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Chemical Bromatological Evaluation of Biomass for Silage of the Winter Cereals

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Abstract: Winter cereals are cultivated in order to produce grain for food and feed, green forage and haylage for cattle. The objectives of this study are to assay the production and chemical characteristics bromatological of winter cereal forages. The factorial arrangement of treatments 5 × 2 (5 cultivars and two cutting heights—low 7-10 cm and 20 cm from the soil surface) harvested when the grain was at the dough stage. Genetic materials tested were rye BRS Serrano, wheat BRS Umbu and BRS Pastoreio, triticale BRS Saturno, barley BRS Aliensa and Brevis oats BRS Centauro. The experimental design was a randomized complete block design with four replications. The assay carried out to forage, BRS Centauro showed oat forage yield higher than the other genotypes. Barley BRS Aliensa stood out for DMD (dry matter digestibility) and CP (crude protein) for the two tested cutting heights. BRS Pastoreio wheat had lower NDF (neutral detergent fiber) concentration than BRS Serrano rye.

Key words: Cellular content, assay, physiologic, production, forage.

1. Introduction

The chemical constituents of the forage plants are divided into two parts: constituents of the cell wall and constituents of the cellular content. The cell wall is composed of structural carbohydrates, cellulose and hemicellulose and lignin, these correspond to the fraction called CF (crude fiber) of forage [1]. As for the bromatological evaluation of cellular components, it can be said that: The cell wall is separated into the NDF (neutral detergent fiber) and expressed to the digestible fiber (cellulose, hemicellulose and lignin); and in the qualitative component, ADF (acid detergent fiber) that is expressed as the indigestible fraction (cellulose and lignin) [1]. The nutritional value of the food is determined, when considered, the elements of the set: NDT (total digestible nutrient concentration) or LE (liquid energy) for different animal functions (maintenance, lactation or weight gain); the CP (crude protein) concentration, the concentrations of NDF and ADF and other mineral compounds, as well as DMD (dry matter digestibility) [2].

The objectives of this study were to assay the chemical characteristics of winter cereal fodder, being two kinds of wheat (BRS Pastoreio and BRS Umbu), a rye cultivar (BRS Serrano), a black oat (BRS Centauro), a triticale cultivar (BRS Saturn) and a barley cultivar (BRS Aliensa) at two 10 cm and 20 cm cutting heights.

2. Materialand Methods

The experiment was carried out at Embrapa Trigo, in Passo Fundo, State RS, Brazil. The genetic materials tested were BRS Serrano rye, BRS Umbu and BRS Pastoreio wheat, BRS Saturn triticale, BRS Aliensa barley and Brevis BRS Centauro oat. The factorial arrangement of 5 × 2 treatments (5 cultivars and 2 cutting heights—low 7-10 cm and 20 cm of the soil surface) harvested when the plants were in the grains stage in mass. The experimental design was a randomized complete block design, with four replications.

The cutting for ensiling was performed when the plants were in the grain stage in soft mass to firm

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mass. The oven dried samples were ground to 1 mm in Willey mill and conditioned for subsequent determinations. The laboratory evaluations were performed by the method of NIR (near infrared reflectance). The data were submitted to analysis of variance and the means were compared by the Tukey test at 5% level of significance.

3. Results and Discussion

In an experiment to verify the production and quality of oat fodder, considering the cut at different moments of the development stages, with cut realized in the phase of physiological maturity the dry matter production was up to 259% higher than the rubber phase and 43% more than in the pasty grain phase [3]. The authors also mention that other studies also report that the highest yield was reached between the flowering and milky phases, and then decreased in the stages from milky to pasty. Another explanation for the variation in DM content and forage yield found can be attributed to studies on FOS (oligofructosaccharides), being that maximum FOS content is reached at the beginning of the milky stage, and a marked reduction occurs during the later stage of grain filling [3]. This fact was observed, for other authorin barley, wheat and triticale. These authors recently suggested the need to reconsider recommendations for harvesting cereal crops when the goal is green feeding [4].

