonality of herbage production. Searches found higher CP content during the rainy season (9.7%) compared to the dry season (8.9%) [10]. **Table 3** presents an examination of the seasonal effects on each cultivar and shows that summer and spring CP contents were similar among the grasses. In the fall and winter, the Piata palisadegrass showed higher CP content than the Marandu and Xaraes by 11.3%

Table 1. TDN and CP contents of *Brachiaria brizantha* cultivars managed with different cutting intensities.

Brachiaria brizantha Cultivars	Cutting intensities		
	10 cm	20 cm	30 cm
		CP Content (%)	
Marandu palisadegrass	10.67 Bb	11.51 Ba	12.08 Ba
Xaraes palisadegrass	11.25 Bb	11.82 Bba	12.50 Ba
Piata palisadegrass	12.13 Ab	12.97 Aa	13.38 Aa
CV (%)		5.41	
		TDN Content (%)	
Marandu palisadegrass	53.63 Bb	54.81 Bb	58.60 Ba
Xaraes palisadegrass	53.22 Bc	54.74 Bb	57.87 Ba
Piata palisadegrass	57.14 Ac	59.28 Ab	61.87 Aa
CV (%)		1.96	

Averages followed by different letters, uppercase in columns (cultivars) and lowercase in rows (cutting intensity), differ significantly (Tukey's test; P < 0.05). CP = Crude protein; TDN = Total digestible nutrient.

Table 2. TDN and CP contents of *Brachiaria brizantha* cultivars managed at different cutting intensities in different seasons.

Year Seasons	Cutting intensities		
	10 cm	20 cm	30 cm
		CP Content (%)	
Summer	12.43 Ab	13.33 Aa	14.03 Aa
Autumn	11.25 Bb	12.15 Ba	12.22 Ba
Winter	8.82 Cb	9.65 Cab	10.35 Ca
Spring	12.92 Ab	13.26 Aab	14.03 Aa
CV (%)		5.27	
		TDN Content (%)	
Summer	55.34 Ab	56.76 Ab	60.50 Aa
Autumn	54.82 Bc	55.83 Ab	60.51 Aa
Winter	53.76 Cc	55.70 Ab	57.35 Ba
Spring	54.72 Bc	56.76 Ab	59.41 Aa
CV (%)		1.40	

Averages followed by different letters, uppercase in columns (season) and lowercase in rows (cutting intensity), differ significantly (Tukey's test; P < 0.05). CP = Crude protein; TDN = Total digestible nutrient.

and 9.7%, respectively. This increase in CP content for the Piata palisadegrass was likely attributed to a higher leaf: stem ratio in the Piata palisadegrass compared to the other grasses [4]. However, the CP content was above 7% even in the fall and winter, which is considered the nonrestrictive minimum for pasture use. The nutrient intake from forage with a CP content of less than 7% is due to microbial activity in the rumen, resulting in decreased processing rates and an increased alimentary retention time during digestion [11].

[12] found that the Marandu palisadegrass had a higher CP content in the summer and spring compared to the Xaraes palisadegrass during the same time period when analyzing the nutritional value of tropical herbage

Table 3. TDN and CP contents of *Brachiaria brizantha* cultivars examined during different seasons.

Year Seasons	*Brachiaria brizantha* Cultivars		
	Marandu palisadegrass	**Xaraes palisadegrass**	**Piata palisadegrass**
		CP Content (%)	
Summer	12.50 Aa	13.12 Aa	14.16 Aa
Autumn	11.11 Ab	11.73 Bb	12.78 Ba
Winter	9.23 Bb	9.37 CBb	10.21 Ca
Spring	12.85 Aa	13.19 Aa	14.17 Aa
CV (%)		6.56	
		TDN Content (%)	
Summer	55.99 Ab	55.54 Ab	61.06 Aa
Autumn	55.91 Ab	55.70 Ab	59.55 Ba
Winter	55.06 Ab	54.26 Ab	57.56 Ca
Spring	55.75 Ab	55.60 Ab	59.55 Ba
CV (%)		1.33	

Averages followed by different letters, uppercase in columns (season) and lowercase in rows (cultivars), differ significantly (Tukey's test; $P < 0.05$). CP = Crude protein; TDN = Total digestible nutrient.

