



In situ dry matter and fiber fraction degradability of the Mineirão stylos

Daniel Staciariini Corrêa^{1*}, Roberto Toledo de Magalhães² and Domingas Cruvinel Batista de Siqueira¹

¹Programa de Pós-graduação em Ecologia e Produção Sustentável, Pontifícia Universidade Católica de Goiás, Av. Engler, s/n, Cx. Postal 86, 74605-010, Goiânia, Goiás, Brazil. ²Departamento de Zootecnia, Pontifícia Universidade Católica de Goiás, Goiânia, Goiás, Brazil. *Author for correspondence. E-mail: daniel.staciariini@terra.com.br

ABSTRACT. This research evaluated, using the *in situ* technique, the dry matter and fiber fraction degradability of the Mineirão stylo (*Stylozanthus guianensis*). The nylon bag method was used for the degradability assay, with two incubations in rumen-cannulated adult female cows. In each incubation, 25 samples of 7.0 g each were used. The samples were collected at 0, 6, 9, 12, 24, 36, 48, 72 and 96 hours. The experiment was conducted according to a randomized blocks design and data were submitted to analysis of variance. The maximum effective degradability was obtained in the 2% passage rate. For the 5% passage rate the Mineirão stylo showed effective degradation of 75.70% for dry matter, 59.01% for neutral detergent fiber and 76.81% for acid detergent fiber. The digestibility achieved by the dry matter and fibrous fraction from Mineirão was considered high. These results, coupled with the low lag time found reveal the forage potential of the cultivar.

Keywords: cattle breeding, leguminous species, digestibility, forage.

Degradabilidade *in situ* da matéria seca e fração fibrosa do estilosantes Mineirão

RESUMO. Neste trabalho avaliou-se, por meio da técnica *in situ*, a degradabilidade da matéria seca e da fração fibrosa da leguminosa estilosantes Mineirão (*Stylozanthus guianensis*), leguminosa nativa do Cerrado brasileiro. Para o ensaio da degradabilidade, usou-se o método dos sacos de náilon, com duas incubações em fêmea bovina adulta canulada no rúmen. Em cada incubação, foram utilizadas 25 amostras de 7,0 g cada. As amostras foram retiradas nos tempos 0, 6, 9, 12, 24, 36, 48, 72 e 96h. O experimento foi conduzido segundo o delineamento de blocos ao acaso e os dados submetidos à análise de variância. As máximas degradabilidades efetivas foram atingidas na taxa de passagem 2%. Para a taxa de passagem de 5%, o estilosantes Mineirão apresentou degradabilidade efetiva de 75,70% para a matéria seca, 59,01% para a fibra em detergente neutro e 76,81% para a fibra em detergente ácido. A digestibilidade alcançada tanto pela matéria seca quanto pela fração fibrosa estilosantes Mineirão foi considerada alta. Estes resultados, aliados ao baixo tempo de colonização *lag time* encontrado revelam o potencial forrageiro da cultivar.

Palavras-chave: bovinocultura, leguminosas, digestibilidade, forrageira.

Introduction

This study evaluated, through the *in situ* technique, the digestibility of dry matter (DM), neutral detergent fiber (NDF) and acid detergent fiber (ADF) from *Stylozanthus guianensis* cv. Mineirão.

The Brazilian Cerrado (savanna-like biome) is one of 25 global hotspots (MYERS et al., 2000), so it is important to find alternatives that lead to increased animal productivity without the need to expand grazing areas and leverage native forage. According to Eastridge (2006), in coming years, efforts to improve the digestibility of dietary components, optimize rumen fermentation, improve use of nitrogen and phosphorus to reduce the risk of contaminating the environment

and better understanding of the nutritional requirements of animals, will become increasingly important.

Leguminous plants are characterized by the ability to biologically fix the atmospheric nitrogen in the soil, thus improving diet quality and reducing the use of nitrogen fertilizers (CARVALHO; PIRES, 2008; PACIULLO et al., 2003; SILVA; SALIBA, 2007).

