NIRS ESTIMATION OF THE NUTRITIVE VALUE OF *UROCHLOA* sp. (SYN. *BRACHIARIA* sp.) FORAGES

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ABSTRACT

The pasture-based production system is the most economical for cattle feeding, which is why new cultivars of *Urochloa* sp. (syn. *Brachiaria* sp.) are being released in Brazil. However, the method of analyzing the chemical composition of forages in the laboratory is time-consuming and costly. As an alternative, the near-infrared spectroscopy (NIRS) method emerges, which is rapid and non-polluting, as it does not use chemical reagents in the analyses. The aim of study was to evaluate the nutritive value estimation of *Urochloa* sp. forages using near-infrared spectroscopy (NIRS). The experimental design was completely randomized design with four replications. The treatments were arranged in split-plot arrangement, consisting of eight species/cultivars of *Urochloa* sp. in the main plot (*U. decumbens* cv. Basilisk; *U. humidicola* cv. Tupi, *U. brizantha* cultivars Piatã, Xaraés, MG-5 Vitória, MG-13 Braúna; *U. hibrida* cultivars Ipyporã and Mavuno) and four harvesting ages in the subplots (30, 60, 90, and 120 days). The contents of dry matter (DM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), ash, and indigestible neutral detergent fiber (iNDF) were evaluated. With advancing age, there is an average daily increase in the contents of DM (0.28%), NDF (0.15%), ADF (0.17%), and iNDF (0.08%) and an average daily reduction in the contents of CP (0.12%) and ash (0.02%) in most evaluated cultivars. The nutritive value worsens with age, recommending grazing of cattle at an age below 60 days for most cultivars. The Ipyporã grass, an interspecific hybrid of *U. ruziziensis* and *U. brizantha*, presents good nutritive value as it advances in age, making it an option for diversification and deferred grazing. The NIRS estimates are excellent ($R^2_{cv} > 0.95$) for CP and ash, demonstrating the potential of this technology for rapid analysis of the nutritive value of *Urochloa* sp. forages and offering a fast and cost-effective service to ranchers.
Key words: age; cultivars; crude protein; indigestible neutral detergent fiber; near-infrared spectroscopy

ESTIMATIVA DO VALOR NUTRITIVO DE FORRAGENS DE *UROCHLOA* sp. (SIN. *BRACHIARIA* sp.) PELO NIRS

RESUMO

O sistema de produção em pasto é o mais econômico para alimentação de bovinos, e por isso novas cultivares de *Urochloa* sp. (sin. *Brachiaria* sp.) são lançadas no Brasil. No entanto, o método de análise da composição química de forragens em laboratório é demorado e de custo elevado, e como alternativa surge o método NIRS (espectroscopia no infravermelho próximo), sendo rápido e não poluente, por não utilizar reagentes químicos nas análises. Objetivou-se avaliar a estimativa do valor nutritivo de forragens de *Urochloa* sp. pelo NIRS de modo a oferecer um serviço rápido e de baixo custo aos produtores. O delineamento experimental foi o inteiramente casualizado com quatro repetições. Os tratamentos foram arranjados em esquema de parcelas subdivididas, sendo oito espécies/cultivares na parcela (*U. decumbens* cv. Basilisk; *U. humidicola* cv. Tupi, *U. brizantha* cultivares Piatã, Xaraés, MG-5 Vitória, MG-13 Braúna; *U. hibrida* cultivares Ipyporã e Mavuno) e quatro idades de corte na subparcela (30, 60, 90 e 120 dias). Foram avaliados os teores de matéria seca (MS), proteína bruta (PB), fibra detergente neutro (FDN) e ácido (FDA), cinzas (CIN) e fibra em detergente neutro indigestível (FDNi). Com o avanço na idade, observa-se aumento médio diário nos teores de MS (0,28%), FDN (0,15%), FDA (0,17%), FDNi

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, e redução nos teores de PB e CIN na maioria das cultivares avaliadas. O valor nutritivo piora com a idade, recomendando o pastejo dos bovinos em idade inferior a 60 dias para a maioria das cultivares. O capim Ipyporã, híbrido interespecífico de *U. ruziziensis* e *U. brizantha*, apresenta bom valor nutritivo com o avanço na idade, sendo uma opção para diversificação e diferimento de pastagens. As estimativas pelo NIRS são excelentes (R^2_{cv} > 0,95) para PB e CIN, demonstrando o potencial desta tecnologia para a análise do valor nutritivo de forragens de *Urochloa* sp., oferecendo um serviço rápido e de baixo custo aos produtores.
Palavras chave: cultivares; espectroscopia no infravermelho próximo; fibra em detergente neutro indigestível; idade; proteína bruta.