The experimental data for the two heights of tested plants are showen in Table 1. The variations found in for DM find justification, that in the *Poaceae*, the dynamics of fructans is regulated by the balance between biosynthesis and fructan degrading enzymes.

Table 1 Height of winter cereal plants, DM (dry matter) yield and DM for ensilable foddertwo yield (10 and 20 cm). Passso Fundo, State RS, Brazil.

Genotype	Yield (cm)	DM (%)
Barley BRS Aliensa	63e	21.4c
Barley BRS Aliensa: 10		22.74
Barley BRS Aliensa: 20		27.84
Triticale BRS Saturno	108c	38.24a
Triticale BRS Saturno: 10		40.18
Triticale BRS Saturno: 20		35.46
Oat BRS Centauro	129b	28.88b
Oat BRS Centauro: 10		28.35
Oat BRS Centauro: 20		26.89
Rye BRS Serrano	161a	37.14a
Rye BRS Serrano: 10		35.57
Rye BRS Serrano: 20		34.55
Wheat BRS Umbu	84de	41.18a
Wheat BRS Umbu: 10		40.81
Wheat BRS Umbu: 20		38.91
Wheat BRS Pastoreio	96cd	41.82a
Wheat BRS Pastoreio: 10		35.9
Wheat BRS Pastoreio: 20		35.78
Mean whole plant	106.83	34.20a
Meancut: 10 cm	106.83	34.59a
Meancut: 20 cm	106.83	33.25a
CV(%)	40.93	6.84

Means followed by the same letter in the column did not differ significantly by the Tukey test ($p > 0.05$). CV: Coefficient of Variation.

Table 2 CP content, DMD, NDF, ADF, and ensilable fodder of winter cereal genotypes at different heights of rest. Passo Fundo, State RS, Brazil 2015.

Genotype and heightcut (cm)	CP (%)		DMD (%)		NDF (%)		ADF (%)	
Barley BRS Aliensa: 20	10.77	a	64.88	a	61.44	bc	33.02	c
Barley BRS Aliensa: 10	10.03	ab	63.02	ab	62.24	bc	33.72	c
Oat BRS Centauro: 20	8.43	abc	60.66	abc	59.52	bc	38.71	c
Triticale BRS Saturno: 10	8.34	abcd	61.27	abc	61.11	bc	37.86	c
Rye BRS Serrano: 20	7.81	bcd	57.89	cd	65.07	ab	44.48	ab
Triticale BRS Saturno: 20	7.58	bcd	62.45	ab	62.69	abc	37.91	c
Wheat BRS Pastoreio:20	6.79	cd	62.53	ab	58.56	c	38.69	c
Oat BRS Centauro:10	6.55	cd	59.04	bc	62.46	bc	39.02	bc
Wheat BRS Umbu: 20	6.09	cd	60.39	bc	60.65	bc	37.00	c
Wheat BRS Umbu: 10	6.05	cd	59.89	bc	61.87	bc	37.04	c
Wheat BRS Pastoreio: 10	5.99	cd	60.98	abc	58.10	c	38.71	c
Rye BRS Serrano: 10	5.83	d	54.19	d	68.44	a	46.08	a
Mean: 10 cm	6.12 a		59.72 a		62.37a		38.73a	
Mean: 20 cm	7.91 a		61.46 a		61.32a		38.30a	
Means	7.51		60.59		61.79		38.52	
CV(%)	14.31		5.16		9.32		3.48	

Means followed by the same letter in the column did not differ significantly by the Tukey test ($p > 0.05$)
CV: Coefficient of Variation.

Before anthesis, the relative levels of hexoses and sucrose (WSC, minus fructans) account for about 80% and 75% of the water-soluble carbohydrates present in the stem, peduncle and penultimate training [5]. With its increased production of DM and digestible DM [6], inherent soil factors should not be disregarded, such as texture, density, depth, compaction, as well as their chemical attributes of fertility, the latter, with respect to the availability of nutrients for the development of winter cereals. The chemical bromatological data were translated in Tables 2 and 3.

