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PASTURE AND FORAGE UTILIZATION

Nutritional composition of pre-dried silage of different winter cereals

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ABSTRACT. This study aimed to assess the chemical composition of the forage and pre-dried silage from twelve winter cereals harvested at pre-flowering. We used black oat (*Avena strigosa*) cv. EMB 139 and cv. IAPAR 61; white oat (*Avena sativa*) cv. IPR and 126 hp. URS Taura; barley (*Hordeum vulgare*) cv. BRS Brau and cv. BRS Cauê; wheat (*Triticum aestivum*) cv. BRS Umbu and cv. BRS Tarumã; rye (*Secale cereale*) cv. Temprano and cv. BRS Serrano; and triticale (*X. Triticosecale*) cv. IPR and 111 hp. BRS Saturno. Plants were harvested at pre-flowering, when they were pre-dried and ensiled. The analysis of variance evidenced nutritional differences between species and cultivars. Triticale cv. IPR 111 showed notorious chemical characteristics in relation to the other treatments, highest protein content (113.7 g kg^{-1}) and lower content of NDF and ADF (657.9 and 380.9 g kg^{-1}, respectively). Among the pre-dried silages, barley cv. BRS Cauê had the highest level of NDT (614.7 g kg^{-1}). Triticale cv. IPR 111 was shown as a high-quality nutritional food as forage and kept these characteristics after conservation. On the other hand, the pre-dried silage of barley cv. BRS Cauê showed the highest potential for nutrient degradability.

Keywords: bromatological composition; crude protein; vegetative stage; wilted silage.

Composição nutricional da silagem pré-secada de diferentes cereais de inverno

RESUMO. Esse estudo objetivou avaliar a composição bromatológica da forragem e da silagem pré-secada de doze cereais de inverno colhidos em estádio de pré-florescimento. Utilizou-se aveia preta (*Avena strigosa*) cv. EMB 139 e cv. IAPAR 61, aveia branca (*Avena sativa*) cv. IPR 126 e cv. URS Taura, cevada (*Hordeum vulgare*) cv. BRS Brau e cv. BRS Cauê, trigo (*Triticum aestivum*) cv. BRS Umbu e cv. BRS Tarumã, centeio (*Secale cereale*) cv. Temprano e cv. BRS Serrano e triticale (*X Triticosecale*) cv. IPR 111 e cv. BRS Saturno. A colheita ocorreu quando as plantas atingiram estádio de pré-florescimento, onde foram pré-murchadas e ensiladas. O triticale cv. IPR 111 apresentou características químicas notórias em relação aos demais tratamentos, tendo o maior teor de proteína bruta (113,7 g kg^{-1}) e os menores teores de FDN e FDA (657,9 e 380,9 g kg^{-1}, respectivamente). Dentre as silagens pré-secadas a cevada cv. BRS Cauê apresentou a maior concentração de NDT (614,7 g kg^{-1}). O triticale cv. IPR 111 se mostrou como um alimento de alta qualidade nutricional enquanto forragem, e manteve essas características após conservação. Já a silagem pré-secada da cevada cv. BRS Cauê apresentou o maior potencial de degradabilidade de nutrientes.

Palavras-chave: composição bromatológica; proteína bruta; estádio vegetativo; silagem emurchecida.

Introduction

Southern Brazil is a region to an intensive livestock system due to the high productive potential and the excellent growing conditions for several forage species throughout the year (Oliveira, Almeida, Lanes, Lopes, & Carmo, 2010). In a special way, Guarapuava, State of Paraná has ideal climatic conditions for the cultivation of several winter cereals, each with different nutritional characteristics.

In a timely manner, a professional production system requires the use of alternative forage throughout the year. Regarding the production of these foods, all forages are potentially preservable and keep nutrients, with more or less protein, soluble carbohydrates and digestible fiber.

Among the food that can be preserved, corn is the most used (Bernardes & Rêgo, 2014) as it is highly energetic. In contrast, the winter cereals tend to have a high protein content, mainly in the vegetative stage (Fontaneli et al., 2009), and highly digestible fiber. Therefore, one does not replace the other, but rather, each has a distinct function within each diet. It should be noted that winter cereals at pre-flowering stage contain crude protein content higher than in other stages, but have little energy, and when advancing to the dough stage, they suffer alterations that reduce the fiber nutritional quality, but gain energy by the deposition of starch in the grains (Floss, Palhano, Soares Filho, & Premazzi, 2007).