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INTRODUCTION

The pasture-based animal production system is the most economical option for cattle feeding in Brazil. The forages from the *Urochloa* sp. (syn. *Brachiaria* sp.) genus are particularly prominent in the states of Goiás, Mato Grosso, and Mato Grosso do Sul due to their wide adaptability to the region's climate and soil conditions (DIAS-FILHO, 2014).

However, there is a need to intensify forage production systems by optimizing the relevant management factors in order to achieve greater increases in productivity and quality (DANTAS et al., 2016). Consequently, new cultivars of forage plants are launched every year in Brazil.

It is worth noting that over 70% of the pastures in the Cerrado biome are composed of forage species from the *Urochloa* sp. genus, which allows estimating that around 80 million hectares are covered by pastures of this genus. Therefore, studies should be conducted to recommend new species and/or cultivars with greater productive potential that can better utilize soil nutrients (CAMACHO et al., 2015), such as the *Urochloa* hybrid cultivars Mavuno and Ipyporã, and the *U. humidicola* cultivar, known as Tupi grass.

In addition to productivity, it is essential to analyze the nutritional value of forage. According to Barros et al. (2019), most forage species undergo an increasing lignification of the cell wall and an increase in the proportion of cellulose, hemicellulose, and acid detergent fiber (ADF) with age. It is worth noting that the levels of ADF, lignin, neutral detergent fiber (NDF), and crude protein (CP) are directly related to forage digestibility, as a decrease in fiber and lignin content leads to increased digestibility and CP of the forage.

The evaluation of the chemical composition of forages relies on several important parameters, including dry matter (DM), crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), ash, and total digestible nutrients (TDN) (RECH, 2018). The conventional laboratory analysis method for these parameters is time-consuming and costly. As an alternative approach, near-infrared spectroscopy (NIRS) has emerged as a highly accurate method for predicting CP, NDF, ADF, and ash content in forages, hay, and silages (ARZANI et al., 2015; ANDUEZA et al., 2016; RAFFRENATO et al., 2018).

The significant advantage of NIRS technology lies in its ability to perform multiple constituent analyses, its faster speed, lower cost, and its non-polluting nature as it does not require the use of chemical reagents (MASSIGNANI et al., 2021; SERAFIM et al., 2021; SIMONI et al., 2021; PETERS et al., 2023).

Considering the recent release of the grasses Tupi (2013), Mavuno (2016), and Ipyporã (2017), research should be conducted to assess the nutritional value of these new cultivars compared to those already used in the production system. Furthermore, the analysis of the chemical composition of *Urochloa* sp. forages should be expedited to provide prompt feedback to ranchers for decision-making, with the potential use of NIRS technology.

Therefore, the aim of study was to assess the estimation of the nutritional value of *Urochloa* sp. cultivars using near-infrared spectroscopy.

MATERIALS AND METHODS

Location and experimental design

The experiment was conducted at the Experimental Farm of the Federal University of Mato Grosso, located at coordinates 15°47' South Latitude and 56°04' West Longitude, with an altitude of 140 meters. The climate, classified according to the Köppen classification, is of the Aw type (megathermal tropical climate), characterized by two distinct seasons: a dry season (from May to September) and a rainy season (from October to April). The annual rainfall reaches 1500 mm, with the highest intensity occurring in the months of December, January, and February.

The predominant soil in the area is Plintosol (Plintosol Tb albic moderate), characterized by a medium texture and a flat relief. This type of soil facilitates water infiltration, soil aeration, root penetration, and the development of root systems.

