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Chemical composition and crude protein fractions of Coastcross grass under grazing on winter, spring and summer in Southern Brazil

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ABSTRACT. The objective of this study work was to assess crude protein fractions in structural components (leaves, stem and dead material) of Coastcross grass (*Cynodon dactylon* (L.) Pers) under grazing, on winter, spring and summer seasons, in the Northwestern of Paraná, South of Brazil. Were determined CP, NDF, ADF contents and protein fractions, A, B1, B2, B3 and C. The analysis of CP showed great differences among months, but there was no difference among seasons. NDF and ADF in the stem were lower ($p < 0.05$) during the spring. The season did not affect ($p > 0.05$) protein fractions A, B1, B2, B3 and C of leaves. However, it was observed that the highest proportions of CP were B3 and A fractions. For the stem, the most important crude protein fraction is A, and it was observed that B1 fraction was lowest ($p < 0.05$) in the spring. Considering crude protein fractions of the Coastcross grass, in this study conditions, we can conclude that Coastcross grass presents adequate protein value for beef cattle production on pasture.

Keywords: seasons, nitrogen, ruminants, CNCPS.

Composição química e fracionamento da proteína bruta da gramínea Coastcross no inverno, primavera e verão no sul do Brasil

RESUMO. O objetivo deste estudo foi determinar as frações da proteína bruta dos componentes estruturais (lâmina verde, colmo e material morto), da gramínea Coastcross (*Cynodon dactylon* (L.) Pers), nas estações do inverno, primavera e verão, no Noroeste do Estado do Paraná, Sul do Brasil. Foram determinados os teores de PB, FDN, FDA e a frações proteicas A, B1, B2, B3 e C. A análise de PB mostrou grande variabilidade entre os meses, porém, não houve diferença entre as estações. Os teores de FDN e FDA no colmo foram menores ($p < 0,05$) durante a primavera. As frações proteicas A, B1, B2, B3 e C da lâmina verde não foram alteradas pela estação do ano ($p > 0,05$). Porém, foi observado que as frações mais representativas foram a B3 e a A em sua ordem. No colmo, a fração da proteina bruta de maior importância é a A e foi observado que a fração B1 foi menor ($p < 0,05$) na primavera. Considerando as frações da proteina bruta da gramínea Coastcross, nas condições deste estudo, pode-se concluir que essa apresenta valor proteico adequado para produção de bovinos de corte em pastagem.

Palavras-chave: estações, nitrogênio, ruminantes, CNCPS.

Introduction

Pastures are the main and more economical feed in beef cattle production and, as such, represent the base for beef cattle systems in Brazil (PRIMAVESI et al., 2004). However, it is necessary to consider the nutritional quality of each grass species, to make possible to provide a balanced diet, according to the requirements of each animal category. Coastcross (*Cynodon dactylon* (L.) Pers) is one of the most important and widely forage used in tropical and subtropical America, for grazing and to produce hay, as result of its desirable characteristics for hay production, due to its high dry matter production per area unit and its high nutritional value (CAMPOS et al., 2005).

To formulate a diet for ruminants with greater accuracy, crude protein should be fractionated in nitrogen components (SNIFFEN et al., 1992). The evaluation can be done using CNCPS (Cornell Net Carbohydrate and Protein System), to fractionate the crude protein in five parts A, B1, B2, B3 and C.

The fraction A consists of non-protein nitrogen (NPN), which is highly degradable in the rumen and fractions B and C represent the true protein. Fraction B is subdivided in three sub-fractions, based on rate of rumen degradation. B1 fraction (albumins and globulins) is soluble in rumen and has a high degradation rate. B2 fraction (mainly albumin and glutelin) has an intermediate degradation rate, and B3 fraction is protein associated with cell wall (prolamins, extensins and denatured proteins), and show slow degradation rate. C fraction is composed by acid detergent insoluble protein (ADIP), and, therefore, is non-digestible in rumen nor intestine (RUSSELL et al., 1992; SNIFFEN et al., 1992). This system aims to better characterize the food in order to combine proteins and carbohydrates to get the maximum performance of the rumen microbial flora, reducing losses of nitrogen by the animal, and to estimate the ruminal escape of nutrients (RUSSELL et al., 1992; SNIFFEN et al., 1992). This, ultimately, would enable nutritionists to work with more reliable predictions in relation to animal performance. The aim of this study was to characterize and quantify the chemical composition and protein fractions of the structural components of Coastcross grass (*Cynodon dactylon* (L.) Pers) according to the system CNCPS, in the winter, spring and summer seasons.