grasses irrigated in different seasons. Differences were observed in the TDN content of the cultivars managed with different cutting intensities. The Piata palisadegrass had a higher TDN content compared to the Xaraes and Marandu palisadegrass at all cutting intensities (**Table 1**). However, there was no significant difference ($P > 0.05$) between the Marandu palisadegrass and Xaraes palisadegrass. When examining the cutting intensities of each cultivar (**Table 1**), the TDN content was greater at a 30 cm sward height for all cultivars. At the 10 cm sward height, 8.7% and 8.2% reductions were determined for the TDN content of Xaraes palisadegrass and Piata palisadegrass, respectively. [13] found that the TDN content ranged between 55.26% and 59.31% when studying the chemical composition of Tanzania guineagrass at three post-pasturing residue levels. These values were similar to those obtained in this study at different cutting intensities. During the evaluated periods, the TDN content at all cutting intensities varied across the seasons (**Table 2**). It appeared that only the 10 cm sward height had a significant effect ($P < 0.05$) across the seasons, with summer producing the highest TDN content. However, at cutting heights of 20 and 30 cm, the TDN content was similar across the evaluated seasons. The diet and alimentary energy value estimates are important for high-production animals, especially dairy cows, which require large amounts of energy. Diets deficient in energy can reduce milk production, causing excessive weight loss, reproductive problems, and a potential reduction in disease resistance [14]. **Table 2** showed that in all seasons studied, the highest TDN content was observed when grasses were managed at the 30 cm sward height, except in the summer, when the TDN values were similar at all sward heights. The lowest TDN content at the 10 cm cutting height was obtained in the fall, winter, and spring. These results can be attributed to low pasture regrowth due to unfavorable weather conditions after uniform cutting. The decrease may also be a result of cutting the apical buds when the pasture was managed at 10 cm, which may have hindered more vigorous re-growth. Thus, when grasses were managed at 30 cm, a higher TDN content was obtained. During the evaluated periods, the CP content in the cultivars varied by season (**Table 3**). The Marandu palisadegrass and Xaraes palisadegrass showed no significant difference ($P > 0.05$) across seasons. However, there was a significant difference ($P < 0.05$) between seasons for the Piata palisadegrass, where the lowest TDN content was obtained in the winter compared to other seasons. This was attributed to the effect of climate among other factors because the plant tends to decrease water and nutrient translocation in the shoot during a drought, thereby increasing the stem fraction with reduced grass re-growth during that period. In a study evaluating the intercropped Marandu palisadegrass production at sowing, [15] showed that the highest TDN content was obtained in the fall-winter. However, [16] found that the TDN content of Marandu palisadegrass decreased as the winter progressed. [13]

had found the highest TDN content in the spring and summer. When cultivars are assessed across seasons (**Table 3**), the TDN contents of the Marandu palisadegrass and Xaraes palisadegrass were similar in all seasons with differences observed only in Piata palisadegrass. The TDN content of Piata palisadegrass when compared to the averages of the Marandu palisadegrass and Xaraes palisadegrass was greater by 9.5%, 6.7%, 5.3%, and 6.9% in the spring, summer, autumn, and winter, respectively. Grass contains approximately 55% TDN, and changes in content are possible due to climatic conditions, soil, and plant cutting age [11]. When assessing cultivars managed at different cutting intensities, the lowest NDF and ADF contents were obtained in the Piata palisadegrass at all sward heights compared to the Marandu palisadegrass and Xaraes palisadegrass, which showed similar contents (**Table 4**). [8] obtained contrary results demonstrating that the Piata palisadegrass showed higher NDF content than the Marandu palisadegrass and Xaraes palisadegrass. When analyzing cutting intensity with each cultivar, the NDF and ADF contents were influenced by sward height (**Table 4**). The highest contents were observed at a height of 10 cm for all cultivars. This result was due to a high content of fiber when the pasture is managed at that height due to the decrease in leaf: stem ratio combined with high cell wall lignifications in the stem [17]. The average NDF content of the grasses at different cutting intensities was 74.30%, 71.93%, and 67.27% for heights of 10, 20 and 30 cm, respectively; these data showed that increasing in cutting intensities caused a reduction in the NDF content of 3.3% from a height of 10 to 20 cm and 10.5% from a height of 10 to 30 cm. This greater reduction at a height of 30 cm was expected due to the increased amount of leaves present. The NDF content is inversely proportional to diet energy density, and the NDF values above 60% are negatively correlated with forage intake [18]. The ADF content of the grasses was 35.57%, 34.06%, and 31.60% at heights of 10, 20, and 30 cm, respectively; this showed that even when cultivars were managed at a height of 10 cm, the ADF content was within the appropriate range [19], who reported that forage grasses with an ADF content of approximately 40% or more led to low consumption and lower digestibility.