The experimental design was a completely randomized design (CRD) with four replications. The treatments were arranged in a split-plot arrangement, with eight species/cultivars of *Urochloa* sp. in the main plot (*U. decumbens* cv. Basilisk; *U. humidicola* cv. Tupi, *U. brizantha* cultivars Piatã, Xaraés, MG-5 Vitória, MG-13 Braúna; *U. hibrida* cultivars Ipyporã and Mavuno) and four harvesting ages in the subplot (30, 60, 90, and 120 days).

The experiment was conducted in an established pasture area with *Urochloa* sp. cultivars, and soil samples were collected from the 0 to 10 cm layer for chemical and particle size analysis. The specific results of these analyses can be found in Table 1.

Table 1. Chemical and granulometric characteristics of the soil of the experimental area (Santo Antônio do Leverger, MT, Brazil).

pH	P	K	Ca	Mg	Al+H	MO	Sand	Silt	Clay	SB	CEC	V
$CaCl_2$	mg dm^3			cmol$_c$ dm^3		g dm^3		g kg^{-1}		cmol$_c$ dm^3		%
5.9	5.3	31.1	1.9	0.77	2.98	1.89	740	59	201	2.75	5.72	47.88

OM: organic matter; SB: sum of bases; CEC: cation exchange capacity; V: base saturation.

Considering the cultivars' minimum requirement of 40 to 45% base saturation, there was no need to apply lime. Following a uniform harvest, maintenance fertilization was carried out by top-dressing with 40 kg P_2O_5 ha^{-1}, 100 kg N ha^{-1}, and 100 kg K_2O ha^{-1}.

At the predetermined harvesting ages, the cultivars were harvested with residue heights set at 20 cm (Braúna, Ipyporã, Mavuno, MG-5 Vitória, Piatã, Xaraés), 15 cm (Decumbens), and 10 cm (Tupi), in accordance with the recommendations by Costa and Queiroz (2017). The harvested forages were then chopped, placed in paper bags, and dried in a forced ventilation oven at a temperature of 55 °C for 72 hours.

Chemical analysis

The chemical composition analyses of the forages were conducted at the Forage Laboratory of the Federal University of Mato Grosso, Cuiabá.

The pre-dried samples were weighed and milled using a stationary mill with a 1.0 mm sieve. They were then stored in polyethylene containers for analysis of the definitive dry matter (DM) content. This analysis was conducted by placing the samples in an oven at 105 °C for 4 hours, following the AOAC (1995) guidelines.

Forage samples were subjected to analysis of ash, crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF contents, according to Silva and Queiroz (2002). The indigestible neutral detergent fiber (iNDF) was determined following Cochran et al. (1986).

The obtained data were subjected to analysis of variance and regression, using a significance level of 5% probability of error.

Calibration curves

The calibration using NIRS were carried out at the Forage Laboratory of the Federal University of Santa Catarina, Florianópolis.

Approximately 15.0 g of milled forage sample was transferred to a quartz bottom sample holder, which was then coupled to an MPA FT-NIR device (Bruker® Optik GmbH, Rudolf Plank Str. 27, D-76275 Ettlingen). Spectra were generated in triplicate, with 64 different scanned points and a resolution of 16 cm^{-1}, covering the wavenumber range from 4,000 to 12,500 cm^{-1}.

Reference values of CP, NDF, ADF, iNDF, and ash content as a percentage of DM were added to the spectra of the forage samples. Data pretreatment and chemometric model development, including the construction of calibration curves, were performed using the Opus 7.5 software, employing the partial least squares model (PLS) (BJORSVIK & MARTENS, 2001).

The calibration model was selected based on the lowest root mean square error of cross-validation (RMSECV) and the highest coefficient of determination (R^2) values. Additionally, values of relative deviation performance (RDP) and relative error ratio (RER) above 3 and 10, respectively, were considered as criteria for model selection (WILLIAMS & SOBERING, 1993).

Samples that appeared as discrepant in the graphs were detected and excluded from the models.