Material and methods

The experiment was conducted at Dona Elisa Farm, in Luiziana Town, Northwest of Paraná State, from June 2000 to February 2001 (Winter, spring and summer season). The farm soil is classified as Typical Dark (RAUEN et al., 1996) and climate (Table 1) is subtropical humid mesothermal (SEAB, 2009).

Table 1. Average rainfall, maximum and minimum air temperatures recorded during the experiment.

Month	Maximum Temperature °C	Minimum Temperature °C	Precipitation (mm)
June	23.0	13.3	155
July	23.7	13.1	106
August	25.6	14.6	209
September	26.2	15.7	252
October	28.4	17.6	138
November	29.5	18.8	154
December	29.9	20.0	127
January	30.3	20.6	184
February	30.1	20.5	159

Source: Agronomic Institute of Paraná - IAPAR (2000 - 2001).

The total area used in the experiment (12.4 hectares) was divided into seven paddocks, where Coastcross grass (*Cynodon dactylon* (L.) Pers) was implemented in 1997. In the winter were used three paddocks with a total area of 7.35 hectares (2.6, 2.45, and 2.3 ha paddock^{-1}). In the spring and summer, were used four paddocks, with a total area of 5.05 ha (1.2, 1.4, 1.1 and 1.35 ha paddock^{-1}). The area was fertilized based on the results of soil analysis. The fertilization with phosphorus and potassium was carried out and haul in coverage, using simple superphosphate and potassium chloride, respectively, in April 2000. The nitrogen in the form of urea was split in two applications in May and August 2000.

The analysis of pasture quality was accomplished according to the structure component (green blade, stem and dead material), obtaining samples by the method of double sampling, every 28 days in each paddock (WILM et al., 1944).

The samples were dried in an oven with forced ventilation of air at 55°C for 72h, and processed sequentially in Willey mill type, using strainer with 1 mm sieve. The levels of dry matter (DM) at 105°C, crude protein (CP), were determined according to AOAC (1990), neutral detergent fiber (NDF) and acid detergent fiber (ADF) by the method of fiber partition (VAN SOEST et al., 1991). Samples of green blade, stem and dead material were analyzed to obtain protein fractions through the CNCPS (SNIFFEN et al., 1992). The fraction A was obtained from the treatment of one subsample (0.5 g) with 50 mL of water per 30 min., with subsequent addition of 10 mL of trichloracetic acid (TCA) 10% per 30 min. (KRISHNAMOORTHY et al., 1983). Then filtration was performed by vacuum suction, the material in glass crucible (the same used for the march of FDN), previously weighed. Then, the crucible with the residue was taken in the oven (105°C) for 8h. After, a residual subsample of that crucible was removed (0.1 g), for determination of residual nitrogen (fraction A). Nitrogen insoluble in borate phosphate buffer (TBF) was determined incubating a subsample (0.1 g) with phosphate-borate buffer ($NaH_2PO_4.H_2O$ at 12.2 g L^{-1} + $Na_2B_4O_7.10H_2O$ at 8.91 g L^{-1} + 100 mL 1-butyl alcohol tertiary).

The total soluble nitrogen (NPN + soluble protein) was obtained by the difference between total nitrogen and residual nitrogen insoluble in TBF (SNIFFEN et al., 1992). The B1 fraction was obtained by the difference between total soluble nitrogen fraction and fraction A. Fraction B2 was determined by the difference between the insoluble in borate-phosphate buffer fraction and neutral detergent insoluble nitrogen (NDIN) fraction (SNIFFEN et al., 1992). Fraction B3 resulted from the difference between the NDIN and acid detergent insoluble nitrogen (ADIN) (SNIFFEN et al., 1992). Fraction C was determined as ADIN (VAN SOEST et al., 1991). The neutral detergent insoluble protein (NIDP) and acid detergent (ADIP) were obtained by multiplying NIDN and ADIN by 6.25.

The results of chemical analysis and fractionation of PB were subjected to analysis of variance using the program SAEG - System for Genetic Analysis and Statistics (SAEG, 1997). The averages of each variable for each season were compared, using the Tukey test at 5% probability.

Results and discussion

The percentages of crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF), in green blade, stem and dead material of the Coastcross grass (*Cynodon dactylon* (L.) Pers) on the winter, spring and summer seasons are shown in Table 2. The CP content varied with the material analyzed. CP analysis of green blade showed variation among months, from 12.28 to 28.06%, and these values were found on November and August, respectively. Considering the season, the highest average was observed on winter (18.69 %), and the lowest on summer (14.86%), however, there was no statistical difference ($p > 0.05$) for this variable. CP content in the stem was not influenced ($p > 0.05$) by season, however, was observed a direct correlation with monthly rainfall (Table 1) in which the highest value of CP in the stem (10.35%) was observed in months with higher precipitation (252 mm). Similar result was also observed by Soares Filho et al. (2002) who found higher content of CP in Coastcross on months with greater rainfall, in the Northwest of São Paulo State.