In Brazil, the use of pre-dried silage of temperate forages is still considered as an alternative to providing quality forage in periods of pasture shortage (Zamarchi, Pavinato, Menezes, & Martin, 2014). However, in Europe, the winter cereals have shifted from the status of strategic forage crops during food shortage periods to a status of basal forage crop of diets, constituting a real strategy in forage planning (Debaeke & Bertrand, 2008). However, the quality of the forage produced by winter cereals depends on several factors such as the variability among species, genotypes of the same species and its adaptability to different soil and climatic conditions (Meinerz et al., 2011a), although requiring greater information on various factors involved in the production of these materials.

The objective of this study was to evaluate the chemical composition of forage and pre-dried silage of twelve winter cereals harvested at the pre-flowering stage.

Material and methods

The experiment was conducted in Guarapuava, State of Paraná, Brazil, situated in the subtropical zone, at the geographical coordinates 25º23'02" South latitude and 51º29'43" West longitude and 1,026 m altitude. The region weather according to Köppen classification is Cfb (mesothermal humid subtropical), with mild summers and mild winter, no dry season and severe frosts (Köppen, 1900). The annual rainfall average is 1,944 mm, annual minimum average temperature is 12.7°C, annual maximum average temperature is 23.5°C and air relative humidity is 77.9%.

The soil of the experimental area was classified as Typical Bruno Latosol (Pott, Müller, & Bertelli, 2007), and before the crop implementation presented the following chemical characteristics (profile 0-20 cm): pH $CaCl_2$ 0,01M: 4.7; P: 1.1 mg dm^{-3}; K^+: 0.2 cmolc dm^{-3}; OM: 2.62 g dm^{-3}; Al^{3+}: 0.0 cmolc dm^{-3}; $H^+ + Al^{3+}$: 5.2 cmolc dm^{-3}; Ca^{2+}: 5.0 cmolc dm^{-3}; Mg^{2+}: 5.0 cmolc dm^{-3} and base saturation (V%): 67.3%.

Winter cereals were planted according to the agricultural zoning of the Guarapuava region in no-till system. Sowing was carried out at 0.17 meters spacing, 2 cm depth, and 300 seeds m-2 seeding rate. The experimental area consisted of 570 m^2, distributed in 48 plots of 9 m^2 each (4.00m x 2.25m). Each plot represented an experimental unit (replication). The experimental design was a randomized block, consisting of twelve treatments and four replications. As experimental material, we used black oat (*Avena strigosa*) cv. EMB 139 and cv. IAPAR 61; white oat (*Avena sativa*) cv. IPR 126 and cv. URS Taura; barley (*Hordeum vulgare*) cv. BRS Brau and cv. BRS Cauê; wheat (*Triticum aestivum*) cv. BRS Umbu and cv. BRS Tarumã; rye (*Secale cereale*) cv. Temprano and cv. BRS Serrano; and triticale (*X Triticosecale*) cv. IPR 111 and cv. BRS Saturno.

At sowing, basal fertilization was realized with 400 kg ha^{-1} N-P_2O_5-K_2O formulated fertilizer (04-20-20), respecting the recommendations of soil fertility of Santa Catarina and Rio Grande do Sul (Comissão de Química e Fertilidade do Solo RS/SC [CQFS RS/SC], 2004). Nitrogen topdressing was split in two applications: the first, 30 days after planting with 140 kg ha^{-1} urea (46-00-00), and the second application, 30 days after the first, with 250 kg ha^{-1} urea (46-00-00), totaling 191.5 kg ha^{-1} nitrogen. The weeds were chemically controlled with the use of glyphosate based herbicide (commercial product Roundup WG®: 3.0 kg ha^{-1}) in desiccation of the experimental area 15 days before sowing and crop management, 30 days after planting with application of the metsulfuron-metyl based herbicide (commercial product Ally®: 6.6 g ha^{-1}). For preventive control of crown rust sheet (*Puccinia triticina*) was used epoxiconazole + pyraclostrobin (commercial product Opera®: 1 L ha^{-1}) based fungicide at the onset of symptoms, while 10 to 20% of the total leaves present attack symptoms.

