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Chemical composition of Phasey Bean (*Macroptilium Lathyroides* (L.) Urb.)

Composição química do Feijão-dos-Arrozais (*Macroptilium lathyroides* (L.) Urb.)

Composición química del Frijol de los Arrozales (*Macroptilium lathyroides* (L.) Urb.)

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Abstract

The objective of the study was to determine the chimical composition of phasey bean throughout the productive cycle. The experiment was carried out in the municipality of Capão do Leão – RS, physiographic south coast region of Rio Grande do Sul. At 45 days after the emergence of the plants, the first cut of the forage evaluation was performed and, at intervals of 15 days, another nine cuts were made, all 5 cm from the soil. The treatments corresponded to different evaluation dates of Macroptilium in free growth in an experiment with ten treatments and three replicates in a completely randomized design. The variables studied were neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), crude protein (PB), total lipids (TL), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg). The results were submitted to analysis of variance and polynomial regression. All variables presented significance (P≤0.05) for cubic regressions, with mean values of: NDF = 58.15; FDA = 38.94; ADL = 9.15; PB = 11.59; TL = 1.18% e; P = 2.29; K = 10.19; Ca = 26.48 and Mg = 4.53 g / kg DM; similar to other hot-legged forage legumes. The bromatological quality of the *Macroptilium lathyroides* varied during the productive cycle, being directly influenced by the habit of indeterminate growth of the species. From the bromatological quality, the forage of the first growth of the *Macroptilium lathyroides* should be harvested up to 75 days after emergence, when the lower fiber and lignin contents associated with higher levels of crude protein, lipids, magnesium, and calcium.

Keywords: Forage legume; Murray phasey bean; Nutritive value; Wild pea bean.

Resumo

O objetivo do estudo foi determinar a composição química do Feijão-dos-Arrozais (*Macroptilium lathyroides* (L.)) Urb. ao longo do ciclo produtivo. O experimento foi realizado no município do Capão do Leão - RS região fisiografia Litoral Sul do Rio Grande do Sul. Aos 45 dias após a emergência das plantas realizou-se o primeiro corte de avaliação da forragem e, com intervalos de 15 dias, foram realizados outros nove cortes, todos a 5 cm do solo. Os tratamentos corresponderam a diferentes datas de avaliação do Macroptilium em crescimento livre, constituindo um experimento com dez tratamentos e três repetições em delineamento inteiramente casualizado. Foram determinados os valores de fibra em detergente neutro (FDN), fibra em detergente ácido (FDA), lignina em detergente ácido (LDA), proteína bruta (PB), lipídios totais (LT), fósforo (P), potássio (K), cálcio (Ca) e magnésio (Mg). Os resultados foram submetidos à análise de variância e regressão polinomial. Todas as variáveis apresentaram significância para regressões cúbicas, com valores médios de: FDN= 58,15; FDA= 38,94; LDA= 9,15; PB= 11,59; LT= 1,18% e; P= 2,29; K= 10,19; Ca= 26,48 e Mg= 4,53 g/kg de MS; semelhantes a outras leguminosas forrageiras de clima quente. A qualidade química do feijão-dos-arrozais variou ao longo do ciclo produtivo, sendo diretamente influenciada pelo hábito de crescimento indeterminado da espécie. Do ponto de vista da qualidade química, a forragem do primeiro crescimento do feijão-dos-arrozais deve ser colhida até 75 dias após a emergência, período em que se conjugam menores teores de fibras e lignina associados a maiores teores de proteína bruta, lipídios, magnésio e cálcio.

Palavras-chave: Feijão-de-pomba; Feijão-de-rola; Feijão-de-campo; Leguminosa forrageira; Valor nutritivo.