Table 2. Chemical composition of Coastcross grass (*Cynodon dactylon* (L.) Pers), in three seasons of the year.

	Green Blade			Stem			Dead Material		
	PB	FDN	FDA	PB	FDN	FDA	PB	FDN	FDA
Jun	14.15	67.18	31.12	5.18	75.53	42.33	4.94	78.95	43.23
Jul	13.87	65.25	27.21	6.44	76.69	41.94	8.84	75.10	40.02
Aug	28.06	54.33	23.31	6.81	74.54	42.93	5.03	82.24	46.87
Winter	18.69	62.25	27.21	6.14	75.58[a]	42.40[a]	6.27	78.76	43.37
Sept	21.67	59.54	26.44	10.35	70.45	36.09	5.04	80.84	47.04
Oct	15.73	63.88	28.32	8.00	70.91	35.28	4.86	84.19	46.51
Nov	12.28	64.33	31.64	5.99	69.71	39.68	4.76	77.51	45.42
Spring	16.56	62.58	28.80	8.11	70.36[b]	37.02[b]	4.89	80.85	46.32
Dec	15.69	63.35	27.76	7.65	75.83	36.96	5.32	76.17	43.66
Jan	15.32	69.35	32.63	6.54	77.65	41.08	6.96	78.77	44.54
Feb	13.56	63.83	30.44	6.11	75.48	40.22	4.63	77.60	42.93
Summer	14.86	65.51	30.28	6.76	76.32[a]	39.42[ab]	5.67	77.51	43.71
CV (%)	32.73	7.40	10.65	20.39	1.32	4.71	26.10	3.70	4.69

Averages followed by minor letters in the column are different ($p < 0.05$) by Tukey test.

The increase in the plant age causes a decrease in percentage of leaf blades, and consequently CP content, mainly because of the increase on stem mass (MOTA et al., 2010).

According to the literature, the content of CP observed for Coastcross grass is influenced by the weather and management (GONÇALVES et al., 2002). Nitrogen fertilization associated with shorter period between cuts and climatic variables enable the development of larger amount of leaf mass, rich in protein and low in the cell wall. As the period between cuts increase occur a decrease in CP, and an increase in cell wall content. On the other hand, it was observed that there was a lower concentration of NDF and ADF in the stem ($p < 0.05$) in the spring, with values ranging from 70.36 to 37.02%, respectively, given that climatic conditions, especially the temperature, limited plant growth. There was no ($p > 0.05$) influence of season on the chemical composition of dead material.

Overall, NDF content ranged from 54.33% in the green blade to 84.19% in the dead material. In the green blade, the DNF ranged from 69.35 to 54.33%, with the highest average in the summer and the lowest in the winter. In the stem NDF ranged from 77.65 to 69.71%, and the highest average was found in the winter and summer seasons, and the lowest in the spring. ADF content ranged from 23.31% in the green blade to 47.04% in the dead material. ADF represents the less digestible forage portion (VAN SOEST, 1994), so it is desirable that ADF content in forages is the lowest possible. According to Gonçalves et al. (2002), the initial growth of Coastcross is more vigorous in the early growing season (spring). In the initial stages of growth, forage consists mainly of leaves at the expense of the stem (REIS et al., 2003).

This higher proportion of green blade can be attributed to the needs that the plant has to produce substances for their development, increasing the photosynthetic area which is represented in higher content of CP and lower NDF and ADF in the plant in spring. The forage structural components of most interest are the leaves, because when there is a good forage availability, ruminants select leaves with minimal consumption of stem. In the leaves, nutrients are concentrated and present higher quality for the animal. However, as the plant reaches maturity, there is a decrease in the proportion of leaves, associated with an increase in senescent material (OLIVEIRA et al., 2008).

CP fractions for green blade, stem and dead material are shown in Table 3. The season of the year did not influence ($p > 0.05$) content of crude protein fractions, A, B1, B2, B3 and C, in green blade. It was observed that the highest proportion of CP fraction corresponded to B3 fraction, followed by A fraction. It is remarkable that C fraction (indigestible fraction) in green blade had the lowest values, which is interesting from a nutritional standpoint.