Mineirão stylo is a native Cerrado legume whose genus belongs to the Fabaceae family. It features a strong root system and high colonization capacity (BARROS et al., 2005). This cultivar was commercially released by Embrapa Cerrados and Embrapa Gado de Corte in 1993 and is characterized by semi-erect or erect growth, good adaptation to low-fertility acid soils, high retention of leaves

during the dry season, resistance to anthracnose and late flowering (BARCELLOS et al., 2008; KARIA et al., 2010).

Barcellos et al. (2008) cited the high cost of seed, low natural seeding, slow establishment and early growth as weaknesses of the Mineirão.

The nutritional assessment of food is of fundamental importance for the accuracy and efficiency of feed management. While chemical analysis is the starting point in determining the nutritional value of foods, the use of these nutrients depends on the use that the organism is able to make of them and the consumption capacity of the animals (ANDRIGUETTO et al., 2002).

Several techniques can be used to determine food quality, from measuring animal production to direct and indirect techniques. The *in situ* technique allows the evaluation of various feed items simultaneously, evaluates the time of ruminal degradation of several nutrients from the diet, and does not require large numbers of animals or special equipment, such as metabolic cages or gas chambers. Moreover, the technique, when used to evaluate forages, foregoes adaptation time, uses small amounts of feed and has lower cost compared to other methodologies. Although food items are not subject to certain digestive events such as chewing, salivation, rumination and passage, the technique allows close contact of food with the rumen (SILVA et al., 2009; VELOSO et al., 2006). These characteristics make the *in situ* technique a reliable and valid method of food evaluation.

Material and methods

All processes were conducted at the Department of Animal Sciences (Campus II) areas of the Pontifícia Universidade Católica de Goiás. About 5,000 square meters were used for the planting and management of *Stylosanthes guianensis* cv. Mineirão. Part of the material was collected and analyzed at the Bromatology Laboratory de and the remainder was used in the *in situ* digestibility assay.

The samples were collected at 119 days after germination. In the 45th day after germination, a pruning of uniformity was made and in the 74th day after this pruning, the forage was harvested to be used in the experiment. This period was used to simulate a common situation in the farms, in which the legume is planted with the objective to be used by the animals during the dry season of the year. Forage was harvested using a 0.5 x 1.0 meter square in different parts of the plots and pre-dried at 65°C until constant weight, ground in a "Thomas-Willey" stationary mill with 1 mm sieve and stored in plastic

pots for further chemical analysis. Another part of the material was ground in a 5 mm sieve for analysis of *in situ* degradability.

Forage nutritive value was analyzed by drying the material in a forced ventilation oven at 65°C, followed by 105°C, in which dry matter content was determined by the weight difference (SILVA; QUEIROZ, 2002).

Crude protein (CP) was determined by the Kjeldahl method (AOAC, 1975). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were analyzed by the sequential method (ROBERTSON; VAN SOEST, 1981).

Degradability was determined with two inoculations, using in each one, a rumen-cannulated adult cow (Zebu x Holstein) housed in a tie stall with access to water, mineral mixture and corn silage.

The samples were placed in nylon bags with 50 µm diameter pore size, dimensions of 5 x 14 cm, sealed at the edges and properly labeled. A total of 25 samples (7.0 g each) were used in each incubation. To obtain the weight of the empty bags, they were placed in a stove at 65°C until constant weight for approximately 72 hours, and after 30 minutes in the desiccator their weights were recorded. The samples were placed all at once and withdrawn at 0 (T0), 6 (T1), 9 (T2), 12 (T3), 24 (T4), 36 (T5), 48 (T6), 72 (T7) and 96 (T8) hours, washed in running water until the water was clear, and dried at 55°C until constant weight. Then the digestibility of DM, NDF and ADF was determined.

The degradability equations were determined from the model proposed by Orskov and McDonald (1979), as follows:

$$Dg = A - B \cdot e^{-ct},$$

where:

"A" is the maximum degradation rate of the material contained in the nylon bag. "B" is a parameter with no biological value of interest. If there were no lag time it would correspond to the total settlement to be degraded by microorganism action, "c" is the fractional constant degradation rate of the fraction that remains in the nylon bag, and "t" is the incubation time in the rumen.

The effective digestibilities (ED) were calculated according the model proposed by Orskov and McDonald (1979):

$$DE = S + (B \cdot c) / (c + K),$$

where:

"K" is the fractional passage rate of small particles

obtained after the use of different feeding levels and diets.