The collection of materials was performed when the plants reached the pre-flowering stage, close to stage 10 of the scale Feeks & Large (Large, 1954), characterized by the end of stem elongation, when the sheath of the flag leaf is completely developed, but the spikes are still not visible. After harvesting, the material was pre-wilted in the field to achieve ideal contents of dry matter for ensiling. For ensilage of the cut and pre-dried material, we used laboratory silos made of PVC tubes, 40 cm high and 10 cm diameter. The material was pressed manually inside the silos with a wooden socket aiming to set a specific average density of 650 kg FM m^{-3}. After filling, the silos were sealed with double face canvas and adhesive tape, identified, weighed and stored in the shade, under controlled laboratory conditions.

Both after cutting the forage and after opening the silos, samples of 0.50 kg each material were sent immediately to the laboratory for determination of dry matter contents, where the material was oven dried at 55°C to constant weight. Subsequently, the pre-dried samples of the original material were ground in a Wiley mill with a 1 mm sieve.

In pre-dried samples, we determined crude protein (CP) by micro Kjeldahl method and mineral matter (MM) by means of incineration at 550°C, for 4 hours. The contents of neutral detergent fiber (NDF) and acid detergent fiber (ADF) were also determined. All analyses followed Silva and Queiroz (2002) determinations. The total digestible nutrients (TDN, g kg^{-1}) were obtained by the equation:

$$\mathrm{TDN} = 87.84 - (0.70 \text{ x } \mathrm{ADF});$$

while the relative value of the food was estimated by the equation:

$$\mathrm{RVF} = \frac{\mathrm{TDN \text{ x } DMCLW}}{1.29},$$

both suggested by Bolsen, Ashbell, and Weinberg (1996). The net energy of lactation was measured using the equation:

$$N\mathrm{El} = (0.0245\mathrm{xTDN}) - 0.12,$$

as Moe, Flatt, and Tyrell (1972). The dry matter intake in percentage of body weight was estimated via equation:

$$\mathrm{DMILW} = \frac{120}{\mathrm{NDF}}.$$

Data were subjected to the Shapiro-Wilk and Bartlett tests to check the assumptions of normality and homogeneity of variances, respectively. Once these assumptions were met, we applied the F-test, through Analysis of Variance (ANOVA) followed by the Tukey's test for multiple means comparison at 5% significance through the Statistical Analysis System (SAS, 1993).

Results and discussion

Temperate forage species are characterized by their good levels crude protein, particularly at the pre-flowering stage (Fontaneli et al., 2009). Also, other authors claim that at this cutting stage, the NDF and ADF fractions tend to be reduced compared to later cutting stages (Floss et al., 2007). However, beyond the maturity stage, other factors may interfere with the chemical composition of the forage, such as the species, the number of tillers per plant and the age (Queiroz, Gomide, & Maria, 2000).

By observing the data in table 1, it is observed that triticale cv. IPR 111 showed satisfactory chemical characteristics in relation to the other treatments, with the highest crude protein content (113.7 g kg^{-1}), and the lowest content of NDF and ADF (657.9 and 380.9 g kg^{-1}, respectively), but not different from some treatments in the table. Although not presented in this study, it should be reported that this cultivar had the earliest cycle (88 days) and the lowest tillering among the evaluated winter cereals, which may have interfered with this these results. As supported by Paciullo et al. (2007), the advancement of age and the greater number of tillers result in an increase in cell wall components and a decrease in crude protein content. Reinforcing such hypothesis, Ferolla et al. (2008) state that this variation in the constitution of nitrogen compounds and carbohydrates occurs due to the growth of the cell wall in order to provide structural stability.

In contrast, black oat cv. IAPAR 61 and rye cv. Temprano showed the lowest content of crude protein (80.6 and 84.8 g kg^{-1}, respectively), and not coincidentally, these cereals reached the pre-flowering stage later (133 days). With the plant elongation, even at the pre-flowering stage, there is a decrease in crude protein, as well as fiber quality. Also in Table 1, rye cv. Temprano obtained the lowest content of hemicellulose, the most degradable fraction of fiber carbohydrates (256.6 g kg^{-1}). The rye cv. Temprano is characterized by its large size at the pre-flowering stage, with predominance of stem in relation to the leaves; in which the first fraction is poor in hemicellulose, which justifies such finding.

In relation to mineral matter, wheat cv. BRS Umbu stood out negatively from the other treatments, with 43.1 g kg^{-1} in its constitution. The black oat cv. EMB 139 showed 58.7 g kg^{-1} mineral matter, however, this same cultivar together with the triticale cv. BRS Saturno presented the highest NDF contents (740.9 and 742.2 g kg^{-1}, respectively).