Table 3. Values of A, B1, B2, B3 AND C fractions of crude protein of Coastcross grass (*Cynodon dactylon* (L.) Pers), in three seasons of the year.

	A (% CP)	B1 (% CP)	B2 (% CP)	B3 (% CP)	C (% CP)
			Green Blade		
June	25.40	10.58	11.40	44.88	7.74
July	32.68	13.85	22.44	25.71	5.31
August	29.12	16.18	23.97	28.24	2.50
Winter	29.06	13.54	19.27	32.94	5.18
September	25.15	14.68	14.63	39.83	5.71
October	26.32	12.60	14.68	38.23	8.17
November	35.86	11.19	14.61	30.85	7.49
Spring	29.11	12.82	14.64	36.30	7.12
December	31.58	13.39	9.57	38.76	6.69
January	27.68	7.97	27.68	29.41	7.26
February	41.19	7.47	18.95	25.08	7.01
Summer	33.48	9.61	18.73	31.08	6.99
CV (%)	18.56	22.47	37.38	23.18	26.28
			Stem		
June	35.03	4.05	23.07	18.21	19.65
July	39.11	1.26	24.52	22.24	12.86
August	41.10	3.06	26.34	12.38	17.13
Winter	38.41	2.79^{b}	24.64	17.61	16.55
September	38.65	6.27	25.22	22.11	7.74
October	43.73	5.79	20.01	22.76	7.71
November	44.77	5.88	22.72	13.27	13.35
Spring	42.38	5.98^{a}	22.65	19.38	9.60
December	50.46	6.25	9.47	17.04	16.78
January	26.51	5.10	29.08	26.36	12.95
February	22.15	4.01	39.62	21.25	12.98
Summer	33.04	5.12^{ab}	26.06	21.55	14.24
CV (%)	24.18	22.72	36.85	25.53	22.36
			Dead Material		
June	22.05	1.92	35.29	14.30	26.43
July	29.43	2.43	31.96	22.99	13.18
August	12.44	2.94	38.72	18.14	27.75
Winter	21.31	2.43	35.32	18.48	22.45
September	17.95	2.98	33.68	17.16	28.22
October	22.52	4.05	22.29	22.66	28.48
November	18.17	4.72	34.39	14.70	28.01
Spring	19.55	3.91	30.12	18.17	28.24
December	23.61	2.58	38.03	9.21	26.56
January	36.99	2.96	27.68	13.31	19.05
February	10.97	4.75	41.15	17.39	25.74
Summer	23.86	3.43	35.62	13.30	23.78
CV (%)	42.19	27.29	17.75	25.08	21.05

Averages followed by minor letters in the column are different ($p < 0.05$) by Tukey test.

Considering the intake habit of cattle to select the leaves, it is important that fractions A, B1, B2 and B3 represent the highest proportion in this fraction. In this sense, it was observed that the sum for the winter, spring and summer were 94.81, 92.87 and 92.90%, respectively.

In relation to the stem, the fraction of protein most important was A fraction, followed by B2 fraction, and the lowest values were found in B1 fraction. However, the season influenced ($p < 0.05$) content of B1 fraction, showing a higher proportion of this fraction on spring (5.98%), followed by summer (5.12%) and winter (2, 79%).

C fraction, was observed in highest concentration in dead material and stem comparing to green blade. Acording to Gonçalves et al. (2002), grasses of *Cynodon* species show lowest nutricional quality during winter, because the proportion of leaves at this time of year decreases drastically. In this study there was no differences between crude protein fractions among seasons of the year, probably because of the good climatic conditions in the period (Table 1).

B3 fraction, which is associated to the plant cell wall, with fraction B2, represents the highest part of digestible protein present in feeds that will reach the small intestine without being degraded in the rumen. The indigestible residue of B3 and C fraction, represent the majority of ingested proteins to be excreted in the feces (PEREIRA et al., 2000). Therefore, the lowest are these two fractions in the forage the highest will be CP digestibility. Contents of C fraction in the whole plant were 14.73, 14.98 and 15.01% for winter, spring and summer, seasons, respectively. These values are close to those observed by Ribeiro et al. (2001), in Tifton 85 grass (13.59 to 17.87%). The percentages of crude protein fractions in these three structural components studied remained homogeneous throughout the season but there was variation between months, which may have been influenced by climatic factors.

Conclusion

The chemical composition and crude protein fractions in the structural components of Coastcross grass (*Cynodon dactylon* (L.) Pers) under the conditions of this study showed small variation on the seasons. It is possible to conclude that Coastcross grass contains high concentrations of crude protein fractions of interest in greater proportion in the green blade and stem.

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