Resumen

El objetivo del estudio fue determinar la composición química del frijol de los arrozales (*Macroptilium lathyroides* (L.)) Urb. a lo largo del ciclo productivo. El experimento fue realizado en el municipio de Capão do Leão - RS, región fisiográfíca Litoral Sur de Rio Grande do Sul. A los 45 días después de la emergencia de las plantas se realizó el primer corte de evaluación del forraje y, a intervalos de 15 días, fueron realizados otros nueve cortes, todos a 5 cm del suelo. Los tratamientos correspondieron a diferentes fechas de evaluación de Macroptilium en libre crecimiento. Se estableció un experimento con diez tratamientos y tres repeticiones en un diseño completamente al azar. Fueron determinados los valores de fibra detergente neutra (FDN), fibra detergente ácida (FDA), lignina detergente ácida (LDA), proteína bruta (PB), lípidos totales (LT), fósforo (P), potasio (K), calcio (Ca) y magnesio (Mg). Los resultados fueron sometidos a análisis de varianza y regresión polinomial. Todas las variables mostraron diferencias significativas para las regresiones cúbicas, con valores promedios de: FDN = 58,15; FDA = 38,94; LDA = 9,15; PB = 11,59; LT = 1,18% y; P = 2,29; K = 10,19; Ca = 26,48 y Mg = 4,53 g/kg de MS; similares a otras leguminosas forrajeras de clima cálido. La calidad química del frijol de arroz varió a lo largo del ciclo productivo, siendo directamente influenciada por el hábito de crecimiento indeterminado de la especie. Desde el punto de vista de la calidad química, el forraje del primer crecimiento del frijol de arroz debe ser cosechada hasta 75 días después de la emergencia, período en el que se combinan menores tenores de fibra y lignina asociados con mayores tenores de proteína bruta, lípidos, magnesio y calcio.

Palabras clave: Frijolillo; Habichuela parada; Frijol de Monte; Pico de aura; Leguminosa forrajera; Maribari; Porotillo; Valor nutritivo; Verdechaco.

1. Introduction

In pasture ruminant production systems, forage plants are the food base of animals and play a vital role in the profitability and sustainability of production. Summer grasses, despite their rapid growth and high forage production, usually have a lower quality than winter grasses, so that the animals' performance is below their potential (Kröning et al., 2017). In this context, the practice of introducing legumes into pastures is recognized as important, which in addition to playing an essential role in the physical and chemical characteristics of the soil, significantly improves the quality of the forage offered (Alonzo et al., 2017).

Among the possible legumes to be used in the warm season is the phasey bean (*Macroptilium lathyroides* (L.) Urb.), a species that stands out because it adapts to the conditions of hydromorphic soils with low pH and fertility. It is an annual or biannual plant, with the habit of indeterminate growth and successive blooms, a height of 60 to 80 cm, stems erect that, growing along with tall grasses, can acquire the habit of winding and reach 150 cm of height. It presents regeneration by soil seed bank and in favorable climatic conditions manifests more than one flowering wave. In addition to being cited for its forage quality, it is highlighted as an improvement of the productive capacity of the soils, through the supply of organic matter and biological nitrogen fixation is also used as green fertilization (Ferreira et al., 2003; Ferreira et al., 2004; Monks et al., 2006; Heuzé et al., 2015; Prabhukumar et al., 2016; Tobisa et al., 2019).

Based on discussed characteristics and the results already obtained in research programs, we can notice a growing interest in forage quality of such specie. However, according to Heuzé et al. (2015), information about the chemical composition of phasey bean forage is very scarce. Thus, the objective of the study was to determine the chemical composition of phasey bean (*Macroptilium lathyroides* (L.) Urb.) along its crop cycle.

2. Methodology

The present study is a quantitative investigation (Pereira et al, 2018) conducted at the Palma Agricultural Center, Federal University of Pelotas (UFPEL), Capão do Leão, Rio Grande do Sul State, Brazil, geographical coordinates 31° 52′ S and 52° 29′ W and altitude 13.24 m.

The region climate is Cfa according to the Köppen classification, and the experimental area soil is classified as Planossolo Háplico solódico eutrophic. Presents medium depth, poor drainage, low porosity, and impermeable B-horizon. Soils are used for irrigated rice or soybean, in rotation with pastures. Chemical analysis the soil presented: Clay = 200 g dm³; pH (H2O) = 6.5; pH (SMP - Shoemaker-McLean-Pratt) = 6.8; OM = 31.4 g dm³; P-Mehlich =

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9.5 mg dm^3; K = 26 mg dm^3; Na = 29 mg dm^3; Al = 0.01cmolc dm^3; Ca = 0.5 cmolc dm^3; Mg = 3.1 cmolc dm^3.

