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Influence of the time of the year on the nutritional value of forage consumed by beef cattle raised on grassland

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Abstract. Due to the large territorial dimension used for the practice of livestock activity, Brazil has several pasture ecosystems, in which animals are subjected to different management conditions during their productive life. In this scenario, tropical forages present high production of dry mass, with marked seasonality between the “water”, “drought” and transition seasons. The objective of this work is to carry out a literature review on the interference of the time of year on the nutritional value of forages consumed by beef cattle raised on pasture. Seasonality determines the uneven distribution of forage production throughout the year, causing quantitative and qualitative changes in the chemical composition of pastures, resulting in lower quantity and quality in periods with lower rainfall. As the plant matures, the levels of crude protein, minerals and other components of the cellular content decrease, while those of the cell wall tend to increase, interfering with the digestibility of nutrients in the food. This digestibility will mainly determine the availability of nitrogen compounds in the rumen for microbial growth, as well as the availability of amino acids that reach the small intestine influencing the growth of animals. In this way, the pasture supplementation technique, associated with the deferral of pasture, presents itself as an alternative to low production and forage quality at critical times of production, making it possible to obtain adequate weight gain of the animals at different times of the year, resulting in efficient and sustainable animal production.
Keywords: Digestibility, seasonality, tropical forages, protein-energy supplementation

Introduction

Due to the large territorial dimension used for the practice of livestock activity, Brazil has several pasture ecosystems, in which animals are subjected to different management conditions during their productive life within a given environment. Paulino et al. (2003), highlights that beef production systems in Brazil have the common factor of using pastures as a basic roughage, constituting up to 99.0% of the diet of beef cattle.

The pastures represent the main source of nutrients for the feeding of Brazilian herds, being the majority formed by grasses. The pastoral fields represent 3.0 billion hectares in the world, practically 20% of the surface of the terrestrial globe (GUERRA FILHO, 2012). Given the large production of grasses, Brazil is characterized as one of the countries with the greatest potential for livestock production under grazing, mainly determined by climatic conditions and vast territorial extension (SERAFIM and GALBIATTI, 2012).

As the physiological age of the plant advances, it leads to an increase in the percentages of cellulose, hemicellulose and lignin, reducing the proportion of soluble carbohydrates, proteins, minerals and vitamins (potentially digestible nutrients) contributing to lower animal performance, caused by the sharp drop in food digestibility. (REIS et al. 2005).

During the rainy season, due to the high availability and nutritional value of the forage, satisfactory performance of the animals is observed. However, in the dry season, there is a reduction in weight gain, and even weight loss of the animals due to the reduction in the nutritional value of the roughage available for grazing (MAGALHÃES et al. 2012), making it the critical season for the production of beef cattle.

Between the rainy season and the dry season, there is a transition period between dry-water and dry-water, in which few works are found characterizing the chemical composition of the available forage, making it essential to study its nutritional composition during all periods, to provide satisfactory productive and reproductive performance of animals raised in a grazing system (FERNANDES, 2016).

In this context, it is important to know the nutritional characteristics of forage plants during the different seasons of the year in order to determine the correct management, since these are the main sources of roughage for cattle raised on pasture. Therefore, the objective was to carry out a literature review of the influence of the time of year on the nutritional value of forage available for beef cattle raised on pasture.

Contextualization and Analysis

Characterization of bulky foods

The correct feeding management of beef cattle is one of the main responsible for their development, reproduction, increase in productivity and meat quality, needing to be carefully planned, due to the cost of feeding, in some cases, reaching up to 70% to 80% of the total cost. The choice of food must first consider their quality, regardless of the rearing system adopted.

Forage foods from a tropical climate change their composition and nutritional value according to the time of year, with the advance of the physiological state and the maturity of the plant. Therefore, it is necessary to know the qualitative characteristics of the food to balance a ration with all the necessary nutrients and at a lower cost.

Bulky foods – are classified as low-energy foods, with high fiber or water content. They have less than 60% of NDT and/or more than 18% of crude fiber (FB), divided into dry and wet. The most used for cattle are natural or cultivated pastures, grass, silage, sugar cane, crop residues, agro-industrial residues, husks, cobs and others.