The cutting intensities and seasons influenced the NDF and ADF contents (**Table 5**). At height of 10 cm, the NDF content differed in the winter ($P < 0.05$) and summer, whereas at 30 cm, only the winter differed from the other seasons. The high NDF content found in the winter can be explained by a lack of precipitation (**Figure 1**) in that period, limiting growth and new tiller formation, causing pasture maturation, and thus decreasing nutritional quality. Before the trial period, the grasses remained undisturbed for a 56-day period, which contributed to the high NDF content, where in other seasons, the cutting occurred at 28 days. The grazing can be used as a tool to open the canopy and stimulate pasture growth, which encourages the emergence of new and superior-quality tiller, provided that environmental factors like temperature, moisture content, and light are favorable [20]. The ADF content was highest at 30 cm in the winter and spring compared to the summer and autumn. However,

Table 4. NDF and ADF contents of *Brachiaria brizantha* cultivars observed at different cutting intensities.

Brachiaria brizantha Cultivars	Cutting intensities		
	10 cm	20 cm	30 cm
		NDF Content (%)	
Marandu palisadegrass	75.82 Aa	74.10 Aa	68.52 Ab
Xaraes palisadegrass	76.43 Aa	74.19 Ab	69.60 Ac
Piata palisadegrass	70.67 Ba	67.51 Bb	63.70 Bc
CV (%)		2.31	
		ADF Content (%)	
Marandu palisadegrass	36.41 Aa	35.13 Ab	32.71 Ac
Xaraes palisadegrass	36.60 Aa	34.56 Ab	32.31 Ac
Piata palisadegrass	33.70 Ba	32.46 Ba	29.80 Bb
CV (%)		3.60	

Averages followed by different letters, uppercase in columns (cultivars) and lowercase in rows (cutting height), differ significantly (Tukey's test; $P < 0.05$). NDF = Neutral detergent fiber; ADF = Acid detergent fiber.

when the grasses were managed at heights of 10 and 20 cm, the NDF and ADF contents were similar across the seasons.

During the evaluated periods, the CP content in cultivars varied with the seasons (**Table 6**). The Marandu palisadegrass showed similar NDF content across all seasons. Different results were obtained by [21], who eva-

Table 5. NDF and ADF contents of *Brachiaria brizantha* cultivars observed at different cutting intensities in different seasons.

Year Seasons	Cutting intensities		
	10 cm	**20 cm**	**30 cm**
		NDF Content (%)	
Summer	73.31 Ba	71.23 Ab	65.72 Bc
Autumn	74.07 BAa	72.60 Ab	65.71 Bc
Winter	75.63 Aa	72.68 Ab	70.35 Ac
Spring	74.22 BAa	71.22 Ab	67.32 Bc
CV (%)		1.64	
		ADF Content (%)	
Summer	34.81 Aa	34.24 Aa	30.54 Bb
Fall	35.02 Aa	33.58 Ab	30.80 Bc
Winter	36.20 Aa	34.65 Ab	32.82 Ac
Spring	36.26 Aa	33.73 Ab	32.27 Ac
CV (%)		2.31	

Averages followed by different letters, uppercase in columns (season) and lowercase in rows (cutting height), differ significantly (Tukey test; $P < 0.05$). NDF = Neutral detergent fiber; ADF = Acid detergent fiber.

Table 6. NDF and ADF contents of *Brachiaria brizantha* cultivars observed in various seasons.

Year Seasons	*Brachiaria brizantha* Cultivars		
	Marandu palisadegrass	**Xaraes palisadegrass**	**Piata palisadegrass**
		NDF Content (%)	
Summer	72.35 Aa	73.01 Ba	64.90 Cb
Autumn	72.47 Aa	72.78 Ba	67.12 Bb
Winter	73.72 Aa	74.90 Aa	70.05 Ab
Spring	72.71 Aa	72.93 Ba	67. 12 Bb
CV (%)		1.56	
		ADF Content (%)	
Summer	33.82 Ca	33.80 Ba	31.97 ABb
Autumn	34.08 CBa	34.27 Ba	31.04 Bb
Winter	35.30 Aa	35.91 Aa	32.46 Ab
Spring	35.81 Aa	33.98 Bb	32.47 Ac
CV (%)		2.87	

Averages followed by different letters, uppercase in columns (season) and lowercase in rows (cutting height), differ significantly (Tukey test; $P < 0.05$). NDF = Neutral detergent fiber; ADF = Acid detergent fiber.