It is known that the NDF of any forage has a direct relationship with the intake, where, the lower the NDF content of the forage, the greater the intake capacity of the animal; therefore, triticale cv. IPR 111, which showed the lowest NDF content (Table 1), is the forage with greater intake potential (1.82% body weight) and with one of the highest content of NDT in its constitution (611.8 g kg^{-1}). In addition, the sum of these two characteristics provided to the forage the highest relative value of the food, besides a high caloric density (1.063 Mcal kg $milk^{-1}$), however, for all variables, white oat cv. URS Taura was statistically similar.

Table 1. Average contents of dry matter (DM), crude protein (CP), mineral matter (MM), organic matter (OM), neutral detergent fiber (NDF), acid detergent fiber (ADF) and hemicellulose (HEM) of forage of different winter cereals harvested in the pre-flowering stage

Species – Grow Crops	DM	CP	MM	OM	NDF	ADF	HEM
	g kg^{-1} DM						
Black Oat – EMB 139	211.9^{cdef}	92.8^{ab}	58.7^{a}	941.3^{d}	740.9^{a}	468.2^{a}	272.7^{bc}
Black Oat – IAPAR 61	234.6^{bcd}	80.6^{b}	57.3^{ab}	942.7^{cd}	720.9^{ab}	459.0^{ab}	261.9^{c}
White Oat – IPR 126	243.4^{bcde}	88.5^{ab}	55.7^{abc}	944.3^{bcd}	709.7^{abc}	448.9^{abc}	260.8^{c}
White Oat – URS Taura	185.1^{f}	99.6^{ab}	56.2^{abc}	943.8^{bcd}	668.5^{cd}	386.9^{e}	281.6^{bc}
Barley – BRS Brau	247.8^{bc}	88.7^{ab}	46.6^{bcd}	953.4^{abc}	705.6^{abc}	392.0^{de}	313.6^{a}
Barley – BRS Cauê	252.8^{b}	86.5^{ab}	50.5^{abcd}	949.5^{abcd}	686.5^{bcd}	388.0^{e}	298.5^{ab}
Wheat – BRS Umbu	267.8^{ab}	94.6^{ab}	43.1^{d}	956.9^{a}	700.6^{abc}	414.2^{cde}	286.4^{bc}
Wheat – BRS Tarumã	252.1^{b}	93.6^{ab}	45.0^{cd}	955.0^{ab}	702.2^{abc}	400.4^{de}	301.8^{ab}
Rye - Temprano	323.8^{a}	84.8^{b}	47.2^{abcd}	952.8^{abcd}	695.7^{bcd}	439.0^{abc}	256.7^{d}
Rye – BRS Serrano	207.8^{def}	102.7^{ab}	54.4^{abcd}	945.6^{abcd}	703.1^{abc}	429.6^{bcd}	273.5^{bc}
Triticale – IPR 111	194.3^{ef}	113.7^{a}	52.2^{abcd}	947.8^{abcd}	657.9^{d}	380.9^{e}	277.0^{bc}
Triticale – BRS Saturno	186.8^{f}	102.7^{ab}	56.1^{abc}	943.9^{bcd}	742.2^{a}	443.5^{abc}	298.7^{ab}
Average	234.0	93.8	51.9	948.1	702.7	420.8	281.9
P > F	0.0001	0.0359	0.0003	0.0001	0.0001	<0.0001	<0.0001
CV, %	6.90	12.36	9.09	8.89	2.38	3.62	5.21
SEM	4.6985	1.3469	0.2227	0.2011	2.8143	2.3250	2.0615

Means, followed by different lowercase letters in the column, differ from each other by the Tukey test at 5%.

Lopes, Silva, Lanes, Duque, and Ramos (2008) evaluated the chemical composition of triticale at different cutting ages and concluded that the material has nutritional superiority in the range of 83 to 90 days, similar to the cutting age of the present study for this treatment. As observed here, the available literature shows a trend in results regarding bromatological composition, however, these values are inconstant (Coan, Freitas, Reis, & Rodrigues, 2001; Meinerz et al., 2011a), proving that pasture management directly influence final quality of the material available for animals.

All the cultivars reached TDN content higher than the minimum of 550 g kg^{-1} as recommended by National Research Council (NRC, 2001) as necessary for ruminants. In general, TDN values for all evaluated winter grains were very similar to those found in NRC (2001). The values of net energy of lactation for both forage and pre-dried silage can be classified as optimal (Costa et al., 2005).