The soil was prepared with plowing and tillering, and fertilization was carried out 15 days before seeding, as recommended by CQFS RS/SC (2004) for warm season forage legumes. Thus, fertilization was100 kg/ha of P2O5 and 90 kg/ha of K2O.

The seeds of phasey bean (*Macroptilium lathyroides* (L.) Urb.) were manually scarified with thick sandpaper and inoculated with specific rhizobium. After they were sown in lines at a density of 3.0 kg/ha viable seeds, in plots of 8 m2. The area of 5.6 m2 had seven lines with 2.0 m spaced 0.40 m.

At 45 days after plant emergence the first crop evaluation was performed. After this, another nine cuts were realized at 15-day intervals (Table 1), at 5 cm from the soil and at a sample of 0.25 m2, closing the experiment at 180 after the emergence of the plants. The treatments corresponded to different evaluation dates of *Macroptilium lathyroides* in free growth. It is an experiment with ten treatments and three replicates in a completely randomized design.

Table 1 – Date and thermal accumulation of the emergence at the first cut (45 days) and between *Macroptilium lathyroides* cuts throughout the production cycle.

D.A.E.	45	60	75	90	105	120	135	150	165	180
Date	17/01	01/02	16/02	02/03	17/03	01/04	16/04	01/05	16/05	31/05
TA (ºC)	1034,7	335,5	349,5	331,3	354,1	346,6	298,4	259,1	202,8	242,4

DAE: Days After Emergence; TA: Thermal Accumulation; Source: Authors.

The forage samples were dried in stove with forced air circulation at 55 ° C for 72 hours and later milled in Wiley mill with a 1mm sieve. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) fractions were obtained by the method of Van Soest (1965). The total nitrogen (N) content was determined by the Kjeldahl method (AOAC, 1995; AOAC, 2000), modified by using 4% (w/v) boric acid solution as the free ammonium receptor during distillation, a solution of 0.2% (w/v) bromocresol green and 0.1% (w/v) methyl red as indicator, and standard sulfuric acid solution for titration and crude protein by the equation, PB = N x 6.25. Total lipid contents (TL) were obtained by the Soxhlet method with extraction in diethyl ether (AOAC, 2000; AOAC, 2000a). The extraction of minerals was done through the technique of wet digestion with sulfuric acid. Phosphorus (P) was read in photocolorimeter, potassium (K) in the flame photometer, and calcium (Ca) and magnesium (Mg) in atomic absorption spectrophotometer. The results were submitted to the analysis of variance and polynomial regression, following the model $Yij = \mu + Si + \varepsilon ij$, where: Yij = response variable, μ = general mean, Sij = plant age effect, 45 ... 180 days) and εij = experimental error.

3. Results and Discussion

The NDF and ADF levels present significant variation with the development of the plants (p=0.0001), both with a cubic regression model (Tabela 2). The lowest levels of these variables were observed at the beginning of the cycle (NDF= 470.28 g dm^3 at 45 days, ADF= 253.32 g dm^3 at 54 days), due to the low accumulation of structural cellular components that occurs at this stage. Advancing the crop cyclethe *Macroptilium lathyroides* plants in free growth increased the number of secondary and tertiary branches, decreasing the leaf/stem ratio, thus raising the fibrous components contents until the end of the experimental period. The highest levels of NDF (700.18 g dm^3) and ADF (534.39 g dm^3) were observed at 172 and 175 days, respectively.

As *Macroptilium lathyroides* has a habit of indeterminate growth, possible that the beginning of the new crop cycle contributed to the decrease of the fiber contents at the end of the experimental period (180 days), by the contribution of less fibrous components, such as young leaves and stems, in the total forage mass. At this time NDF and ADF levels were 697.01 and 532.85 g dm^3, respectively. If the experiment had been conducted for a few more days, probably even smaller values of these variables would have been recorded.

The forage nutrient value related to NDF content should be between 380 and 530 g dm^3 (Mertens, 1985). In the study, the minimum NDF value was taken at the beginning of the growth period (45 days) and the maximum amount reached at 172 days. Therefore, from the best utilization of *Macroptilium lathyroides* fodder, should preferably up to 86 days after emergence.