RESULTS AND DISCUSSION

Chemical composition of forage

The nutritional value of the forage from different cultivars of *Urochloa* sp. was found to be influenced by the harvesting ages. There was a linear increase in the contents of DM, NDF, and ADF with advancing age, as indicated in Table 2. However, it should be noted that the cultivars Tupi, Piatã, and Xaraés presented average contents of ADF at 46.27%, 43.30%, and 45.91%, respectively, deviating from the observed linear trend.

Table 2. Means of dry matter (DM, %), crude protein (CP, % DM), neutral detergent fiber (NDF, % DM), acid detergent fiber (ADF, % DM), ash (% DM) and indigestible neutral detergent fiber (iNDF, % DM) in forages of *Urochloa sp.* cultivars (syn. *Brachiaria* sp.) at different ages (days).

Contents	Age (days)				Regression equation[1]	R^2	CV(%)
	30	60	90	120			
Brauna							
DM	22.42	24.67	34.61	42.02	$\hat{y}$= 13.7500 + 0.2291x**	0.95	5.26
CP	16.34	8.08	5.03	4.48	$\hat{y}$= 18.1462 – 0.1287**	0.84	9.83
NDF	66.21	72.52	81.55	81.35	$\hat{y}$= 61.7962+0.1814x**	0.89	2.14
ADF	32.55	39.05	48.82	54.48	$\hat{y}$= 24.8425 + 0.2518x**	0.99	4.65
Ash	10.06	8.41	7.94	8.05	$\hat{y}$= 10.2437 – 0.0216x**	0.73	2.84
iNDF	18.75	24.05	28.67	27.45	$\hat{y}$= 17.0537 + 0.1024x**	0.80	3.73
Decumbens							
DM	24.40	30.14	41.12	42.61	$\hat{y}$= 18.1675 + 0.2187x**	0.93	8.92

CP	12.14	7.75	5.46	5.30	ŷ= 13.3662 – 0.0760x**	0.85	14.64
NDF	66.56	67.79	68.93	70.96	ŷ= 64.9762 + 0.0478x**	0.98	3.60
ADF	36.58	39.54	40.96	42.82	ŷ= 34.9487 + 0.1137x**	0.97	4.62
Ash	9.28	8.75	8.38	8.02	ŷ= 9.4737 – 0.0120x**	0.81	2.78
iNDF	18.03	18.06	20.63	21.78	ŷ= 16.1662 + 0.0461x**	0.89	7.53
				Tupi			
DM	-	23.68	34.60	42.99	ŷ=4.7929 + 0.3218x**	0.99	3.15
CP	8.04	10.41	7.79	7.47	ŷ= 6.1581 + 0.0974x- 0.0007x^2**	0.51	11.71
NDF	71.05	75.80	69.66	69.63	ŷ= 68.145 + 0.1561x- 0.0013x^2**	0.44	2.82
ADF	46.78	43.39	46.43	48.49	ȳ= 46.27	-	3.98
Ash	8.94	9.40	8.78	9.38	ȳ= 9.12	0.68	3.87
iNDF	21.27	19.68	22.23	22.15	ȳ= 21.30	0.92	3.57
				Ipyporã			
DM	17.38	19.18	33.14	43.00	ŷ= 5.3512 + 0.3035x**	0.93	3.78
CP	14.94	12.88	8.47	4.47	ŷ= 19.1462 – 0.1193x**	0.98	9.20
NDF	47.08	55.03	53.36	71.83	ŷ= 54.5616 + 0.1354x**	0.94	3.81
ADF	26.95	33.06	41.33	52.06	ŷ= 17.4912 + 0.2782**	0.98	7.82
Ash	10.68	9.34	8.84	7.74	ŷ= 11.4875 – 0.0311x**	0.93	3.04
iNDF	17.91	21.12	25.03	29.02	ŷ= 13.9637 + 0.1241x**	0.99	3.04
				Mavuno			
DM	-	21.67	37.08	40.20	ŷ= 5.1987 + 0.3087x**	0.87	7.54
CP	13.99	7.71	4.42	3.96	ŷ= 15.8650 – 0.1112x**	0.88	15.32
NDF	58.95	67.70	62.59	60.02	ŷ= 48.651 + 0.4652x- 0.0031x^2**	0.70	4.76
ADF	38.89	46.64	46.14	48.02	ŷ= 38.2000 + 0.0896x**	0.72	6.25
Ash	10.55	7.71	8.00	7.38	ŷ= 10.7187 – 0.0307x**	0.67	11.30
iNDF	16.27	19.85	19.89	20.55	ŷ= 15.9212 + 0.0429x**	0.73	7.73
				MG-5			
DM	20.55	23.94	36.24	-	ŷ= 11.2175 + 0.2616x**	0.90	8.95
CP	15.80	9.05	5.92	-	ŷ= 20.1391 – 0.1646x**	0.95	7.12
NDF	63.53	65.84	77.89	-	ŷ= 54.7316 + 0.2392x**	0.86	1.89
ADF	39.08	42.64	45.96	-	ŷ= 35.6783 + 0.1147x**	0.99	3.42
Ash	10.17	8.69	8.09	-	ŷ= 11.0708 – 0.0347x**	0.94	1.10
iNDF	15.37	22.53	25.30	-	ŷ= 11.1408 + 0.1655x**	0.93	23.68
				Piatã			
DM	21.86	23.55	42.91	47.98	ŷ= 9.6475 + 0.3257x**	0.89	5.20
CP	16.52	10.35	4.45	4.15	ŷ= 19.6187 – 0.1432x**	0.90	13.14
NDF	65.52	71.87	77.46	76.84	ŷ= 63.0400 + 0.1318x**	0.85	2.30
ADF	40.99	37.39	50.34	44.47	ȳ= 43.30	-	7.87
Ash	10.22	9.04	7.51	7.75	ŷ= 10.8712 – 0.0297x**	0.91	2.60
iNDF	20.69	21.69	26.58	27.51	ŷ= 17.7800 + 0.0845x**	-	8.06
				Xaraés			
DM	22.84	28.16	37.95	43.01	ŷ= 13.0950+0.2519x**	0.98	5.87
CP	12.10	7.28	4.35	5.29	ŷ= 13.0950-0.0778x**	0.76	16.56
NDF	62.88	71.5	80.41	77.86	ŷ= 59.7275+0.1793x**	0.79	3.78