Colonization times (lag time) were calculated following the model of McDonald (1981):

$$(eRDP t_0 - eRDP t)/c,$$

where:

eRDP t₀ is the natural logarithm of the potentially degradable residue at time 0, eRDP t is the natural logarithm of the potentially degradable residue in the final incubation time and “c” is the degradation rate of fraction B. The chemical composition of the leguminous plant is presented in Table 1.

Table 1. Average contents of dry matter (DM), organic matter (OM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (FDA) and Ash of forage used in incubation.

| Forage portion | <i>Stylosanthes guianensis</i> cv. Mineirão |
|----------------|---|
| DM (%) | 28.20 |
| OM (%) | 90.50 |
| CP (% of DM) | 20.05 |
| NDF (% of DM) | 45.93 |
| ADF (% of DM) | 33.07 |
| Ash (% of DM) | 10.50 |

Results and discussion

After 6 hours of incubation the disappearance rates of DM and ADF are very close. Although the NDF disappearance rate is shorter than the DM and ADF disappearance rates, all the analyzed portions showed similar behavior, with their rates rising until the 48-hour period and tending to remain constant after that period (Figure 1).

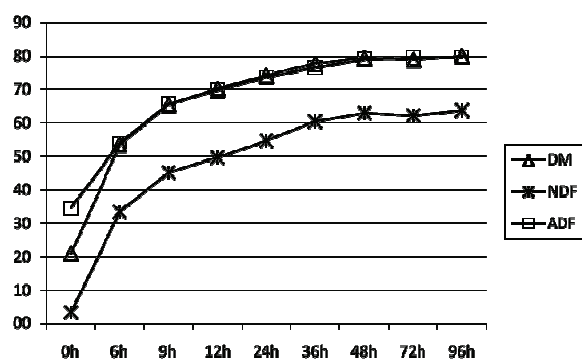


Figure 1. Mean disappearance (%) of dry matter (DM), neutral detergent fiber (NDF) and acid detergent fiber (ADF) of legume according incubation time (hours).

Similar behavior of the disappearance curve was identified by Pires et al. (2006), using different tropical leguminous species, but in their research, the authors found a tendency of constant disappearance rate from 36 hours of incubation.

If the NDF disappearance is too slow, it will affect forage intake because rumen repletion decreases nutrient intake, limiting productivity.

The fractions A, B and C, potential degradability, lag time and effective degradability of dry matter, neutral detergent fiber and acid detergent fiber of Mineirão stylo are presented in Table 2. In a degradability assay, the “A” fraction corresponds to the disappearance in time 0h or soluble fraction, “B” is the insoluble potentially degradable fraction, and “C” is the degradation rate of the “B” fraction. Passage rates of 2, 5 or 8% per hour correspond to low, medium or high food intake levels (CARVALHO et al., 2006a; MAGALHÃES et al., 2005; OLIVEIRA et al., 2003). Although the effective degradability decreases while the passage rate increases, as the food goes from one compartment to another, the animal can ingest more food.

Table 2. Fractions A, B and C, potential degradability (PD), lag time (LT) and effective degradability (ED) for three rates of passage (0.02, 0.05 and 0.08h) of dry matter (DM) neutral detergent fiber (NDF) and acid detergent fiber (ADF) of Mineirão stylo.

| | A (%) | B (%) | C (%h) | PD (%) | LT (h) | ED (%) | | |
|-----|-------|-------|--------|--------|--------|--------|-------|-------|
| | | | | | | 0.02 | 0.05 | 0.08 |
| DM | 20.91 | 59.13 | 0.6313 | 80.04 | 2.18 | 78.23 | 75.70 | 73.39 |
| NDF | 3.41 | 60.25 | 0.5981 | 63.66 | 1.63 | 61.71 | 59.01 | 56.55 |
| ADF | 34.57 | 45.02 | 0.7576 | 79.59 | 1.54 | 78.44 | 76.81 | 75.29 |

The fiber portion is an insoluble structural plant compound; thus, the disappearance at time zero is expected to be near 0. The high value of the ADF “A” fraction must be due to lack of homogeneity in sample preparation, a portion of particles must have escaped through the pores of the nylon bags without being degraded (MAGALHÃES et al., 2005).