The average NDF level observed in *Macroptilium lathyroides* (Tabela 2) is higher than that found by Sosa-Montes (2020) in Clitoria ternatea, Macroptilium atropurpureum and Stylosanthes guianensis. Moura et al. (2011) evaluating the chemical composition of Stylosanthes sp. reported 560 g dm^3 of NDF and up to 450 g dm^3 of ADF with a quadratic trend.

Table 2 - Regression equation parameters and mean (± Stander Deviation) of neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), crude protein (CP) and total lipids (TL) in *Macroptilium lathyroides* plants from 45 to 180 days after emergence.

	β_0	β_1	β_2	β_3	r^2	*P value* Intercept	*P value* Slope	Mean (g dm³)
NDF	568.85	-4.94	0.071	-22.10^{-5}	0.90	<0.0001	0.0179	581.55± 84.5
ADF	474.89	-9.11	0.11	-32.10^{-5}	0.97	<0.0001	<0.001	389.44±110.7
ADL	283.65	-7.99	0.084	-25.10^{-5}	0.68	0.0024	0.0027	91.5± 38.0
CP	208.07	-0.84	-0.004	27.10^{-6}	0.59	0.0201	0.6983	115.9±30.5
TL	58.76	-1.17	0.009	-23.10^{-6}	0.46	0.0132	0.2305	11.84±6.1

Source: Authors.

Acid detergent lignin (ADL) concentrations varied significantly (p=0.0001), also fitting to a cubic regression model throughout the crop cycle (Table 2). There was a slight decrease in ADL from 45 to 68 days, which was the moment of its lowest level (50.14 g dm³). From this point the ADL increased until reaching its maximum value at 156 days (132.33 g dm³), again decreasing in the subsequent period, a variation that suggests the occurrence of new, less fibrous components. Because it is a structural component of the cell wall, the oscillation of the ADL content may be related to the shrub characteristic of the phasey bean (Prabhukumar et al., 2016) associated with its already mentioned indeterminate growth habit, which provides reproductive growth related to vegetative growth (Ferreira et al., 2003; Monks et al., 2006). Lignin is inversely related to digestibility (Forbes, 1995), increasing the indigestible fraction of forage and interfering with the use of carbohydrates and proteins by the ruminal microbiota, but whitout no consistent relationship with the voluntary consumption (Mowat et al., 1969; Bidlack & Buxton, 1992; Medeiros et al., 2015). Although legumes have higher lignin concentrations compared to grasses, apparently ligninof grass is most strongly inhibits digestion (Mowat et al., 1969).

The CP content varied according to a cubic regression (p=0.0002), with maximum point (164.63 g dm³) at 45 days and minimum (81.8 g dm³) at 163 days, after a slight increase to the 180 days, when the content was 84.73 g dm³ (Tabela 2). The high CP content presented at the cycle beginning is related to the higher leaf/stem ratio this crop phase presents and consequently the lower the proportion of structural carbohydrates. In turn, the lower levels presented after 101 days (< 100 g dm³) is due to the proximity of end of the crop cycle, when the fibrous fractions present largely in the total dry matter. The elevation of the levels observed immediately afterward, results from a new regrowth with consequent increase of young leaves, due to the occurrence of favorable climatic conditions like rainfall and mild temperatures (Ferreira et al., 2004). Plants with indeterminate growth habit develop and branch out even during flowering, pod formation, and grain filling, and there may be flowers and pods at different stages of maturation (Ferreira et al., 2003). The variation in the forage quality according to its stage of maturity is common sense and according to Van Soest (1994) the relation leaf/stem is an indicator used in the description of this quality, principally of legumes.

The average CP content (115.90 ± 30.5 g dm³) observed is low (Tabela 2), when compared to a recent *Macroptilium lathyroides* study (Tobisa & Nakano, 2019) and other tropical climate legumes. Sampling in the vegetative different stage tropical legumes Longo et al (2012) obtained values of 241; 236; 246; 191 g dm³ PB for Styzolobium aterrimum, Styzolobium deeringianum, Leucaena leucocephala, and Mimosa caesalpiniaefolia, respectively. Summer legumes (Crotalaria spectabilis, Cajanus cajan, Macrotyloma axillare, Mucuna aterrina, Stylosantis sp. And Canavalia ensiformis) found average CP contents varying from 118 to 250 g dm³ PB, and the plants were evaluated in free growth from 48 to 110 days (Fluck et al., 2013).