Pasture represents most of the bulky food consumed by beef cattle on grazing, most of which is formed by varieties of the genera Panicum and Urochloa (*Brachiaria*). According to Euclides et al. (2008), it is estimated that 50% of the cultivated pastures in the Midwest region and 65% in the North region are formed by Urochloa brizantha cv. Marandu (*Brachiaria brizantha*).

This cultivar stands out in the national scenario for presenting high production of dry matter in soils whose fertility varies from medium to low, being characterized as an important source of roughage for ruminants, making it essential to collect information on the factors that interfere in its production and quality, which will be described in the course of this work.

Forage available for grazing

Pastures represent one of the largest and most important ecosystems in Brazil. They are characterized by varying levels of complexity, ranging from native pastures, where several species and categories of forage plants coexist, to cultivated pastures, normally composed of introduced, selected or improved forage plants (DA SILVA et al. 2008).

Natural pastures in certain situations can be an option for feeding the herds, however, as production systems seek to become more and more efficient, the introduction of more productive forage plants, which allow for an increase in pasture productivity and, consequently, the stocking rate has become an important production tool (ALMEIDA, 2014). Through the use of more productive varieties, surplus production may occur in periods of favorable weather conditions, such as the rainy season, which can be used for hay and silage production (ARAÚJO FILHO, 2015).

According to Araújo Filho (2015), the forage plants most used in the pasture ecosystem in Brazil are grasses and legumes, characterized as: where we can mention Pannisetum, Panicum, Cynodon and Brachiaria (Table 1). They are perennial plants, that is, they are capable of sprouting after cutting and/or grazing, and forage legumes, which have C3 metabolism, and may present low growth like Arachis pinto, shrubs and trees.

As can be seen in the table above, there is a great diversity of genera and cultivars of forage grasses available in the market, where the use of each one will depend on the region where it will be implanted, the technological level used and the management practices adopted. When properly implemented and managed, it makes it possible to increase the production of dry matter per hectare, consequently there is an increase in the stocking rate and in the weight gain of the animals, making the production system more sustainable.

Table 1. Main forage grasses used in the production of beef cattle in grazing.

Genus	Plant	Growth Habit
Brachiaria brizantha	Marandu Piatã Xaraes MG4	Cespitose
Brachiaria Decumbens	Basilisk	Decumbent
Brachiaria Humidicula	Llanero Tupi Comum kennedy	Stoloniferous
Panicum maximum	Tanzânia Mombaça Tobiatã Colonião Massai Aruana	Cespitose
Cynodon dactylon	Tifton 44 Tifton 78 Tifton 85 Florakirk Coastcross-1 Jiggs Vaquero	Stoloniferous and rhizomatous
Cynodon nlemfuensis	Tifton 68 Florico Florona	Stoloniferous and not rhizomatous

Source: Machado et al. (2010).

Influence of time of year on pasture nutritional composition

Tropical forages have high production, with marked seasonality between the "water" and "dry" seasons. This seasonality determines uneven distribution of production throughout the year (EVANGELISTA et al. 2004), affecting the beef cattle system on pasture. In the Center-West region of Brazil, in addition to the wet and dry periods, there is a transition period between them, which have a different chemical composition of the forage, being characterized as seasons: wet, wet-drought transition, dry season and dry-water transition.

These different periods cause a change in the plant, resulting in lower quality in periods where there is low rainfall. In addition, most tropical forages have a high percentage of cell wall and low cell content (PRADO, 2007). The cellular content, represented by the soluble fraction, has about 100% digestibility. The cell wall, formed by the insoluble fraction, has a lower degradation potential, being resistant to the attack of enzymes from the ruminant gastrointestinal tract (SILVA and QUEIROZ, 2002). In the case of animal production, neutral and acid detergent fiber (NDF and ADF) can be used to predict forage intake and digestibility. The NDF is related to the rumen filling effect and inversely to the energy concentration of the cattle diet (BERCHIELLI et al. 2006) being basically composed of cellulose, lignin and hemicellulose, thus high levels of this fraction contained in the dry matter indicate greater thickening of the cell wall, and lower contents of digestible nutrients such as protein, lipids, vitamins, among others present in the cellular content.