The “A” fraction influences the potential degradability of the nutrient, but has no influence on effective degradability.

NDF is a portion of low degradation rate, commonly associated with physical limitation of food intake (ALLEN, 1996). Tjardes et al. (2002) shown the negative effect of high dietary NDF levels on dry matter intake and body weight gain. The ADF fraction includes cellulose and lignin as primary components in addition to varying amounts of ash and nitrogen compounds. Low ADF values means high energy and high digestibility, while low NDF values means high consumption (MOURA et al., 2011).

Akinlade et al. (2008), found values from the DM “A” fraction near the values obtained with Mineirão; however, the values for the “B” fraction are not similar. The values of “A” were 19.0, 17.2, 22.0 and 20.4%, while the values of “B” found for

DM were 47.3, 50.5, 47.3 and 47.0% respectively for *Stylosanthes scabra* cvs. Fitzroy, IITA-140, Seca and IITA-441D.

The values of the “C” fraction indicate that NDF is the nutrient with the highest potentially degradable portion, but it is also the nutrient with the lowest degradation rate. This fact leads us to believe that there is a physical limitation for Mineirão intake.

In the 5% passage rate, the ED shows high digestibility of DM and ADF. Again, the NDF is the nutrient with the lowest value.

Ladeira et al. (2001) studied the degradation of *Stylosanthes guianensis* hay in sheep and observed potential DM degradability of 38.1 and 30.3% of effective DM degradability for a passage rate of 2.7%h, however; the authors emphasize that the legume was harvested at the reproductive stage, with more than half of the plants showing flowers.

Carvalho et al. (2006b) and Veloso et al. (2006) studied other tropical leguminous species and found effective degradability at the 5% passage rate ranging from 26.70 to 71.43% for dry matter. The values found in this study were 75.70 (DM) and 59.01 (NDF) for the same passage rate. Valarini and Possenti (2006) found effective DM degradability of 53.5% and effective NDF degradability of 35.3% for *Stylosanthes guianensis*; the authors did not indicate which cultivar they used in their study.

The high ED reached by the ADF (76.81 for the 5% passage rate) indicates a low tannin concentration, which shows that Mineirão stylo is a low toxicity legume compared to other tropical leguminous plants, which allows more freedom in its intake by ruminants.

For other leguminous species, such as those studied by Carvalho et al. (2006b) and Pires et al. (2006), the effective ADF degradability ranged from 13.1 to 41.2 at the 5% passage rate, suggesting a higher tannin concentration, which increases the legume’s toxicity, limiting its consumption by ruminants.

The lag time is an indicative of the nutritional quality of food, a shorter lag time, especially NDF, indicates a faster start of rumen degradation, reducing the constraint by repletion of the digestive tract. ADF showed the lower lag time among the three analyzed portions (1.54h), followed by the NDF portion (1.63h).

The lag time of DM (2.18h) was higher than that found by Veloso et al. (2006), for *Leucaena leucocephala* (1.37h) and *Neonotonia wightii* (1.74h), but was lower than *Cajanus cajan* (5.72h).

Conclusion

Cultivar Mineirão showed a highly effective degradability of dry matter and acid detergent fiber,

regardless of passage rate, which indicates good nutritional value and suggests low toxicity. Neutral detergent fiber was less digestible, however, digestibility values found for this fraction was satisfactory.

Forage showed low lag times of dry matter and fibrous portion, showing that rumen cellulolytic bacteria are able to quickly reach it, which proves its high digestibility.

Mineirão stylos can be recommended as protein source or in association with other forage. This leguminous must be considered as an alternative in the Cerrado’s grasslands-based production systems, as it is native to the region.