The total lipids (TL) ($p = 0.0171$) content had a maximum value (22.44 g dm³) at 45 days, and minimum (8.86 g dm³) at 180 days. Its cubic trajectory (Tabela 2) presented a phase of strong decrease to approximately 100 days. From this point, up to 125 days, TL content presented slight stabilization, again decreasing more sharply until 180 days. The mean TL content (Table 2) observed in phasey bean (11,84 g dm³) corresponds to those to those reported by Silva et al. (2009). The authors observed average lipid contents of 11.9 and 11.4 g dm³ for forage peanut (Arachis pintoi cv. Amarillo) and alfalfa respectively.
Forages naturally have low values of this nutrient, close to 30 g dm³ in the dry matter, in addition, lipids have limitations of inclusion in the diets of ruminants, animals that had their evolution linked to the consumption of fodder, and should not exceed 60 g dm³ of dry matter intake (Medeiros et al., 2015). The main reason would be a negative influence of fat on fiber degradability. In plants, lipids play a fundamental role, acting mainly as a structural

membrane component and as a reserve in the form of reduced carbon for seed germination (Taiz & Zeiger, 2004), in the diet of animals has a function of energy supply (Medeiros et al., 2015).

The mineral composition of the phasey bean varied significantly ($p<0.0001$) as a function of the crop cycle, with cubic regression models for all studied minerals (Table 3). With different dynamics throughout the development of plants, the maximum content of all minerals was verified up to 69 days after emergence, when magnesium presented 7.12 g/kg. Phosphorus, potassium and calcium had their maximum values (P = 3.06 g/kg, K = 17.29 g/kg, Ca = 39.59 g/kg) at 45, 45 and 53 days respectively. The minimum values (Mg = 3.65 g/kg; Ca = 14.40 g/kg; P = 0.52 g/kg; K= 5.48 g/kg) were 151, 157, 180, and 180 days, respectively (Table 3).

The concentration of minerals in the forage depends on the interaction of several factors, among which, besides the forage species, the soil, climate, yield, management and stage of development of the pasture are included (Carvalho et al., 2005). In the first moment, the concentration of minerals in the plants is a potential positive function related to the biomass accumulation, especially during the vegetative period (Cavalheiro & Trindade, 1992). Then, as the plant cycle progresses, the minerals are being translocated from the roots to the young parts. Thus, in the case of phasey bean, a new vegetative growth provided by its habit of general growth would promote mineral contribution in the aerial biomass, as verified in the present study.

In Crotalaria juncea, Canavalia ensiformis and Mucuna aterrimum found Ca, Mg, P and K about 8.8 g/kg, 2.8 g/kg, 4.5 g/kg and 12.9 g/kg respectively; except for P, the results are lower than found in the present study (Duarte Júnior & Coelho, 2008). Likewise, when evaluating the nutritional value of Arachis pintoi cv. Amarillo, observed, except for the amount of K, mineral contents lower of the present study (Gobbi et al., 2010).

A detailed review of minerals in warm climate legumes would be interesting, in order to identify which species are distinguished by their composition and supply of minerals to the animals. For ruminants, the minimum or optimal nutritional minerals requirement is challenging to determine, since they are expressed in daily quantities or per unit of product, or by the proportion of the dry matter intake (Cavalheiro & Trindade, 1992). The breed or genetic group of the animal, aspects of the diet, rate of production and by the breeding environment, affects these requirements. However, any mineral that is supplied by the pasture not need be supplemented (Underwood, 1981).

Table 3 - Regression equation parameters and mean (± Stander Deviation) of magnesium (Mg), phosphorus (P), potassium (K) and calcium (Ca) in *Macroptilium lathyroides* plants from 45 to 180 days after emergence.

	β_0	β_1	β_2	β_3	r^2	*P value* Intercept	*P value* Slope	Mean (g Kg)
Mg	-4.14	0.382	-0.0040	12.10^{-6}	0.70	0.3239	0.0028	4.62 ± 1.97
P	7.98	-0.157	0.0012	-31.10^{-7}	0.59	<0.0001	0.0060	2.18 ± 0.47
K	48.57	-1.017	0.0081	-21.10^{-6}	0.66	<0.0001	0.0119	9.3 ± 3.92
Ca	12.15	1.157	-0.0145	46.10^{-6}	0.67	0.6393	0.0528	25.08 ± 12.28

Source: Authors.