ADF	43.29	45.35	48.77	46.18	ȳ= 45.91	0.84	9.17
Ash	9.21	8.30	7.76	8.29	ȳ= 8.39	0-	3.27
iNDF	23.24	23.20	25.87	25.99	ŷ= 21.8500+0.0363x**	0.81	6.27

CV: Coefficient of variation; R^2: Coefficient of determination; [1]**: Significant at a 1.0% level of probability, by the F test.

Regarding DM content, the increase ranged from 0.21 to 0.32% per day, and the cultivars Piatã and Tupi obtained the highest daily increases (0.32%) (Table 2). The DM contents obtained ranged from 17% to 48%. Loreto et al. (2019), when evaluating the nutritional value and DM accumulation of *U. brizantha* cv. Marandu forage, under different deferral periods with nitrogen fertilization levels, also observed similar DM contents, ranging from 17% to 46% between the months of March and June, respectively.

Smaller increments in NDF (0.04% per day) and ADF (0.08% per day) were obtained by the cultivars Decumbens and Mavuno, respectively. According to Melo et al. (2023), increasing age leads to changes in the content and cell wall associated with intensified deposition of phenolic compounds, such as lignin, aiming for greater plant sustainability. However, this compromises the forage quality, resulting in decreased protein content and increased NDF contents.

With the exception of Ipyporã grass, the cultivars presented NDF contents above 65%, which is considered as the maximum critical content for forage intake by ruminant animals. The cultivars Tupi, Piatã and Xaraés presented ADF contents above 40% since the age of 30 days, which directly affects the intake and leads to a lower digestibility of the forage consumed. It is worth noting that the maximum contents of NDF (81.55%) and ADF (54.48%) were close to those found by Assis et al. (2014), who evaluated the genetic divergence between *U. humidicola* and hybrids in the Amazon Biome and observed NDF contents of 81.34% and ADF contents of 55.14%, respectively.