luated the nutritional characteristics of Marandu palisadegrass in different seasons and found that the NDF content varied as follows (in decreasing order): spring, summer, fall, and winter. The Xaraes palisadegrass and Piata palisadegrass had higher NDF content in the winter, which differed from the other seasons that showed similar levels, except for the Piata palisadegrass, which had low NDF content in the summer. Low NDF content may improve the nutritional value of forage grasses and increase dry matter consumption by animals because NDF is an important parameter that defines forage quality and limits the ingestive capability for some animals. [16] evaluated the nutritional value of Marandu palisadegrass under grazing conditions in the winter, they found an average NDF content of 74.9%, which is similar to the values found in this study for Marandu palisadegrass and Xaraes palisadegrass in the winter. The ADF content of the Marandu palisadegrass did not differ between the winter and spring seasons; it only differed in the fall and summer, which showed the lowest content. Meanwhile, the Xaraes palisadegrass exhibited a higher ADF content in the winter, and the Piata palisadegrass exhibited a higher content in the winter and spring seasons (**Table 6**).

When comparing the seasons within each cultivar, the NDF and ADF contents of the Piata palisadegrass differed from the Marandu palisadegrass and Xaraes palisadegrass, which showed similar values in all seasons studied (**Table 6**). Among the cultivars studied, the lowest average NDF content was 67.3%, which was observed in the Piata palisadegrass. This result can be explained by the characteristic morphology of the Piata palisadegrass, which has thinner stems [4] compared to the Marandu palisadegrass and Xaraes palisadegrass. [12] evaluated the nutritional value of tropical forage grasses irrigated at different times of the year, and they found no difference ($P < 0.05$) between the fall/winter and spring/summer or between the Marandu and Xaraes cultivars. When analyzing the managed cultivars at different cutting intensities (**Table 7**), the Xaraes palisadegrass had the highest lignin content at all cutting intensities compared to the Marandu palisadegrass and Piata palisadegrass. This result was due to their morphology because they have thicker stems and, thus, have a higher lignin ratio. The Marandu palisadegrass had similar lignin contents at heights of 10 and 20 cm, with a difference observed only at a height of 30 cm. The Piata palisadegrass had the lowest lignin content at a cutting height of 30 cm,

Table 7. Lignin, cellulose, and hemicellulose contents of *Brachiaria brizantha* cultivars observed at different cutting intensities.

***Brachiaria brizantha* Cultivars**	**Cutting Intensities**		
	10 cm	**20 cm**	**30 cm**
		Lignin Content (%)	
Marandu palisadegrass	5.00 Aa	4.83 Aa	3.83 Bb
Xaraes palisadegrass	5.16 Aa	4.91 Aa	4.25 Ab
Piata palisadegrass	4.08 Ba	3.83 Ba	3.16 Cb
CV (%)		6.46	
		Cellulose Content (%)	
Marandu palisadegrass	31.17 Aa	30.41 Aa	28.97 Ab
Xaraes palisadegrass	31.39 Aa	29.67 BAb	28.07 Ac
Piata palisadegrass	29.47 Ba	28.74 Ba	26.66 Bb
CV (%)		4.08	
		Hemicellulose Content (%)	
Marandu palisadegrass	39.40 Aa	38.96 Aa	35.81 Bb
Xaraes palisadegrass	39.83 Aa	39.62 Aa	37.28 Ab
Piata palisadegrass	36.96 Ba	35.05 Bb	33.90 Cb
CV (%)		3.56	

Averages followed by different letters, uppercase in columns (cultivars) and lowercase in rows (cutting height), differ significantly (Tukey's test; $P < 0.05$).

which was a 25.1% reduction compared to the average content at heights of 10 and 20 cm. [13] studied the chemical composition of Tanzania guineagrass at three post-pasturing residue levels and found that the lignin content ranged between 3.10% and 4.68%. These percentages were similar to those obtained in this study.