4. Final Considerations

The chemical quality of the phasey bean varies throughout the crop cycle, being directly influenced by the habit of indeterminate growth of the species.

From the chemical quality, the forage of the first growth of the phasey bean should be harvested up to 75 days after emergence, when the lower fiber and lignin contents associated with higher levels of crude protein, total lipids, magnesium, and calcium.

Long-term studies with animals use should be conducted so forage quality of *Macroptilium lathyroides* is even more detailed.

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References:

Allen, M., & Beck, J. 1996. Relationship between spring harvest alfalfa quality and growing degree days. *In: 26º National Alfalfa Symposium, East Lansing*, MI, USA.

Alonzo, L. A. G., Ferreira, O. G. L., Vaz, R. Z., Costa, O. A. D., Motta, J. F., Brondani, W. C. 2017. Amendoim forrageiro manejado com baixos resíduos de pastejo por ovinos. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, 69 (1), 173–180.

Association of Official Analytical Chemists International - AOAC. 1995. *Official Methods of Analysis. Arlington*.

Association of Official Analytical Chemists International – AOAC. 2000. *International, Gaithersburg, MD, Method.*

Association of Official Analytical Chemists International - AOAC. 2000a. *International, Gaithersburg, MD, Official Method.*

Bidlack, J. E., & Buxton, D. R. 1992.Content and deposition rates of cellulose, hemicellulose, and lignin during regrowth of forage grasses and legumes. *Canadian Journal of Plant Science*, 72, 809-818.

Carvalho, F. A. N., Barbosa, F. A., McDowell. 2005. *Nutrição de bovinos a pasto*. (2a ed.), Belo Horizonte: PapelForm.

Cavalheiro, A. C. L., & Trindade, D. S. 1992. *Os minerais para bovinos e ovinos criados em pastejo*. Porto Alegre: Sagra-DC Luzzato.

CQFS RS/SC, 2004. *Manual de adubação e de calagem para os Estados do Rio Grande do Sul e de Santa Catarina*, 10th ed. (Sociedade Brasileira de Ciência do Solo. Comissão de Química e Fertilidade do Solo. Porto Alegre).

Duarte Júnior, J. B., & Coelho, F.C. 2008. *Adubos verdes e seus efeitos no rendimento da cana-de-açúcar em sistema de plantio direto*. Bragantia, Campinas, 67 (3), 723-732.

Ferreira, O. G. L., Monks, P. L., Machado, A. N., & Camacho, J. C. B. 2003. Efeito do corte no estádio vegetativo e de épocas de colheita sobre o rendimento de sementes de

Macroptilium lathyroides (L.) Urb. I- Componentes do rendimento. *Sementes Online*, 02 (1), 7-12.

Ferreira, O. G. L., Monks, P. L., Machado, A. N., & Affonso, A. B. 2004. Efeito do corte da parte aérea e de épocas de colheita sobre o rendimento e qualidade das sementes de feijão-dos-arrozais. *Revista Brasileira de Agrociência*, Pelotas, 10 (2), 175-178.

Fluck, A. C., Kozloski, G. V., Martins, A. A., Mezzomo, M. P., Zanferari, F., & Stefanello, S. 2013. Relationship between chemical components, bacterial adherence and in vitro fermentation of tropical forage legumes. *Ciência e Agrotecnologia, Lavras*, 37 (5), 457-464.

Forbes, J. M. 1995. *Voluntary food intake and diet selection in farm animals*. Chap. 10. CAB internacional.

Gobbi, K. F., García, R., Garcez Neto, A. F., Pereira, O. G., & Rocha, G. C. 2010. Valor nutritivo do capim-braquiária e do amendoim forrageiro submetidos ao sombreamento. *Archivos de zootecnia*. Córdoba, 59, 227.

Heuzé, V., Tran, G., Giger-Reverdin, S., Bastianelli. D., & Lebas, F. 2015. Phasey bean (*Macroptilium lathyroides*). *Feedipedia, a programme by INRA*, CIRAD, AFZ and FAO. https://www.feedipedia.org/node/627

Kröning, A. B., Costa, O. A. D., Farias, P. P., Martins, L. A., Ott, O. G., Macari, S., & Ferreira, O. G. L. 2019. Grazing criteria for perennial peanut (Arachis pintoi cv. Amarillo) consumed by sheep in rotational stocking. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, 71 (3), 997–1004.