Values of the chemical composition of pre-dried silages are listed in table 3. It is observed that one of the treatments that stood out in relation to the crude protein content was triticale cv. IPR 111 (105.5 g kg^{-1}). These values of the chemical composition of the pre-dried silages can be considered as intermediate, being higher than that reported by Kara, Ayhan, Akman, and Adiyaman (2009) (83 g kg^{-1}), but lower than the 114 g kg^{-1} found by Oliveira et al. (2010). Another interesting treatment was white oat cv. URS Taura, which presented crude protein content higher than black oat cv. IAPAR 61, for example. Nevertheless, David et al. (2010) reported crude protein content of 62 g kg^{-1} for white oats and 82 g kg^{-1} for black oats, with significant difference. These results point out the divergent potential between the species, but mainly between cultivars of the same species, being indispensable studies about these, specific for each region.

The black oat cv. IAPAR 61 showed only 74.1 g kg^{-1} crude protein in its composition, but this value is similar to that described by David et al. (2010), 79.0 g kg^{-1}. However, when the silage fermentation process is taken into account, this low content of crude protein reduces the buffering capacity of the ensiled material, providing a quick pH drop and stabilizing the ensiled masses faster (Cherney & Cherney, 2003).

Regardless of the treatment, all presented lower crude protein content than those found in the NRC (2001). However, in general, the values obtained for NDF and ADF were higher than those reported by Meinerz et al. (2011b) and Lehmen, Fontaneli, Fontaneli, and Santos (2014). Only the two cultivars of barley and triticale cv. IPR 111 presented content of ADF within the recommended range, so that, there is no restriction to forage intake. According to Meinerz et al. (2011a), forages with ADF values higher than 400 g kg^{-1} lead to reduction in intake, besides presenting low digestibility. The low content of ADF found in both barley cultivars had already been reported by Huuskonen (2013), who observed the low amount of lignified material and the high potential of digestion of this material. The pre-dried silage of triticale cv. BRS Saturno presented higher NDF content in comparison to the other evaluated materials. This characteristic is very concise in the literature, which is also one of the factors that give this forage a great rusticity and greater resistance to foliar diseases (McGoverin et al., 2011). In contrast, barley cv. BRS Cauê presented the lowest NDF content, and it is a cultivar highly susceptible to fungal attack.

Regarding the bromatological values of pre-dried silage, it can be seen, that barley cv. BRS Brau, wheat cv. BRS Tarumã and Triticale BRS Saturno maintained the highest values of hemicellulose fraction, which were of 319.4, 305.2 and 298.9 g kg^{-1}, respectively, as previously observed also for green-forage.

Pre-drying provides direct effects on forage carbohydrate content, varying particularly with initial moisture content (Horst et al., 2017). When assessing the silage fiber composition of different winter cereals, Meinerz et al. (2011b) they reported higher values of hemicellulose (348 g kg^{-1}). It is suggested that such variations are results from losses caused by leaching and volatilization during pre-drying in the field, concentrating the less volatile fractions. Coan et al. (2001) also evaluating green forage and pre-dried forage, described similar results for fiber composition, and emphasize that pre-drying increases hemicellulose. As previously mentioned, hemicellulose is the constituent of NDF that has the highest digestion potential (Silveira et al., 2009). Further, this component has an important role in the fermentation process, since solubilization during the process would increase the level of soluble carbohydrates (Rooke & Hatfield, 2003), which would allow silage with high nutritional value for a longer time.

Barley cv. BRS Brau presents lowest mineral content (42.1 g kg^{-1}); while triticale cv. IPR 111 obtained the highest value (66.4 g kg^{-1}). Schmidt, Novinski, Junges, Almeida, and Souza (2015) elucidated the tendency of higher mineral matter content in the silage than in the forage, because the losses of organic matter during the fermentation process result in concentration of this fraction. This was very evident in the pre-dried silage of triticale cv. IPR 111, which had an increase of 27% in the mineral matter in relation to the forage contents (52.2 g kg^{-1} against 66.4 g kg^{-1}).