Regarding the effect of cutting intensity within each cultivar (**Table 7**), it appeared that the cultivars had similar lignin contents ($P > 0.05$) at cutting intensities of 10 and 20 cm. However, when the herbages were managed at a height of 30 cm, they showed the lowest lignin content ($P < 0.05$) when compared to heights of 10 and 20 cm with a 34.5% reduction due to the higher leaf ratio with the 30 cm canopy. There was no significant effect ($P < 0.05$) of season at intensities of 10 and 20 cm when assessing the lignin contents (**Table 8**). However, for a cutting intensity of 30 cm, the highest lignin content was obtained in the winter, which differed from the other seasons. This result was due to the longer grass rest period (56 days) as explained above. In addition, there was reduced tissue renewal and increased tiller survival during this time of the year, which would explain the greater lignification. [8] studied the nutritional value *of Brachiaria brizantha* over several years at pre-pasturing levels and found similar lignin contents of 3.2%, 3.3%, and 3.6% for the Marandu palisadegrass, Piata palisadegrass, and Xaraes palisadegrass, respectively. The average lignin content was 2.9% and 3.2% in the rainy and dry seasons, respectively. As can be seen in **Table 8**, the lowest lignin content was obtained at cutting height of 30 cm in both seasons studied, which showed similar lignin content at different intensities at heights of 10 and 20 cm.

During the periods evaluated, the lignin content of the cultivars varied by season (**Table 9**) and was similar for the Marandu palisadegrass and Piata palisadegrass among all the seasons studied. Only the lignin content of the Xaraes palisadegrass differed between the summer and winter seasons. However, when comparing seasons with each cultivar, there was no significant difference in lignin content ($P > 0.05$) between the Marandu palisa-

Table 8. Lignin, cellulose, and hemicellulose contents of *Brachiaria brizantha* cultivars observed at different cutting intensities in different seasons.

Year Seasons	Cutting Intensities		
	10 cm	20 cm	30 cm
		Lignin Content (%)	
Summer	4.66 Aa	4.44 Aa	3.66 Bb
Autumn	4.77 Aa	4.55 Aa	3.56 Bb
Winter	4.67 Aa	4.66 Aa	4.22 Ab
Spring	4.77 Aa	4.44 Aa	3.44 Bb
CV (%)		4.43	
		Cellulose Content (%)	
Summer	30.06 Aa	29.94 Aa	27.01 Bb
Autumn	30.12 Aa	29.13 Aa	27.08 Bb
Winter	31.21 Aa	30.01 Ab	28.73 Ac
Spring	31.32 Aa	29.35 Ab	28.78 Ab
CV (%)		2.89	
		Hemicellulose Content (%)	
Summer	38.50 Aa	36.98 Ba	35.17 Bb
Autumn	39.05 Aa	39.01 Aa	34.91 Bb
Winter	39.43 Aa	38.03 ABab	37.53 Ab
Spring	37.95 Aa	37.48 Ba	35.05 Bb
CV (%)		3.30	

Averages followed by different letters, uppercase in columns (season) and lowercase in rows (cutting intensity), differ significantly (Tukey's test; $P < 0.05$).

Table 9. Lignin, cellulose, and hemicellulose contents of *Brachiaria brizantha* cultivars observed in different seasons.

Year Seasons	*Brachiaria brizantha* Cultivars		
	Marandu palisadegrass	Xaraes palisadegrass	Piata palisadegrass
		Lignin Content (%)	
Summer	4.55 Aa	4.66 Ba	3.55 Ab
Autumn	4.55 Aa	4.77 ABa	3.66 Ab
Winter	4.66 Ab	5.11 Aa	3.88 Ac
Spring	4.44 Aa	4.55 Ba	3.66 Ab
CV (%)		6.46	
		Cellulose Content (%)	
Summer	29.33 Ba	29.16 Ba	28.53 ABa
Autumn	29.61 Ba	29.44 Ba	27.28 Bb
Winter	31.26 Aa	30.89 Aa	28.52 ABb
Spring	30.54 Ba	29.35 Bb	28.84 Ab
CV (%)		3.27	
		Hemicellulose Content (%)	
Summer	38.53 Aa	39.21 Aa	32.92 Cb
Fall	38.38 Aa	38.51 Aa	36.07 Ab
Winter	38.42 Aa	38.98 Aa	37.58 Aa
Spring	36.90 Bb	38.94 Aa	34.64 Cc
CV (%)		4.17	

Averages followed by different letters, uppercase in columns (season) and lowercase in rows (cultivars), differ significantly (Tukey's test; $P < 0.05$).

degrass and Xaraes palisadegrass in the summer, fall or spring (**Table 9**); the Piata palisadegrass showed the only difference with the lowest content (3.68%) averaged across seasons. Low lignin content is important because lignin is not a carbohydrate but rather an amorphous polymer that has a phenylpropanoid structure and is considered indigestible and inhibitory to plant digestibility [22].