With advancing age, a linear reduction in the contents of CP and ash was observed in all cultivars evaluated (Table 2). The cultivars that obtained the greatest decreases in CP contents for each one-day increase in age were Decumbens and Xaraés (0.07%); Ipyporã and Mavuno (0.11%). Conversely, the greatest daily reduction in CP content was observed in the cultivars MG-5 (0.16%) and Piatã (0.14%). According to Martins et al. (2013), the protein content was the main limiting factor for dry matter intake and, consequently, weight gain in cattle grazing *U. humidicola* pastures.

In the Central Brazil conditions, where pastures have low nutritional value, the protein content is below the critical level to meet the requirements of ruminal microbiota (7.0% CP), resulting in a reduction in dry matter intake. Therefore, it is recommended to graze cattle under 60 days of age for most cultivars.

Barros et al. (2019) state that this 7.0% threshold applies to adult cattle, but the minimum protein requirement increases to 11.0% for young animals. These authors also claim that protein contents below these limits lead to a decrease in dry matter intake by animals due to nitrogen deficiency for ruminal microorganisms.

The largest daily reductions in ash contents (0.03% per day) were observed in the hybrids (Mavuno, Ipyporã) and MG-5. On the other hand, Decumbens showed a lower daily reduction in ash content (0.01%). The ash content had little variation over the harvesting ages in the cultivars evaluated (7.22 to 10.68%), showing that the aging of the plants little interfered in this characteristic. Melo et al. (2023) also observed a slight reduction in NDF content (0.12% per day) with advancing age. As a result, it is important to emphasize the significance of mineral supplementation for animals maintained in pasture production systems in order to correct the low mineral levels in the forage.

A linear increase in iNDF content was observed with advancing age in all evaluated cultivars (Table 2). The highest daily increase was observed for MG-5 Vitória (0.16%), while the lowest increases were observed for Decumbens and Mavuno (0.04%) and Xaraés (0.03%). According to Carvalho et al. (2021), the forage NDF consists of two fractions: an indigestible fraction (iNDF) and a potentially degradable fraction (pdNDF). The pdNDF disappears in the rumen through microbial digestion, while the iNDF leaves the rumen only by passage. The determination of indigestible NDF in forages is commonly done by measuring the residual NDF of the material remaining after in situ or in vitro incubations. Its study is important to understand the physical repletion to the ruminal environment.

The hybrid grass Ipyporã, which is an interspecific hybrid of *U. ruziziensis* and *U. brizantha*, stands out for its good nutritional value (ECHEVERRIA et al., 2016). It maintains protein content above 7.0% up to 102 days of age, as well as appropriate contents of NDF (<60%) and ADF (<40%) at advanced ages. It is a good alternative, compared to Decumbens and Marandu grasses, for deferred grazing.

U. humidicola cv. Tupi, due to its low variability in protein, NDF, and ADF content, represents an alternative for diversifying pastures in low-fertility soils that are subject to temporary flooding.

Estimates by NIRS

The high variability observed in the bromatological composition of forage samples from different species and/or cultivars of *Urochloa* sp. was a positive factor for the estimates using NIRS. A total of 113 samples were used for the calibration set. In the calibration process, a maximum limit of 10% outliers was adopted, with the protein content showing the lowest percentage (5.60%).

In the calibration process, it was observed that the coefficient of determination of cross-validation (R^2_{cv}), RDP, and RER values were all above 0.95, 3, and 10, respectively. This demonstrates an excellent estimation of the CP and ash contents of *Urochloa* sp. forages (Table 3 and Figure 1). Additionally, low RMSECV values were also observed. For the ash and iNDF contents, no preprocessing was required.

Table 3. Parameters and preprocessing models used to predict crude protein (CP % DM), neutral detergent fiber (NDF, % DM) and acid (ADF, % DM), ash and indigestible neutral detergent fiber (iNDF, % DM) in *Urochloa* sp. forages. (syn. *Brachiaria* sp.) for calibration sets.