The digestibility of organic matter (OM) is another factor that has a high correlation with voluntary consumption, as it will facilitate the process of degradation and passage of forage through the digestive tract. Low digestibility implies longer forage retention time in the rumen, promoting physical consumption limitations. In tropical grasses, the development of stems favors a rapid increase in dry matter production, but, on the other hand, it can have negative effects on the use and nutritional value of the forage produced, altering the ingestive behavior and forage consumption of animals grazing (FERNANDES, 2016).

As a result of the development of the forage plant, there is an increase in fiber content, especially with the beginning of the reproductive stage, contributing to a reduction in the content of protein and soluble carbohydrates. Queiroz (2007) observed a reduction in protein concentration and an increase in fiber content, reduction in digestibility when marandu grass was harvested with 60 days of regrowth instead of 30 days.

The level of ruminal degradability of pasture protein becomes variable between different seasons. This degradability will determine the availability of nitrogenous compounds in the rumen for microbial growth, as well as the availability of amino acids that reach the small intestine, from the synthesis of microbial protein and the undegraded protein fraction in the rumen.

When analyzing forage crude protein (CP) fractions, higher values of fractions A: non-protein nitrogen, B2: true protein (intermediate degradation) and B3: protein of slow degradation, associated with fiber (Cornell System). Different proportions of these fractions generate different amounts of degradable protein in the rumen, because each fraction has a specific degradation rate (SNIFFEN et al. 1992), with its proportions changing according to the season.

During the dry-water transition period, the forage begins to resprout, where the shoots are tender and with greater amounts of non-protein nitrogen (fraction A), requiring adequate management of the animals before this period, so that the old material is consumed (senescent), because with regrowth the animals tend to stop consuming remaining material and feed only on new material, making it difficult to restore the plant stand.

During the rainy season, the forage shows an intense growth, with greater digestibility, containing enough nutrients to promote the adequate growth of the animals. As the forage matures and the amount of senescent and dead material increases, characterized by the transition from dry water, the animals tend to reduce consumption, with a consequent reduction in weight gain, as the pasture reduces the quality, reducing the digestibility and occurs mainly, the reduction in the protein content and increase in the concentration of indigestible neutral detergent fiber (NDFi).

During the dry season, forage growth is interrupted due to reduced or no precipitation, resulting in low quality forage, with an increase in indigestible materials, such as lignin, which cannot be digested by ruminal microorganisms, reducing precursors to correct multiplication and ruminal microbial growth, reducing animal performance.

De acordo com Dove (1998) durante o período seco do ano, ocorre aumento dos teores de celulose, hemicelulose e lignina, tornando a forragem mais resistente, ocorrendo aumento nas ligações entre celulose e lignina, tendo como consequência para o animal, mais dificuldades na mastigação, ruminação e fermentação pelos microrganismos ruminais.

Admittedly, lignin is a key element that limits the digestibility of NDF, but, according to Jung and Allen (1995), the cross-linking between lignin and cell wall polysaccharides, notably hemicellulose, and ferrulic acid are prerequisites for the occurrence of this activity. It is made. Thus, the composition of lignin influences its impact on digestibility and consumption, and indicates the need for qualitative discrimination for its more effective use in prediction models of digestion and consumption (OLIVEIRA et al. 2011).

The efficiency of forage production is directly related to the prevailing environmental conditions in the area and the management practices adopted. Thus, factors such as temperature, light, water and nutrients condition the photosynthetic potential of the canopy, as a result of changes in the leaf area and in the photosynthetic ability of the plant (MARCELINO et al. 2006). In plants with C4 metabolism, there is evidence that the assimilation and absorption of nitrate are strongly reduced when there is little or no precipitation (BECKER and FOCK, 1986; FOYER et al. 1998).

Table 2. Pasture chemical composition at different times of the year.