There were differences in cellulose content when managed cultivars were compared across cutting intensities (**Table 7**). The Marandu palisadegrass and Xaraes palisadegrass showed similar levels of cellulose at heights of 10 and 30 cm, while the Piata palisadegrass showed the lowest content. At a height of 20 cm, there was a significant difference among the Marandu palisadegrass and Piata palisadegrass, where Piata palisadegrass had a 5.8% lower cellulose content compared to the Marandu palisadegrass. This reduction was important because the, cellulose represents the largest portion of the cell wall structure with nutrient availability varying between indigestible and completely digestible contents and depends on the degree of lignification [11]. The leaf blades of the Xaraes palisadegrass have higher cellulose content than those of the Marandu palisadegrass, which could be due to the arrangement and pattern of the cell wall lignification [23]. Analyzing the cellulose content across cutting intensities with each cultivar, the 10 and 20 cm cutting heights for the Marandu palisadegrass and Piata palisadegrass showed similar levels and differed only at 30 cm. A different behavior was observed for the Xaraes palisadegrass, where all cutting intensities affected the cellulose content (**Table 7**). When the grasses were managed at 30 cm, there was a 9.9% and 3.6% reduction in the average cellulose content when comparing 10 cm and 30 cm and 10 cm and 20 cm heights, respectively. There was no significant effect ($P < 0.05$) of seasons on the cellulose contents studied at heights of 10 and 20 cm (**Table 8**). However, the highest cellulose content was obtained in the winter for a cutting intensity of 30 cm, which differed from other seasons. The results obtained for cutting intensities with regards to each season are presented in **Table 8**. There were similarities in cellulose content between the summer and fall seasons at 10 and 20 cm intensities, and differing values ($P < 0.05$) were obtained only at the 30 cm height. Moreover, significant effects at all intensities were observed in the winter and spring seasons with a lower content at 30 cm. Across all seasons and cutting intensities, the cellulose contents ranged from 20% to 40% DM as reported by [11] for tropical forage grasses. Of the seasons evaluated, the cellulose content of the cultivars was only influenced in the winter (**Table 9**), which provided the highest contents in all cultivars. However, when considering the cultivars at each season, no significant difference ($P < 0.05$) was observed for any cultivars analyzed in the summer, and the same trend was observed in the fall and winter seasons for the Marandu palisadegrass and Xaraes palisadegrass. Only the Piata palisadegrass differed ($P < 0.05$) from other cultivars in the fall, winter, and spring seasons, exhibiting the lowest cellulose content (**Table 9**). Comparing the *Brachiaria brizantha* cultivars within each cutting intensity, **Table 7** shows that the hemicellulose contents of the Marandu palisadegrass and Xaraes palisadegrass were similar at cutting intensities of 10 and 20 cm and differed only in the Piata palisadegrass, which had the lowest content. However, the Xaraes palisadegrass had the highest hemicellulose content at the 30 cm cutting intensity with values 4.1% and 9.9% greater than the Marandu palisadegrass and Piata palisadegrass, respectively. The Marandu palisadegrass and Xaraes palisadegrass showed no significant difference at cutting intensities of 10 and 20 cm (**Table 7**). The Piata palisadegrass differed at all cutting intensities with lower contents at 30 cm. For different seasons at each cutting intensities (**Table 8**), the hemicellulose content was similar between seasons at height of 10 cm. At a height of 20 cm, the fall and winter seasons were different from the summer and spring. At a height of 30 cm, the hemicellulose content was influenced only in the winter. As for cutting the intensities within each season there is a significant difference for the content of hemicellulose to the intensity of cut of 30 cm compared the intensity of 10 and 20 cm for all seasons (**Table 8**). The hemicellulose content differed in the Marandu palisadegrass only in the spring, and the Piata palisadegrass exhibited a significant effect in the summer and spring compared to the fall and winter (**Table 9**). Finally, the hemicellulose content of the Xaraes palisadegrass was not affected in any season. Across the seasons, the hemicellulose content was similar for the Marandu palisadegrass and Xaraes palisadegrass in the summer and fall, with a difference observed only in the Piata palisadegrass (**Table 9**). There was no significant difference among the cultivars in spring, where the lowest content was reached for the Piata palisadegrass. However, the hemicellulose content was similar among all the grasses in winte.

4. Conclusion

The results showed that the Piata palisadegrass had the best chemical composition compared to the Marandu palisadegrass and Xaraes palisadegrass. The management of *Brachiaria brizantha* cultivars with the lowest residual height (10 cm) affected the nutritional value of these grasses. The seasonality also influenced the nutritional value of these forages.

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