Longo, C., Hummel, J., Liebich, J., Bueno, I. C. S., Burauel, P., Ambrosano, E. J., Abdalla, A. L., Anele, U. Y., & Südekum, K. H. 2012. Chemical characterization and in vitro biological activity of four tropical legumes, Styzolobium aterrimum L., Styzolobium deeringianum, Leucaena leucocephala and Mimosa caesalpiniaefolia, as compared to a tropical grass, Cynodon spp for the use in ruminant diets. *Czech Journal of Animal Science*, Prague, 57 (6), 255-264.

Medeiros, S. R., Gomes, R. C., & Bungenstab, D. J. 2015. *Nutrição de bovinos de corte: Fundamentos e aplicações*. Brasília, DF: Embrapa.

Mertens, D. R. 1985. *Factors influencing feed intake in lactation cows: from theory to application using neutral detergent fiber. Proceedings Georgia Nutrition Conference.*

Monks, P. L., Ferreira, O. G. L., Pólo, E. A., Silva, J. B. 2006. Produção e qualidade de sementes de *Macroptilium lathyroides* (L.) Urb. sob diferentes espaçamentos e épocas de colheita. *Pesquisa Agropecuária Tropical*, 36 (2), 107-112.

Moura, R. L., Nascimento, M. P. S. C. B., Rodrigues, M. M., Oliveira, M. E., Lopes, J. B. 2011. Razão folha/haste e composição bromatológica da rebrota de estilosantes Campo Grande em cinco idades de corte. *Acta Scientiarum*, 33 (3), 249-254.

Moura, R. L., Nascimento, M. P. S. C. B., Rodrigues, M. M., Oliveira, M. E., Lopes, J. B. 2011.Razão folha/haste e composição bromatológica da rebrota de estilosantes Campo Grande em cinco idades de corte. *Acta Scientiarum*, Maringá, 33 (3), 249-254.

Mowat, D. N., Kwain, M. L., & Winch, J. E. 1969. Lignification and in vitro cell wall digestibility of plant parts. *Canadian Journal of Plant Science*, 49, 499-504.

Pereira, A. S., Shitsuka, D. M., Parreira, F. J., & Shitsuka, R. (2018). *Metodologia da pesquisa científica*. Santa Maria: UFSM, NTE.

Prabhukumar, K. M., Jagadeesan, R., Gangaprasad, A., Mathew, S. P., & Balachandran, I. 2016. Macroptilium (Leguminosae: Faboideae), a new genus record for Kerala. Devagiri *Journal of Science*, 2 (1), 142-145.

Silva, V. P., Almeida, F. Q., Morgado, E. S., França, A. B., Ventura, H. T., & Rodrigues, L. M. 2009. Digestibilidade dos nutrientes de alimentos volumosos determinada pela técnica dos sacos móveis em equinos. *Revista Brasileira Zootecnia*, 38 (1), 82-89.

Sosa-Montes, E., Fuente, J. I. A., Pro-Martínez, A., González-Cerón, F., Enríquez-Quiroz, J. F., & Torres-Cardona, M. G. 2020. Composición química y digestibilidad de cuatro leguminosas tropicales mexicanas. *Revista Mexicana de Ciencias Agrícolas*, 24 (Pub.Esp.), 211-220.

Taiz, L., & Zeiger, E. 2004. *Fisiologia vegetal*. (3a ed.) Porto Alegre: Artmed.

Tobisa, M., & Nakano, Y. 2019. Effects of sowing methods and seeding rates on growth and yield characteristics of phasey bean (*Macroptilium lathyroides*). *Grass Forage Science*, 74 (4), 696–707.

Underwood, E. J. 1981.*The mineral nutrition of livestock.* London: Academic press.

Van Soest, P. J. 1965. Symposium on factors influencing the voluntary intake of herbage by ruminants: Voluntary intake relation to chemical composition and digestibility. *Journal of Animal Science*, 24 (3), 834-844.

Van Soest, P. J. 1994. *Nutritional ecology of the ruminant*. (2a ed.), New York: Cornell University Press.

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