In Table 4, it can be observed that the total digestible nutrient concentrations of all treatments presented values very close to those recommended by NRC (2001) and those reported by David et al. (2010), at the pre-flowering stage, ranging from 525 to 555 g kg^{-1}. Contrary to that observed in table 2 in relation to forage, where triticale cv. IPR 111 and white oat URS Taura showed the best results for all variables, among the pre-dried silages (Table 4), higher values were found for barley cv. BRS Cauê, with the highest content of NDT (614.7 g kg^{-1}), the highest animal intake potential (1.83% body weight), which resulted in the highest relative value of the food (86.98), being a good comparative indicative for forage foods. Finally, the highest net energy of lactation was also assigned to barley cv. BRS Cauê, with 1.89 Mcal kg $milk^{-1}$, showing that the fermentative process can cause changes in any food. Such treatment was statistically similar to triticale cv. IPR 111 as well.

Table 2. Total digestible nutrient values (TDN), estimated dry matter intake as a percentage of live weight (DMILW), relative value of food (RVF), and net lactation energy (NEl) of forage of different winter cereals harvested in a pre-flowering stage.

Species – Grow Crops	TDN	DMILW	RVF	NEl
	g kg^{-1}	%	Index	Mcal kg DM^{-1}
Black Oat – EMB 139	55.07^{e}	1.62^{d}	69.18^{g}	0.551^{e}
Black Oat – IAPAR 61	55.71^{de}	1.67^{cd}	71.98^{efg}	0.605^{de}
White Oat – IPR 126	56.42^{cde}	1.69^{bcd}	74.08^{defg}	0.664^{cde}
White Oat – URS Taura	60.76^{a}	1.80^{ab}	84.58^{ab}	1.029^{a}
Barley – BRS Brau	60.40^{ab}	1.70^{bcd}	79.68^{abcd}	0.998^{ab}
Barley – BRS Cauê	60.68^{a}	1.75^{abc}	82.38^{abc}	1.022^{a}
Wheat – BRS Umbu	58.85^{abc}	1.71^{bcd}	78.23^{bcdef}	0.869^{abc}
Wheat – BRS Tarumã	59.81^{ab}	1.71^{bcd}	79.23^{abcde}	0.949^{ab}
Rye - Temprano	57.11^{cde}	1.73^{abc}	76.38^{cdefg}	0.722^{cde}
Rye – BRS Serrano	57.77^{bcd}	1.71^{bcd}	76.48^{cdefg}	0.778^{bcd}
Triticale – IPR 111	61.18^{a}	1.82^{a}	86.53^{a}	1.063^{a}
Triticale – BRS Saturno	56.80^{cde}	1.62^{d}	71.20^{fg}	0.696^{cde}
Average	58.37	1.70	77.48	0.82
P > F	<0.0001	<0.0001	<0.0001	<0.0001
CV, %	1.83	2.42	3.99	10.83
SEM	1.1421	0.1700	9.6080	0.8090

Means, followed by different lowercase letters in the column, differ from each other by the Tukey test at 5%.

Table 3. Mean dry matter (DM), crude protein (CP), mineral matter (MM), organic matter (OM), neutral detergent fiber (NDF), acid detergent fiber (ADF) and hemicellulose (HEM), of pre-dried silage of different winter cereals harvested in the pre-flowering stage.

Species – Grow Crops	DM	CP	MM	OM	NDF	ADF	HEM
				g kg^{-1} DM			
Black Oat – EMB 139	512.0^{e}	91.8^{ab}	53.6^{bcd}	946.4^{abc}	716.9^{ab}	479.9^{a}	237.0^{d}
Black Oat – IAPAR 61	625.2^{de}	74.1^{b}	48.9^{bcd}	951.1^{abc}	712.6^{ab}	461.3^{abc}	251.3^{c}
White Oat – IPR 126	613.4^{de}	82.9^{ab}	49.1^{bcd}	950.9^{abc}	720.3^{ab}	472.2^{ab}	248.1^{c}
White Oat – URS Taura	538.1^{e}	101.0^{a}	54.1^{abcd}	945.9^{abcd}	696.2^{bc}	420.5^{cd}	275.7^{b}
Barley – BRS Brau	725.1^{bc}	82.6^{ab}	42.1^{d}	957.9^{a}	715.0^{ab}	395.6^{ed}	319.4^{a}
Barley – BRS Cauê	630.0^{de}	85.4^{ab}	47.8^{bcd}	952.2^{abc}	658.5^{c}	376.7^{e}	281.8^{b}
Wheat – BRS Umbu	715.8^{bcd}	92.8^{ab}	43.0^{cd}	957.0^{ab}	719.8^{ab}	423.2^{cd}	296.6^{ab}
Wheat – BRS Tarumã	700.2^{cd}	93.0^{ab}	46.1^{bcd}	953.9^{abc}	740.1^{ab}	434.9^{bcd}	305.2^{ab}
Rye - Temprano	729.3^{bc}	90.9^{ab}	51.9^{bcd}	948.1^{abc}	739.3^{ab}	459.5^{abc}	279.8^{b}
Rye – BRS Serrano	530.3^{e}	91.4^{ab}	54.6^{abc}	945.4^{bcd}	719.9^{ab}	469.8^{ab}	250.1^{c}
Triticale – IPR 111	605.7^{de}	105.5^{a}	66.4^{a}	933.6^{d}	660.8^{c}	399.1^{ed}	261.7^{bc}
Triticale – BRS Saturno	765.0^{a}	96.9^{ab}	55.7^{ab}	944.3^{cd}	757.6^{a}	458.7^{abc}	298.9^{ab}
Average	641.4	90.6	51.1	948.9	713.0	437.5	275.5
P > F	<0.0001	0.0330	<0.0001	<0,0001	<0.0001	<0.0001	<0.0001
CV, %	7.07	11.34	9.67	8.12	2.88	3.87	3.42
SEM	4.9544	1.0584	0.2446	0.2289	4.2250	2.8757	0.9345