Author	Time of the year	Species	Bromatological Composition (%)					
			DM	OM	CP	NDF	ADF	NFC
De Paula, et al. (2019)	Dry	*B. Decumbens*	28.68	90.19	7.99	56.97	-	24.64
De Paula et al. (2019)	Dry-waters	*B. Decumbens*	30.64	91.22	8.10	60.05	-	22.44
De Paula, et al. (2019)	Waters	*B. Decumbens*	24.74	92.52	11.15	53.79	-	26.55
De Paula, et al. (2019)	Dry-waters	*B. Decumbens*	28.24	91.00	10.09	55.84	-	24.06
Fernandes, (2016)	Dry	*B. Brizantha*	-	91.12	5.14	70.39	41.58	13.43
Fernandes, (2016)	Dry-waters	*B. Brizantha*	-	91.02	8.99	67.58	38.45	13.43
Fernandes, (2016)	Waters	*B. Brizantha*	-	91.45	9.59	68.34	36.99	20.30
Fernandes, (2016)	Waters-dry	*B. Brizantha*	-	91.25	8.77	67.29	37.95	17.83
Figueiredo et al. (2011)	Waters	*B. Decumbens*	28.39	90.54	10.10	70.49	-	8.37
Lopes et al. (2017)	Waters-dry	*B. Decumbens*	28.00	90.30	8.40	65.80	-	15.20
Sales et al. (2011)	Dry-waters	*B. Decumbens*	-	89.29	9.95	63.05	-	15.26
Ortega et al. (2016)	Dry-waters	*B. Decumbens*	25.46	92.07	10.71	54.80	-	24.46
Dias et al. (2015)	Waters	*B. Brizantha*	24.81	92.11	12.20	67.52	35.84	10.22
Neves et al. (2018)	Dry	*B. Brizantha*	27.01	89.20	7.26	65.96	-	13.99

DM = dry matter; OM = Organic matter; CP = Crude protein; NDF = Neutral detergent fiber; ADF= Acid detergent fiber; NFC = Non-Fibrous Carbohydrates

Underwater stress, nitrate reductase is not very active and photosynthesis is reduced due to stomatal closure (Kaiser and Huber, 2001). Thus, the intense dehydration of the mesophyll decreases the photosynthetic capacity of the leaves, reducing the influx of nitrate, reducing the activity of the enzyme, which is highly dependent on its substrate. In addition to contributing energy to nitrate reduction, photosynthesis contributes to the reduction of nitrite in leaves, as it is dependent on electrons via ferredoxin. The sensible reduction in the activity of the nitrate reductase in leaves observed in water stress results from the damage to the photosynthetic activity of the leaves and the reduction of the influx of nitrate. This can explain the drop in protein content during the dry season of the year (MARQUES da SILVA and ARRABAÇA, 2004; CARMO-SILVA et al. 2007; GHANNOUM, 2009).

Through some studies available in the literature, it is possible to verify the influence of the time of year on the nutritional composition of forage consumed by beef cattle raised in a pasture system (Table 2).

Strategies to circumvent the seasonality of production and quality of forage plants

The voluntary intake of pasture by the animal is influenced by the quantity and quality of forage offered, that is, the greater the possibility of the animal selecting materials with higher digestible proportions, the greater its weight gain, however, when there is a greater amount of indigestible constituent in the forage its consumption will be reduced decreasing the performance, this is observed in the dry period of the year when there are severe alterations in the constituents of the plants.

According to Fernandes (2016), in his study, the ADF of marandu grass showed the highest value in the dry season of the year (41.58%) and the lowest value in the wet season (36.99%), which is one of the important constituents of the plant. which directly affects its use by cattle in a grazing system, according to Nussio et al. (1998), pastures with ADF values around 40% or more provide low intake and digestibility.

The provision of limiting essential substrates via protein-energy supplementation helps to overcome this problem, accelerating the degradability of the B2 fraction and increasing the rate of passage of the C fraction of the forage, with positive effects on consumption and consequently on the performance of the animals. (MORAES et al. 2006).