References

- AKINLADE, J. A.; FARINU, G. O.; AGBOOLA, O. O.; AKINGBADE, A. A.; OJEBIYI, O. O.; ADERINOLA, O. A. Research note: Nutritive value of four accessions of *Stylosanthes scabra* in the derived savanna zone of Nigeria. **Tropical Grasslands**, v. 42, n. 2, p. 120-123, 2008.
- ALLEN, M. S. Physical constraints on voluntary intake of forages by ruminants. **Journal of Animal Science**, v. 74, n. 12, p. 3063-3075, 1996.
- ANDRIGUETTO, J. M.; PERLY, L.; MINARDI, I.; GEMAEL, A.; FLEMMING, J. S.; SOUZA, G. A.; BONA FILHO, A. **Nutrição Animal Volume I: as bases e os fundamentos da nutrição animal - os alimentos**. São Paulo: Nobel, 2002.
- AOAC-Association of Official Analytical Chemists. **Official methods of analysis**. 12th ed. Washington, D.C.: AOAC, 1975.
- BARCELLOS, A. O.; RAMOS, A. K. B.; VILELA, L.; MARTHA JUNIOR, G. B. Sustentabilidade da produção animal baseada em pastagens consorciadas e no emprego de leguminosas exclusivas, na forma de banco de proteína, nos trópicos brasileiros. **Revista Brasileira de Zootecnia**, v. 37, Suplemento Especial, p. 51-67, 2008.
- BARROS, A. M.; FALEIRO, F. G.; KARIA, C. T.; SHIRATSUCHI, L. S.; ANDRADE, R. P.; LOPES, G. K. B. Variabilidade genética e ecológica de *Stylosanthes macrocephala* determinadas por RAPD e SIG. **Pesquisa Agropecuária Brasileira**, v. 40, n. 9, p. 899-909, 2005.
- CARVALHO, G. G. P.; PIRES, A. J. V. Leguminosas tropicais herbáceas em associação com pastagens. **Archivos de Zootecnia**, v. 57, n. 1, p. 103-113, 2008.
- CARVALHO, G. G. P.; PIRES, A. J. V.; VELOSO, C. M.; DETMANN, E.; SILVA, F. F.; SILVA, R. R. Degradabilidade ruminal do feno de alguns alimentos volumosos para ruminantes. **Arquivo Brasileiro de Medicina Veterinária e Zootecnia**, v. 58, n. 4, p. 575-580, 2006a.
- CARVALHO, G. G. P.; PIRES, A. J. V.; VELOSO, C. M.; SILVA, F. F.; SILVA, R. R. Degradabilidade ruminal do feno de forrageiras tropicais. **Revista Brasileira de Agrociência**, v. 12, n. 1, p. 81-85, 2006b.