Means, followed by lowercase letter, in the column differ by the Tukey test at 5%.

However, as observed in forages, the pre-dried silage with the lowest concentration of total digestible nutrients was black oat cv. EMB 139, with 550.7 g kg^{-1} as forage (Table 2) and with 542.5 g kg^{-1} as pre-dried silage. Comparing the different winter cereals as forage and after conservation, it is possible to observe that some materials are more capable to maintain their nutritional characteristics, through low losses (Pedroso et al., 2008).

Table 4. Total of digestible nutrient values (TDN), estimated of dry matter intake as a percentage of live weight (DMILW), relative value of food (RVF), and net lactation energy (NEl) of the pre-dried silage of the different winter cereals harvested at pre-flowering stage.

Species – Grow Crops	TDN	DMILW	RVF	NEl
	g kg^{-1}	%	Index	Mcal kg MS^{-1}
Black Oat – EMB 139	542.5 ^{e}	1.68 ^{bc}	70.43 ^{cd}	0.782 ^{e}
Black Oat – IAPAR 61	555.5 ^{cde}	1.68 ^{bc}	72.55 ^{cd}	0.591 ^{cde}
White Oat – IPR 126	547.9 ^{de}	1.67 ^{bc}	70.78 ^{cd}	0.527 ^{de}
White Oat – URS Taura	584.1 ^{bc}	1.73 ^{ab}	78.10 ^{bc}	0.832 ^{bc}
Barley – BRS Brau	601.5 ^{ab}	1.68 ^{bc}	78.45 ^{abc}	0.978 ^{ab}
Barley – BRS Cauê	614.7 ^{a}	1.83 ^{a}	86.98 ^{a}	1.089 ^{a}
Wheat – BRS Umbu	582.2 ^{bc}	1.67 ^{bc}	75.25 ^{cd}	0.815 ^{bc}
Wheat – BRS Tarumã	574.0 ^{bcd}	1.62 ^{bc}	72.15 ^{cd}	0.746 ^{bcd}
Rye – Temprano	556.8 ^{cde}	1.63 ^{bc}	70.23 ^{cd}	0.602 ^{cde}
Rye – BRS Serrano	549.6 ^{de}	1.67 ^{bc}	71.03 ^{cd}	0.542 ^{de}
Triticale – IPR 111	599.1 ^{ab}	1.82 ^{a}	84.40 ^{ab}	0.957 ^{ab}
Triticale – BRS Saturno	557.3 ^{bcd}	1.58 ^{c}	68.63 ^{d}	0.606 ^{cde}
Average	572.0	1.68	74.91	0.73
P > F	<0.0001	<0.0001	<0.0001	<0.0001
CV, %	2.07	2.91	4.71	13.66
SEM	1.4104	0.2442	12.4623	0.9930

Means, followed by different lowercase letters in the column, differ from each other by the Tukey test at 5%.

Conclusion

The white oat cv. URS Taura, barley cv. BRS Cauê and the triticale cv. IPR 111 were shown to be high quality nutritional foods as forage, but barley and triticale were able to better maintain these characteristics after conservation. The pre-dried silage of barley cv. BRS Cauê presented the highest nutrient degradability potential.

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