Variables	RMSECV (% DM)	R^2_{cv}	RDP	RER	Preprocessing
CP	0.54	0.98	8.02	34.61	NSDP
NDF	4.87	0.80	2.24	7.62	SDER
ADF	3.33	0.83	2.40	8.34	MMN
Ash	0.13	0.97	6.86	29.15	FDSLS
iNDF	0.98	0.88	2.89	13.73	FDSLS

RMSECV: root mean square error of cross-validation; R^2_{cv}: coefficient determination of cross-validation; RDP: relative deviation performance; RER: relative error ratio; NSDP (*No Spectral Data Preprocessing*), SDER (*Second Derivative*); MMN (*Min-Max Normalization*); FDSLS (*First Derivative + Straight Line Subtraction*)

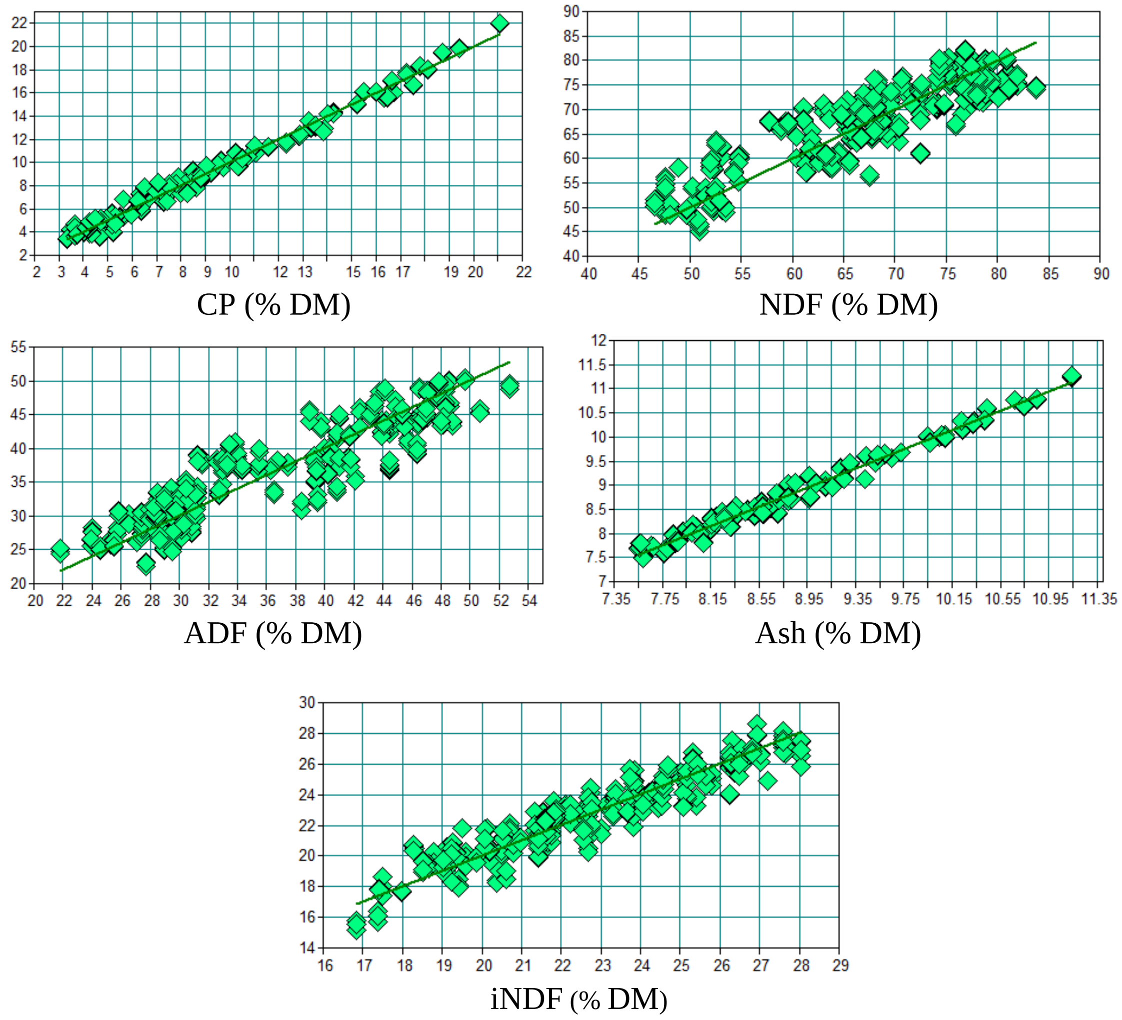

Figure 1. Curve of crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), ash and indigestible neutral detergent fiber (iNDF) of *Urochloa* sp. (syn. *Brachiaria* sp.) forage for calibration sets. X-axis: value analyzed by the reference chemical method; Y-axis: value predicted by NIRS.

Lobos et al. (2013), evaluating the nutritional quality of mixed permanent pastures in southern Chile, comprising different proportions of grasses such as *Lolium perenne*, *Agrostis* sp, *Holcus lanatus*, *Bromus valdivianus*, and *Dactylis glomerata*, as well as legumes such as alfalfa (*Medicago sativa* L.) and clovers (*Trifolium pratense* L.; *T. repens* L.), also found adequate R^2_{cv} values for CP (0.99). However, the estimates were not suitable for DM (R^2_{cv} = 0.85) and *in vitro* DM digestibility (R^2_{cv} = 0.90).

Molano et al. (2016) evaluated 1991 samples of tropical forage grasses and legumes, which showed high heterogeneity in terms of regrowth age, vegetative state, plant parts collected, sampling period, and sample origin. In the NIRS calibration, the authors also found high R^2_{cv} values for CP (0.99). In contrast to our results, they obtained excellent R^2_{cv} values for NDF (0.99) and ADF (0.95).

Hernandez et al. (2021), evaluating forages of *U. humidicola*, *U. brizantha*, and the hybrid Mulato I (*U. ruziziensis* x *U. brizantha*) in Mexico, with harvests performed every 35 days over a one-year period, also found high R^2_{cv} values for CP (0.95). The authors also evaluated other protein fractions such as soluble protein, neutral detergent insoluble protein (NDIP), and acid detergent insoluble protein (ADIP), but the NIRS estimates were inefficient, with R^2_{cv} values of 0.92, 0.30, and 0.07, respectively.

