http://dx.doi.org/10.1590/1678-4162-12478

Arq. Bras. Med. Vet. Zootec., v.74, n.3, p.559-562, 2022

Communication

[*Comunicação*]

Chemical composition *of Andropogon gayanus* cv. planaltina predicted through nirs and analyzed through wet chemistry

[*Composição químico-bromatológica de* Andropogon gayanus, *cultivar Planaltina, predita pelo NIRS e analisada por via úmida*]

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Precision Animal Nutrition is an integrated, information-based system for optimizing nutrient supply and demand for animals to achieve a desired performance, profitability, product characteristics and environmental results (González *et al*., 2018). This requires frequently assessing the composition of the feed provided to animals, to ensure that the nutrient composition of the diet digitally formulated by a nutritionist is as close as possible to the diet provided. St-Pierre and Cobanov (2007) suggest that the chemical composition of the feed provided to large herds should be assessed every four days for better ration adjustments and cost reduction.

The analysis of the chemical composition of animal feed, as routinely performed in laboratories with the use of reagents, is called wet chemistry. Despite worldwide standardization and acceptance of this type of analysis, it is time-consuming, error-susceptible, and has a high operating cost as they use expensive equipment and reagents; they also pose a major risk of environmental contamination in the event of incorrect disposal of chemical waste (Almeida *et al*., 2018).

In contrast, analysis by Near Infrared Reflectance Spectroscopy (NIRS) is an excellent technology to apply the concept of precision nutrition in production systems, providing a precise, environment-friendly measure of the main nutrients in the feed. NIRS has economic and environmental advantages when compared to conventional methods due to its greater speed and reduced costs with manual labor and direct use of reagents; it also eliminates the disposal of waste into the environment, thus reducing costs related to chemical reagents (Fontaneli *et al.*, 2002).

NIRS is based on the unique absorptive characteristics of different feed components: it detects the presence of waves in hydrogenated bonds which undergo heat induction in functional groups of these molecules (Fontaneli *et al*., 2002). Therefore, we can identify different groups of nutrients through NIRS by using specific calibration models for each component. Well-ordered calibration curves can provide effective nutrient analyses through this technology.

Given the numerous advantages of NIRS, several companies have sold NIRS devices for faster, environment-friendly analyses. However, several devices use predefined calibration models, also known as global calibration models, suited for temperate forages, but often unsuitable for predicting the composition of tropical forages. Thus, comparative tests are needed to assess these device's efficiency in predicting the composition of tropical forages and eventually adjust the calibration models so that they can process this type of feed properly. This study aimed to compare the nutrient contents of *Andropogon gayanus* grass, cv. Planaltina, analyzed through NIRS to the values obtained through wet chemistry, with a view to assessing the adequacy of NIRS-related global calibration models for predicting chemical composition.

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Submitted: July 9, 2022. Accepted: November 25, 2021.

NIRS analyses were performed at Laboratório de Bromatologia e Nutrição Animal (LABAN), located at Faculdade de Medicina Veterinária (FAMEV), Universidade Federal de Uberlândia (UFU), in the City of Uberlândia/MG, from August through September 2019. Wet chemistry analyses were carried out at Laboratório de Análise Química de Plantas da Embrapa Cerrados, located in Brasília/DF, from June through August 2018.

Samples from *Andropogon gayanus* grass, cultivar Planaltina, were collected by cutting their top half 20 cm above the ground. Soil analyses were also carried out, testing for pH in water, organic matter, calcium, phosphorus, potassium, and magnesium. The soil was categorized as Dystrophic Red Latosol with a high content of low activity clay (>50%). The values of K and P, pH and organic matter in the soil were adequate for the growth of *Andropogon* grass, with no deficiency that could compromise forage development.

Samples of *Andropogon* grass were dried, ground to a size of 1 mm and analyzed through wet chemistry to obtain dry matter (DM; INCT-CA method G-003/1), mineral matter (MM; INCT method -CA M-001/1), crude protein (CP; INCT-CA method N-001/1), ether extract (EE, INCT-CA method G-004/1), neutral detergent insoluble fiber (NDF; method INCT-CA F-001/1), and insoluble fiber in acid detergent (ADF; INCT-CA method F-004/1), according to the methods recommended by the National Institute of Science and Technology in Animal Science (INCT-CA; Detmann *et al*., 2012).

The ground samples were homogenized and placed in the NIRS' own cuvettes and then scanned in duplicates on the Near Infrared Reflectance Spectrometer (NIRS) NIR, model Spectra Star 2600 XT series of Near Infrared Analyzers (Unity Scientific®). Sample readings were taken using a reflectance band from 400 to 2500 nanometers. The NIRS device's global models (more specifically, the "Pasture" calibration curve) were used to obtain DM, MM, CP, NDF and ADF values. The results were read directly on the device screen.

The average DM, MO, CP, NDF and AFD values obtained through wet bench analysis and through the NIR device were compared in a paired sample t-test with a randomized blocks design, at a level of 5% probability.

Nutrient values predicted through NIRS were statistically different from those obtained through wet chemistry analysis ($P<0.05$). OM, NDF, ADF and CP values were overestimated by 8.7; 10.6; 6.09 and 17.2%, respectively, in the NIRS analysis, which also underestimated dry matter and mineral content by 4.7 and 38.5%, respectively. These results show that the NIRS devices is unable to predict the chemical composition of tropical forages accurately through global calibration models.