- EASTRIDGE, M. L. Major Advances in Applied Dairy Cattle Nutrition. **Journal of Dairy Science**, v. 89, n. 4, p. 1311-1323, 2006.
- KARIA, C. T.; ANDRADE, R. P.; FERNANDES, C. D.; SCHUNKE, R. M. Gênero *Stylosanthes*. In: FONSECA, D. M.; MARTUSCELLO, J. A. (Ed.). **Plantas forrageiras**. Viçosa: UFV, 2010. p. 366-401.
- LADEIRA, M. M.; RODRIGUEZ, N. M.; GONÇALVES, L. C.; BORGES, I.; BENEDETTI, E.; TEIXEIRA, E. A.; LARA, L. B. Consumo e digestibilidades aparentes total e parciais do feno *Stylosanthes guianensis*. **Arquivo Brasileiro de Medicina Veterinária e Zootecnia**, v. 53, n. 2, p. 231-236, 2001.
- MAGALHÃES, R. T.; GONÇALVES, L. C.; RODRIGUES, J. A. S.; BORGES, I.; RODRIGUES, N. M.; SALIBA, E. O. S.; BORGES, A. L. C. C.; ARAÚJO, V. L. Estimativa da degradabilidade ruminal de quatro genótipos de sorgo (*Sorghum bicolor* (L.) Moench) utilizando a técnica *in situ*. **Acta Scientiarum. Animal Sciences**, v. 27, n. 4, p. 483-490, 2005.
- MCDONALD, I. A revised model for the estimation of protein degradability in the rumen. **Journal of Agricultural Science**, v. 96, n. 1, p. 251-252, 1981.
- MOURA, R. L.; NASCIMENTO, M. P. S. C. B.; RODRIGUES, M. M.; OLIVEIRA, M. E.; LOPES, J. B. Razão folha/haste e composição bromatológica da rebrota de estilosantes Campo Grande em cinco idades de corte. **Acta Scientiarum. Animal Sciences**, v. 33, n. 3, p. 249-254, 2011.
- MYERS, N.; MITTERMEIER, R. A.; MITTERMEIER, C. G.; FONSECA, G. A. B.; KENT, J. Biodiversity hotspots for conservation priorities. **Nature**, v. 403, n. 24, p. 853-858, 2000.
- OLIVEIRA, M. V. M.; VARGAS JUNIOR, F. M.; SANCHEZ, L. M. B.; PARIS, W.; FRIZZO, A.; HAYGERT, I. P.; MONTAGNER, D.; WEBER, A.; CERDÓTES, L. Degradabilidade ruminal e digestibilidade intestinal de alimentos por intermédio da técnica *in situ* associada à do saco de náilon móvel. **Revista Brasileira de Zootecnia**, v. 32, n. 6, supl. 2, p. 2023-2031, 2003.
- ORSKOV, E. R.; MCDONALD, I. The estimation of protein degradability in the rumen from incubation measurements weighted according to rate passage. **Journal of Agricultural Science**, v. 92, n. 2, p. 499-503, 1979.
- PACIULLO, D. S. C.; AROEIRA, L. J. M.; ALVIM, M. J.; CARVALHO, M. M. Características produtivas e qualitativas de pastagem de braquiária em monocultivo e consorciada com estilosantes. **Pesquisa Agropecuária Brasileira**, v. 38, n. 3, p. 421-426, 2003.
- PIRES, A. J. V.; REIS, R. A.; CARVALHO, G. G. P.; SIQUEIRA, G. R.; BERNARDES, T. F.; RUGGIERI, A. C.; ALMEIDA, E. O.; ROTH, M. T. I. Degradabilidade ruminal da matéria seca, fração fibrosa e da proteína bruta de forrageiras. **Pesquisa Agropecuária Brasileira**, v. 41, n. 4, p. 643-648, 2006.
- ROBERTSON, J. B.; VAN SOEST, P. J. The detergent system of analysis and its application to human foods. In: JAMES, W. P. T.; THEANDER, O. (Ed.). **The analysis of dietary fiber in food**. New York: Marcel Dekker, 1981. p. 123-158.
- SILVA, D. J.; QUEIROZ, A. C. **Análises de alimentos** (métodos químicos e biológicos). 3. ed. Viçosa: Imprensa Universitária, 2002.
- SILVA, J. J.; SALIBA, E. O. S. Pastagens consorciadas: uma alternativa para sistemas extensivos e orgânicos. **Veterinária e Zootecnia**, v. 14, n. 1, p. 8-18, 2007.
- SILVA, V. P.; ALMEIDA, F. Q.; MORGADO, E. S.; FRANÇA, A. B.; VENTURA, H. T.; RODRIGUES, L. M. Digestibilidade dos nutrientes de alimentos volumosos determinada pela técnica dos sacos móveis em equinos. **Revista Brasileira de Zootecnia**, v. 38, n. 1, p. 82-89, 2009.
- TJARDES, K. E.; BUSKIRK, D. D.; ALLEN, M. S.; TEMPELMAN, R. J.; BOURQUIN, L. D.; RUST, S. R. Neutral detergent fiber concentration in corn silage influences dry matter intake, diet digestibility, and performance of Angus and Holstein steers. **Journal of Animal Science**, v. 80, n. 3, p. 841-846, 2002.
- VALARINI, M. J.; POSSENTI, R. A. Research Note: Nutritive value of a range of tropical forage legumes. **Tropical Grasslands**, v. 40, n. 3, p. 183-187, 2006.
- VELOSO, C. M.; RODRIGUEZ, N. M.; CARVALHO, G. G. P.; PIRES, A. J.; MOURÃO, G. B.; GONÇALVES, L. C.; SAMPAIO, I. B. M. Degradabilidade ruminal da matéria seca e da proteína bruta de folhas e folíolos de forrageiras tropicais. **Revista Brasileira de Zootecnia**, v. 35, n. 2, p. 613-617, 2006.

Received on April 11, 2011.

Accepted on June 21, 2011.

License information: This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.