In a study conducted by Anderson et al. (2018) in the United States, with 30 accessions of Elephant grass (*Pennisetum purpureum* Schum.), excellent estimates were also obtained using NIRS for CP and ash contents, with R^2_{cv} values of 0.99 and 0.98, respectively.

Serafim et al. (2021), evaluating 105 samples of forages and Tifton 85 (*Cynodon dactylon*) hay, also observed low R^2_{cv} values for NDF (0.80) and ADF (0.80). On the other hand, Massignani et al. (2021), assessing 200 samples of forages from 26 grass species and 6 legume forage species, found high R^2_{cv} and RPD values for CP (0.98; 7.23), NDF (0.95; 4.34), and ADF (0.96; 4.75), respectively. The authors concluded that the calibration curves were suitable for routine evaluation of CP, NDF, and ADF content for estimating the nutritional value of forages.

CONCLUSION

With advancing age, there is an increase in the contents of dry matter, neutral detergent fiber, acid detergent fiver, indigestible neutral detergent fiber, and a reduction in the contents of crude protein and ash in most of the evaluated cultivars. The species/cultivars that showed better nutritional value were Ipyporã, Mavuno, Xaraés, and Decumbens.

The nutritional value deteriorates with age, leading to a recommendation of grazing cattle for periods shorter than 60 days for the majority of cultivars.

The hybrid grass Ipyporã, which is an interspecific hybrid of *U. ruziziensis* and *U. brizantha*, exhibits good nutritional value as it matures, making it a suitable option for diversifying pastures and deferred grazing.

The NIRS estimates for crude protein and ash are excellent ($R^2_{cv} > 0.95$), demonstrating the potential of this technology for rapid analysis of the nutritional value of *Urochloa* sp. forages. This offers a fast and cost-effective service to ranchers.

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