Forage intake is a function of both nutritional aspects (chemical composition) and non-nutritional aspects (structural characteristics of the pasture) which directly influence animal performance. In order to express this interrelation more precisely, Paulino et al. (2004) developed the concept of potentially digestible dry matter (DMpd), which constitutes an integrative measure of the qualitative and quantitative aspects of the pasture, and thus, will allow a more accurate assessment of the carrying capacity and performance of the animals in the area used (PAULINO et al. al. 2008).

One of the strategies that can be used on properties to increase DMpd and make it available for consumption in periods of low or no forage growth is the sealing of grazing during the period of greater rainfall. However, the deferral management of pastures causes changes in the plant, such as the elongation of the stems, flowering and reduction of the proportion of green leaves, directly implying the nutritional value of the forage (SANTOS et al. 2010).

The pasture supplementation technique, associated with pasture deferral, presents itself as another alternative to low forage production and quality in critical periods of production. According to Detmann et al. (2014), regardless of the time of year, for latent energy to be available to ruminants, a minimum concentration of 13.0 mg ammonia nitrogen per dL of ruminal content is required, conditions that are necessary for ruminal microorganisms to efficiently degrade the fiber from forage.

Lima et al. (2012), evaluated protein supplementation (mineral salt with urea – control (offered ad libitum); protein salt (0.2% BW)); protein-energy supplement (0.3% BW); and protein-energy supplement (0. 5% BW) on consumption and performance of steers reared on deferred pastures of Brachiaria brizantha cv. Piatã grass during the dry-water transition period. According to the authors, protein supplementation was highly relevant on animal performance in pastures, notably at the end of the transition period, when the CP content declined from 9.4% (April) to 4.1% (June). The supplements used did not reduce the dry matter (DM) intake of the forage, and promoted an effect additive on total DM intake.

Zervoudakis et al. (2011) claim that the objective of supplementation with levels below 0.5% BW is to provide nutrients that are in deficit in tropical forages such as protein, whereas supplementation with higher levels of supply (above 0.5% BW) tends to replace some pasture DM consumed by supplement DM. This substitution can become interesting in situations where an increase in stocking rate is prioritized, with an increase in gain per area, or in situations where there is low forage availability. According to Figueiras et al. (2015) the main effects of supplementation focus on the increase in the balance of nitrogen compounds and the efficiency of nitrogen (N) use as a possible reflection of improvements in the N status in the animal organism. According to Hennessy and Nolan (1988), when the animal is fed a diet deficient in N, it tends to reduce the excretion of this compound, and increases the recycling to the rumen. However, if this condition worsens, it will perform tissue mobilization to support this recycled mass (RUFINO, 2011).

In this way, the N available for animal metabolism would be used for multiple metabolic functions that follow a priority order for ruminant animals, such as: survival (N recycling), maintenance and production (growth, milk production, reproduction). So, the deposition of N as tissues or body products only occurs after the demands of higher priorities are met (DETMANN et al. 2014).

In a food situation where there is no dietary deficiency in CP, a possibility with the use of concentrated supplementation, the amount of nitrogen recycled to the rumen environment tends to remain relatively constant (REYNOLDS and KRISTENSEN, 2008), providing greater deposition of N in the form of nitrogen in muscle tissue, because, according to Paulino et al. (2006), the greater retention by the animal can be attributed to an improvement in NDF digestion with increases in CP levels, favoring greater use of DMpd from the pasture.

The adoption of these alternatives is of paramount importance in the production of beef cattle on pasture, because with them, it is possible to provide the correct growth of the animals even in critical times of production. This situation is favored by the supply of extra nutrients that only with exclusive pasture consumption would not be possible to meet the nutritional requirements.

Final considerations

There is a great possibility of success in the production of beef cattle on pasture, however, high productivity forages associated with proper management must be used, providing forage plants with a suitable environment for their development. In addition, with the deferred grazing technique combined with the use of food supplementation, it is possible to obtain adequate weight gain of the animals at different times of the year, resulting in efficient and sustainable animal production.

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