Several studies have shown good prediction of feed composition using NIRS with calibration models developed for those specific feeds. For instance, Towett *et al*. (2013) created calibration curves to analyze the crude protein (CP) content in Black-eyed peas (*Vigna unguiculata*) based on analyses of 167 samples collected in 5 different regions close to Tanzania. These samples were selected using the mPLS method to correlate their spectral variation to all 561 spectra. The spectral data of these 167 selected samples were then collected to expand the spectral variation of the initial calibration model based on 103 samples, which led to a new calibration model that was later cross validated. The calibration model had R2=0.93 and standard error of validation=0.74. In other words, the authors were successful in estimating CP contents.

Table 1. Chemical composition of *Andropogon* grass obtained through wet chemistry and NIRS

	%DM	%MM	%OM	%NDF	%ADF	%CP
Wet chemistry	94.11 a	7.51 a	92.49 b	68.31 b	39.44 b	10.87 b
Dry (NIRS)	89.66 b	4.62 b	95.38 a	76.46 a	42.00 a	13.13 a
Underestimation (%)	4.73	38.48	-	-	-	-
Overestimation (%)	-	-	8.74	10.66	6.09	17.21

%DM: dry matter; %MM: mineral matter; %OM: organic matter; %NDF: neutral detergent fiber; %ADF: acid detergent fiber; %CP: crude protein.

Also, Monrroy *et al.* (2017) developed NIRS calibration models to estimate neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose and crude protein (CP) contents in *Brachiaria* spp. The standard error of prediction for NDF, ADF, cellulose and CP contents were 1.8, 2.6, 4.1 and 8.5%, respectively. They concluded that the models were adequate to estimate the chemical characteristics of forage.

To assess the efficiency of NIRS in predicting the chemical composition of *Pennisetum purpureum* grass, Thomé *et al.* (2017) used 161 samples of the whole plants, leaves and stalks. A total of 108 samples (2/3) were used for calibration and 53 (1/3) were used for model validation. The calibration standard error (SEC) values were 0.30; 0.39; 1.54; 1.80 and 0.57 for DM, MM, NDF, ADF and LIG contents, respectively. The standard error of prediction was 0.31; 0.42; 1.41; 1.70 for DM, MM, NDF, ADF and LIG, respectively. Both calibration standard error and prediction standard error are important for choosing the ideal model to predict each characteristic. They should ideally be low. This and a high R2 value indicate good calibration, i.e., match between the spectral data and the reference samples.

In all the studies mentioned above where the NIRS results were satisfactory to estimate the chemical composition of feeds, specific calibration models had been developed for the device and for the feeds. The use of NIRS devices is relevant, as they provide reduced reagent costs and greater practicality, saving time and producing faster results. However, the use of global calibration models has proven to be ineffective in predicting nutrient content in grasses from tropical regions.

The NIRS device was unable to predict the chemical composition of *Andropogon* grass accurately through global calibration models. Therefore, specific calibration models are required for tropical forages.

Keywords: environment, tropical forage, reagents

RESUMO

Objetivou-se comparar os teores dos nutrientes do capim Andropogon gayanus *obtidos no equipamento NIRS com os valores obtidos por análises de via úmida, para identificar se os modelos globais de calibração do equipamento NIRS são adequados para predizer a composição químico-bromatológica. As análises de via seca no NIRS foram executadas no Laboratório de Bromatologia e Nutrição Animal (Laban), pertencente à Faculdade de Medicina Veterinária (Famev) da Universidade Federal de Uberlândia (UFU), enquanto as análises de via úmida foram realizadas no Laboratório de Química Analítica de Plantas da Embrapa Cerrados, localizado em Brasília-DF. As amostras utilizadas foram de capim* Andropogon gayanus, *cultivar Planaltina, as quais, após corte de 20cm acima do solo, foram secas e moídas no tamanho de 1mm. Após a moagem, foram analisadas por via úmida para os teores de matéria seca (MS), matéria mineral (MM), proteína bruta (PB), fibra insolúvel em detergente neutro (FDN) e fibra insolúvel em detergente ácido (FDA), segundo metodologias propostas por Detmann* et al. *(2012). As amostras moídas foram colocadas em cubetas próprias do equipamento e escaneadas em espectrômetro de refletância no infravermelho próximo (NIRS) NIR, modelo Spectra Star 2600 XT series of Near Infrared Analyzers (Unity Scientific®), em duplicata. Para obtenção dos teores de MS, MM, PB, FDN e FDA, empregaram-se modelos de calibração do próprio equipamento NIRS, utilizando-se a curva de calibração própria do equipamento. As médias dos teores de MS, MM, PB, FDN e FDA obtidas pelas análises de bancada (via úmida) e pelo uso do equipamento NIRS foram comparadas pelo teste T (dados pareados), ao nível de 5% de probabilidade, empregando-se o delineamento em blocos ao acaso. Houve diferença significativa nos nutrientes preditos pelo NIRS e analisados por via úmida (P≤0,05). O NIRS superestimou os teores de matéria seca e matéria mineral, mas subestimou os teores de FDN, FDA e PB. Esse resultado mostra que, quando do uso de modelos globais de calibração, esse equipamento não é capaz de predizer corretamente a composição químico-bromatológica de forrageiras de clima tropical.*

Palavras-chave: alimentos tropicais, meio ambiente, reagentes

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