Barley presented the highest CP and DMD contents, in the remaining 20 cm, as well as the remaining 10 cm. And the lowest value of ADF is 33.02 in cut height of 20 cm, but differing from rye, more fibrous. This can be explained by the precocity of barley and stage at harvest time. Among the studied heights the results of CP are in line with those found [7]. The relationships between the CP content of the cultures and the maturity stage demonstrate that, at advanced maturity, the CP content of the culture decreases at a slower rate. Existing tendency, stabilizeS, before harvest. In the phase of emission of the flag leaf (rubber) triticale and barley have a higher concentration of CP than oats. With the advancement of maturity, the concentration of CP in triticale, barley and oats decreases more rapidly than in other species. At the time of harvest, there are no differences, among grains, in the CP concentration. As the culture matures, leaves and stems become more fibrous; however, in the later stages of maturity, this is compensated by the increase of the starch content in the grain filling [7].

The values found for the wheat BRS Umbu, and those of the wheat BRS Pastoreio, correspond to the soft mass phase the firm mass. In the rye, the values were from ADF = 46.08 in the remaining 10 cm (the highest observed among the six materials), NDF = 68.44; PB = 5.83% and DMD around 54% (the lowest among species), corresponding to the stage of firm mass to hard grain. The values found for oats corresponded to the soft mass stage and the tables for the triticale corresponded to stage the firm mass.

Emphasizing the NDF data found and tabulated (Tables 2 and 3), for the rest heights studied, these

Table 3 CP content, DMD, NDF, ADF, in the ensilable fodder of winter cereal genotypes at different heights of rest. Passo Fundo, State RS, Brazil 2016.

Genotype andcut height (cm)	CP %		DMD (%)		NDF (%)		ADF (%)	
Barley BRS Marciana: 20	6.77	b	60.87	a	61.67	b	35.80	b
Barley BRSMarciana: 10	6.57	b	60.42	a	62.12	b	36.45	b
Oat BRS Centauro: 20	9.10	ab	59.87	a	59.45	b	37.23	b
Triticale BRS Saturno: 10	6.81	b	60.68	a	62.98	ab	36.42	b
Rye BRS Serrano: 20	8.87	ab	59.13	ab	63.11	ab	38.19	ab
Triticale BRS Saturno: 20	6.75	b	60.44	a	63.29	ab	37.56	b
Wheat BRS Pastoreio: 20	8.60	ab	59.30	ab	60.33	b	38.04	ab
Oat BRS Centauro:10	7.95	ab	58.53	ab	61.21	b	38.97	ab
Wheat BRS Umbu: 20	7.20	ab	59.73	a	61.07	b	37.50	b
Wheat BRS Umbu: 10	6.67	b	58.76	ab	62.34	ab	38.56	ab
Wheat BRS Pastoreio: 10	9.62	a	60.27	a	60.17	b	36.74	b
Rye BRS Serrano: 10	6.80	b	55.40	b	66.94	a	43.09	a
Mean: 10 cm	7.40a		59.01a		62.62a		38.37a	
Mean: 20 cm	7.88a		59.89a		61.48a		37.38a	
Means	7.64		59.45		62.05		37.88	
CV(%)	15.54		3.98		7.41		3.16	

Means followed by the same letter in the column did not differ significantly by the Tukey test ($p > 0.05$).
CV: Coefficient of Variation.

were not different from other studies. In research work for the harvest, there are no differences in the concentrations of NDF. For cereals, the concentration of NDF increases, as the plant progresses through the elongation phase, stabilizes, and then decreases with grain filling [7]. In relation to the levels of ADF, the best are observed for BRS Aliensa barley, not differing from wheat (BRS Pastoreio and BRS Umbu). Although the winter cereals studied did not present statistical differences. Authors report that in the harvest, oats have the highest concentration of ADF, with no differences between the other winter cereals, which can be observed in the two years of study.

4. Conclusions

There is no difference between the genotypes for digestibility, but the barley BRS Aliensa is distinguished for CP content at the two cutting heights tested, together with oats 20 cm and triticale 10 cm. Wheat BRS Grazing has lower NDF content than rye BRS Serrano. The rye BRS Serrano has the highest forage content of ADF.

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